Department of Microbiology

The Department of Microbiology, Gujarat Vidtapeeth, Sadra was established in the year 1995. It is about 50 Kms from Ahmedabad and 25 KM away from Gandhinagar. The department offers B.Sc and M.Sc degree in microbiology. The department also has facilities for M.Phil and Ph.d degree in microbiology. Till date 02 students have obtained Ph.d, 26 students have obtained M.Phil and more than 190 students have obtained their M.Sc degree from the department. The department is also working since 1993 in research and extension activity of Biogas technology.

Courses Offered

Name of the Course	B.Sc.	M.Sc.	M.Phil.	Ph.D.
Seats	46	46	20	02
Eligibility	12^{th} Science with Biology	B.Sc in Microbiology	M.Sc in Microbiology	M.Sc /M.Phil in Microbiology
Duration	3 Yrs	2 Yrs	1 Yrs	As per UGC rules
Course Starting	June	June	June	June/October
Admission Process	Written Examination	Competetive Examination	Competetive Examination	Competetive Examination

Infrastructure and Facilities

The department has separate laboratory facilities for M.Sc, M.Phil and Ph.d students. Department library is equipped with more than 3379 books and 28 journals along with additional books in the central library of the university. For effective teaching department is also having various audio visual teaching facilities. The above mentioned courses are residential in our institute, so separate hostel for boys and girls are available at the campus. Playground and internet facility are also available. Separate laboratory for Bioinformatics is also planned to establish.

List of various equipment available in the department

Sr. No	Equipment
1	High Performance Liquid Chromatography (HPLC)
2	Polymerase Chain Reaction, Gel doc. (PCR)
3	Gas Chromatography
4	UV-Vis Spectrophotometer
5	Anaerobic Glove Box
6	N2 Analyser
7	Orbital environmental Shaker
8	Coolins Centrifuge
9	Autoclaves

Faculty

Sr. No	Name	Qualification	Designation
1	Dr.PradipKumar .B. Acharya	M.Sc, Ph.D (Microbiology)	Associate Professor
2	Dr.Nikhil .S. Bhatt	M.Sc, Ph.D (Biochemistry)	Assistant Professor
3	Dr. Srinivas Murthy Dugdirala	M.Sc, Ph.D (Microbiology)	Assistant Professor
4	Dr. Prateek .G.Shilpkar	M.Sc, Ph.D (Soil Science)	Assistant Professor
5	Dr. Niraj .T. Sheth	M.Sc, Ph.D (Microbiology)	Assistant Professor
6	Shrimati Preetiben .K. Shukla	M.Sc, M.Phil (Microbiology)	Assistant Professor
7	Dr. MayurKumar .C. Shah	M.Sc, Ph.D (Chemistry)	Assistant Professor
8	Shri ArvindKumar .B. Dungrechiya	M.Sc, (Microbiology) NET Cleared	Assistant Professor
9	Dr. Kaushikkumar Ruganathbhai Patel	M.Sc, Ph.D (Physics)	Assistant Professor

Office Contact No: (079)23274274

GUJARAT VIDYAPEETH: Ahmedabad

Curriculum of M.Sc. Microbiology Course, Semester Choice Based System, (Effective from June – 2010)

S. No	Paper code	Name of paper	Semester	Hour		Credit		Marks	
				Th.	Pra.	Th.	Pra.	Th.	Pra.
1	MIC 101	Microbial Diversity	1st	60	90	4	3	100	50
2	MIC 102	Microbial Physiology	1st	60	90	4	3	100	50
3	MIC 103	Instrumentation and Biostatistics	1st	60	90	4	3	100	50
7	COMPL 101	PAD YATRA – 1	1st	-	-	-	2	-	-
8	COMPL 102	UDYOG – 1	1st	-	-	-	2	-	-
9	FC 101	ગાંધીવિચાર	1st	30	-	2	-	50	-
10	MIC 201	Enzymology	2nd	60	90	4	3	100	50
11	MIC 202	Molecular Biology and Microbial Genetics	2nd	60	90	4	3	100	50
12	MIC 203	Recombinant- DNA Technology	2nd	60	90	4	3	100	50
16	COMPL 201	UDYOG – 2	2nd	-	-	-	2	-	-
17	MIC 301	Biomethanation	3rd	60	90	4	3	100	50
	MIC 302	Environmental Biotechnology	3rd	60	90	4	3	100	50
	MIC 303	Industrial Microbiology	3rd	60	90	4	3	100	50
23	COMPL 301	PAD YATRA – 2	3rd	-	-	-	2	-	-
24	COMPL 302	UDYOG – 3	3rd	-	-	-	2	-	-
25	MIC 401	DISSERTATION WORK	4th	-	-	-	16	Grade	Grade
26	COMPL 401	UDYOG -4	4th	-	-	-	2	-	-

Elective Papers

Sr. No	Paper code	Name of paper	Hour		Credit		Marks	
			Th.	Pra.	Th.	Pra.	Th.	Pra.
First Semester								
1	**EC 101**	**Immunology**	**60**	**90**	**4**	**3**	**100**	**50**
2	EC 102	Clinical Microbiology	60	90	4	3	100	50
3	EC 103	Forensic Science	60	90	4	3	100	50
Second Semester								
1	**EC 201**	**Bioinformatics**	**60**	**90**	**4**	**3**	**100**	**50**
2	EC 202	Nanotechnology	60	90	4	3	100	50
3	EC 203	Biostatistics	60	90	4	3	100	50
Third Semester								
	EC 301	**Bioprocess Technology**	**60**	**90**	**4**	**3**	**100**	**50**
	EC 302	Anaerobic Bioreactor Design	60	90	4	3	100	50
3	EC 303	Bioenergy	60	90	4	3	100	50

Papers shown in Bold Letters are currently running.

SUMMARY

Semester	Total Credits
Semester-I	34
Semester-II	30
Semester-III	32
Semester-IV	18
Grand Total	114

MIC 101-Microbial Diversity

Unit I Microbial Evolution and Taxonomy

1.1 Evolutionary History of present day microorganisms

1.1.1 Evolutionary history

1.1.2 Evolution of porphyrin ring

1.2 Endosymbiosis

1.3 Evolutionary significance of microbial life

1.3.1 Fossil record

1.3.2 Geochemical evidences

1.3.3 Molecular Phylogeny

1.4 Evolutionary Chronometers

1.4.1 Protocol for using RNA as a molecular chronometer

1.5 Signature sequences

1.6 Microbial phylogeny as revealed by RNA sequencing

1.6.1 Bacteria

1.6.2 Archaea

1.6.3 Eukarya

1.7 Phenotypic characteristics of the Primary domains (Cell wall; lipids; RNA polymerase; features of protein synthesis)

1.8 Taxonomy, nomenclature and Bergey's manual

Unit II Basics of Microbial Diversity

2.1 Extent of microbial diversity on earth

2.2 Sources of diversity

2.3 Biodiversity study of culturable bacteria

2.4 Biodiversity study of Unculturable bacteria

2.5 Algae (Classification of algae)

2.6 Fungi (Classification of fungi; introductory description of mold, yeast and mushroom)

Unit III Extremophiles

3.1 Extreme environments (Low temperature; high temperature; water stress; salinity; pH; oxygen; low nutrient environment; resting stages and survival; light)

3.2 Habitats, microorganisms, and biochemistry and physiology of adaptation of Hyperthermophiles, Extreme Acidophiles, Psychrophiles, Barophiles, Halophiles, Alkaliphiles

Unit IV Importance and Biotechnological Applications of Microbial Diversity

4.1 Economic value of microbial diversity

4.1.1 Role of microbial diversity in biodiversity maintenance, biosphere functions and in sustainable development

4.1.2 Need for diversity

4.1.3 Categories of microorganisms

4.1.3.1 Substrate based groups

4.1.3.2 Size based groups

4.1.4. Species specific interactions

4.1.5 Qualitative and stabilizing effects of diversity

4.1.6 Changes in biodiversity and microbial activity (Biotic interactions; trace gas production and; Carbon and nutrient cycling)

4.2 Conservation strategies

4.2.1 Causes of biodiversity loss

4.2.2 Biodiversity indicators relevant for decision makers for formulation of conservation strategies

4.3 Biotechnological applications of Microbial diversity

4.3.1 Accessing and using molecular DNA data on biodiversity

4.3.2 Key technologies used in biotechnology studies

4.3.2.1 Chemical screening

4.3.2.2 DNA technologies: Genome mapping

4.3.3 Biotechnology applications in biodiversity assessment and management

4.3.4 Increasing option values: Providing the knowledge base for biodiversity culture and preservation

4.3.4.1 *Ex-situ* conservation

4.3.4.2 Biotechnology-enhances option values

4.3.4.3 Role of DNA libraries and sequence data in biodiversity conservation and in biodiversity assessment and utilization

4.3.5 Application of biotechnology for the utilization of biodiversity

4.3.5.1 Areas of application of biotechnology in biodiversity utilization

4.3.5.2 Biotechnology in the service of industries (Rural industries; manufacturing and processing industries; extractive industries)

4.3.5.3 Using biodiversity for environmental remediation

4.3.5.3.1 Recent discoveries of diversity important for bioremediation (Nitroaromatic compounds; crude oil constituents; aliphatic hydrocarbon degradation; aromatic hydrocarbon degradation; polycyclic aromatic

hydrocarbons; halogenated organic compounds; halogenated aliphatic hydrocarbons; chlorinated aromatic compounds; chlorinated polycyclic hydrocarbons)

4.3.5.3.2 Traits sought in bioremediation (Consortium of organisms; genetically engineered organism; tracking microbial strains added to the environment; bioremediation technologies)

4.3.6 Impact of biotechnology on biodiversity (Direct impacts and indirect impacts)

Reference Books

1. Microbial Evolution, Systematic and Taxonomy" In: Brock Biology of Microorganisms Eighth Edition By- Madigan, T.M.; Martinko, J.M. and Parker, J. Prentice Hall Publication, U.K.

2. The Prokaryotes-A Handbook on The Biology of Bacteria: Ecophysiology, Isolation, Identification, Application" Second Edition, Volume-I Editors-Balows, A.; Truper, H.G.; Dworkin, M.; Harder, W. and Schleiffer, K.H. Springer-Verlag Publication, New York.

3. Encyclopedia of Microbiology" Second Edition, Volume-2 Editor-in-chief- Lederberg, J. Academic Press, New York.

4. Manual of Industrial Microbiology and Biotechnology" Second Edition Editor-in Chief- Arnold, L.; Demain and Julian, E. Davies Editors- Ronald, M. Atlas; Gerald Cohen; Charles, L. Hershberger; Wei-Shou Hu; David, H. Sherman; Richard, C. Willson and David Wu, J.H. ASM Press, Washington

5. Global Biodiversity Status of The Earth's Living Resources" Editor-Groombridge, B. Chapmman and Hall Publication, London.

6. Global Biodiversity Assessment" Editor-Heywood, V.H. and Watson, R.T. Cambridge University, Press.

7. Biodiversity of Microbial Life" Editor-Staley, J.T. and Reysenbach, A.L. Wiley-Liss Publication, New York.

8. Brock Biology of Microorganisms" Eighth Edition By- Madigan, T.M.; Martinko, J.M. and Parker, J. Prentice Hall Publication, U.K.

M.Sc. (1 st_ Semester) MIC-102

MICROBIAL PHYSIOLOGY

UNIT: 1 Principles of Physiology **Total 15 hrs**

1 Cytoplasmic membrane and Nutrient Transport

(1.1) Composition and architecture of membrane **(1 hr)**

- The cytoplasmic membrane in Bacteria and Archea
- Composition and architecture of membrane
- Membrane proteins
- Membrane-strengthning agents: sterols and Hopanoids
- Archaei Membranes

Ref: 1 Lehninger
Principales of biochemistry (4th Edtion) David L. Nelson. Michael M.Cox.
Chapter-II
2. Brock, Biology of microorganismst l Z'" ed.) Chapter- 4

(1.2) The Functions of Cytoplasmic membrane. **(1 hr)**

The Cytoplasmic membrane barrier as a permeability barrier » 'The necessity of trans post proteins

- Properties of transport proteins

Ref.:- Brock. Biology of microorganisms (8th edition) Madigan, Martinko, Dunlap, Clark Chapter-4

(1.3) Transport and transport systems: **(3 hr)**

- Structure and functions of membrane transport proteins.
- Simple transport: Lac permease of Escherichia coli.
- Group translocation:
  The phoshotransferase system.
  Periplasmic-binding proteins and the ABC system.

Ref:- Brock, Biology of micrcorganisms.(12th edition) Chapter-4

2 Regulation of gene expression.

(2.1) Overview of regulation **(1 hr)**

Major modes of regulation

(2.2) DNA binding proteins & regulation of transcription **(1hr)**

- DNA binding proteins
- Negative control of transcription Repression & Induction
- Positive control of transcription

Ref.: Brock Biology of Microarganism (8th Ed.) Chapter-9. Pg. 255-230

3. Signal transduction **(4 hrs)**

3.1 Two-component regulatory system

3.2 Molecular mechanism of signal transduction

- Gated ion channels.

i) Ion channels underlie electrical signaling in excitable cells
ii) The Nicotinic Acetylcholine Receptor is a ligand-Gated ion channel

- G-protein coupled receptors & second massangers (Serpentine receptor)

(i) Adenylyl cyclase.
(ii) Cyclic AMP acts as a second massanger for a number of regulatory molecules.

Ref.: I. Lehninger, Principles of biochemistry. 4th Ed. Chapter-I 2
2. Brock, Biology of microorganisms 12th Ed. Chapter-9

4. Quorum Sensing **(1 hr)**

- Mechanism of Quorum Sensing
- Examples of Quorum Sensing

Ref.: Brock. Biology of Microorganisms 12th Ed.

5. Cellular differentiation **(2 hr)**

- Sporulation in Bacillus (Chapter-9. Pg-242-243)
- Yeast budding (Chapter-IS. Pg. 540-542)

Ref.: Brock. Biology of Microorganisms

UNIT: 2 Physiological and Metabolic Diversity of Microorganisms Total 10 hrs

1. Metabolic strategies for generating cellular energy **(l hr)**

1.1 Sources for generating metabolic energy: Autotrophy and Heterotrophy.
1.2 Metabolic pathways
1.3 Generation of Protonmotive Force (PM F)
1.4 Generation of A TP

Ref: Principles of Micriobiology'" 4th Ed) Ronald M Atlas (Chapter:4, page: 146-150)

2. Evolution and Diversity of Photosynthetic and Autotrophic bacteria

2.1 The Phototrophic way of life (Phototrophy):

(2.11) Photosynthesis **(1 hr)**

- Energy production and CO_2 assimilation
- Pattern of photosynthesis

(2.12) Chlorophylls and Bacteriochlorophylls **(1 hr)**

- Chlorophyll diversity
- Photosynthetic membranes and chloroplasts
- Reaction centres and Antenna pignents.
- Chlorosomes

(2.13) Carotenoids and phycobilins **(1 hr)**

- Carotenoids
- Phycobiliproteins and phycobilisornes

(2.14) Anoxygenic Photosynthesis **(2 hr)**

- Photosynthetic Reaction Centers
- Photosynthetic electron Flow in purple bacteria
- Photophosphoylation

- Genetics of bacterial photosynthesis
- Autotrophy in purple bacteria; Electron donors and reverse electron flow.
- Photosynthesis in other anoxygenic phototrophs

(2.15) Oxygenic Photosynthesis **(1 hr)**

- Elecron flow in oxygenic photosynthesis
-ATP synthesis in oxygenic photosynthesis
- Anoxygenic photosynthesis in oxygenic phototrophs and the evolution of photosynthesis

2.2 Autotrophy

(2.21) The calvin cycle

- Rubis CO and the formation of 3-phosphoglyceric acid (PGA) **(1 hr)**

- Stoichiometry of the calvin cycle

- Carboxysomes

(2.22) Other Autotrophic pathways in Phototrophs.

- Autotrophy in chlorofexus. (Hydroxypropionate Pathway)

Ref: Brock. Biology of microorganisms (12th Ed.) Chapter:20 (pg.579 to 594)

2.3 Nitrogen Fixation **(1 hr)**

(2.31) Nitrogenase and nitrogen Fixation

(2.32) Genetics and Regulation of N_2 Fixation

Ref.: Brock
Biology of Microorganisms (12^{th} Ed.)
Madigan, Martinko, Dunlap and Clark (Chapter-20)

UNIT: 3 Diversity of Microbial Heterotrophic Metabolism

1. Respiration **Total 8 hrs.**

1.1 Oxidative Phosphorylation **(2 hrs)**

- Electron Transport Chain
- Chemiosmotic A TP Generation

Ref.: Principles of Microbiology (2^{nd} ed) Ronald M. Atlas, (Chapter-4)

1.2 Aerobic chemoorganotrophic process **(4 hrs)**

- Molecular oxygen as a reactant in biochemical processes.

- Aerobic hydrogen oxidation
- Hexose, pentose and polysaccharide metabolism.
- Organic acid metabolism.
- Lipid metabolism.

Ref: Brock, Biology of microorganisms 12th Ed. (Chapter-21)

1.3 Anaerobic Respiration: (2 hrs)

- Anaerobic Respiration: General Principles.
- Proton Reduction.

- Anoxic hydrogen oxidation linked to Anaerobic Respiration.

Ref: Brock, Biology of microorganisms 12th Ed. (Chapter-21)

UNIT -4 (1) Physiological & Applied values of fungi Total 15 hrs

(1) Introduction to Fungi (1 hr)

(2) Characteristics of Fungi (1 hr)

(3) Classification of Fungi (1 hr)

Ref.: (I) Introductory mycology (4th Ed.) c.J. Alexopoulas, C.W. Mirns, M. Blackwell, Chapter 1 & 2
(2) Fundamentals of fungi (4th Ed.) Elizabeth, Moore and Landecke
(3) Microbiology (8th Ed.) C.Pelczar, E.C.S. Chan, N.Krieg

(4) Fungal growth (Pg. 279-308) (1 hr)

Ref.: Fundamentals of fungi, Elizabeth, Moore, Landeckp

(5) Applied values of fungi (3 hr)

5.1 fungi as sapropgytes
5.2 fungi in pathological relationships of Agricultural importance
5.3 fungi as Mutualistic syrnbionts
5.4 fungi and Human Affairs Penicillin (Antibiotic)
5.5 Fungi of Veterinary and medical interest

Ref.: Fundamentals offungi (4th Ed.) Elizabeth, Moore, Landecker.

UNIT-4 (2) Physiological and Applied values of Bacteria Total 8 hrs

(2A) The physiological Diversity in Bacteria

(1) Photosynthesis in Heliobacteria (pg. 447-450)
(2) The Nonproteobacteria. Gram negative bacteria
- Spirochaetes
(3) The proteobacteria
- The caulobacter and Hyphomirobium
(4) Bacteria: The low G+C, Gram positive bacteria: The mycoplasma
(5) Bacteria: The high G+C. Gram positive bacteria. Streptomyces.

Ref.: Microbiology (6th Ed.), Part IV, (Chapter - 20,21,22,23,24)

Prescott, Harley, Klein, Megraw-Hill International Publication

(2B) Applied values of baeteria

(1) Beneficial microbial interactions with humans **(2 hrs)**

(i) Normal flora of the skin

(ii) Normal microflora of the oral cavity

(iii) Normal microflora of the Gastrointestinal tract

(2) Virulence factors and Toxins **(2 hrs)**

(i) Tetanus and Botulinum toxin

(ii) Entrotoxin : Cholera toxin

Ref.: Brock. Biology of microorganisms 12th Ed.) Chapter-28

(3) Applications of Genetic Engineering **(1 hr)**

- Medical appl ications
- Industrial applications
- Agricultural applications

Ref. : Microbiology (6th Ed.)

Prescott. Harley, Klein (Chapter-I 4, 29,42)

MIC 103: Instrumentation and Biostatistics

Unit	Topic and Content
1	**Spectroscopy:** (Principle, Instrumentation and Applications): i. Infrared Spectroscopy, Flame emission Spectroscopy and Atomic absorption spectroscopy. **Specialized Spectroscopy:** (Principle, Instrumentation and Applications) Nuclear Magnetic Resonance Spectroscopy, Electron Spin Resonance Spectroscopy, Mass Spectroscopy- X- Ray Diffraction Spectroscopy.
2	**Separation Techniques:** i. **Centrifugation Techniques:** Types of centrifugation; Rate Zone; Isopycnic; High speed; Ultra; preparative; Gradient ii. **Electophoretic Techniques**: Zone EP; Isoelectric; DISC EP; Immuno EP; Pulsed Field; Cellular Gel EP
3	**Specialized Separation Techniques:** i. **Chromatography**: Paper; TLC; **Conventional Column Chromatography**- Ion- Exchange; Affinity; Adsorption. **Specialized Technique**: **GLC**- Column; Detectors. **HPLC**: Pumps; Columns; Instrumentation.
4	**Biostatistics:** sampling methods, data organization, tabulation, graphical representation, Significance tests.

References: MIC 103: Instrumentation and Biostatistics

1. Instrumental methods of chemical analysis. *Sharma B.K*.
2. Instrumental methods of analysis. *Skoog D.A.*
3. An introduction to practical Biochemistry. *Plummer.*
4. Instrumentation: Spectroscopy. *Chatwal and Anand.*
5. Modern experimental Biology. *Boyer.*
6. Biochemistry. 6th Edition. *Freeman, New York. . Berg, J. M., Tymoczko, J. L. and Stryer, L.* (2006)
7. Biophysics: An Introduction. John Wiley & Sons, England. *Cotterill, R. M. J.* (2002)
8. Principles of protein X-ray crystallography. 3rd Ed. Springer, Germany. . *Drenth, J*. (2007)
9. Biochemistry.3rd Ed. Brooks/Cole, Publishing Company, California. *Garrett, R. H. and Grisham, C. M.* (2004)
10. Understanding NMR Spectroscopy. John Wiley & Sons, England. *Keeler, J.* (2002)
11. Methods in modern biophysics. Second Edition. Springer, Germany. *Nölting, B.* (2006)
12. Biophysics. Kluwer Academic Publishers, New York and Narosa Publishing House, Delhi. *Pattabhi, V. and Gautham, N.* (2002)
13. Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed.Cambridge University Press, New York. *Wilson Keith and Walker John* (2005)
14. Sampling Techniques, Wiley estern Ltd, New Delhi. *Cochran W.*
15. Introduction to probability theory and its applications, Asia Publishing House, Mumbai. *Fellller W.*
16. An introduction to Biostatistics. McGraw-Hill , N.Y. *Glover T. and Mitchell K.* 2002.
17. Fundamentals of statistics. World Press, Kolkota. *Goon, Gupta and Dasgupta* Irfan Ali Khan and Atiya Khanum,
18. Fundamentals of Biostatistics. 2nd Ed. Ukaaz Publications, Hyderabad.
19. Design and analysis of experiments, John Wiley and Sons. *Montgomery D. C.*
20. Sampling methods, Indian Statistical Institute, Kolkota. *Murthy M.N.*
21. Biostatistics, a foundation for analysis in the health Sciences, Edn. 7, Wiley-Indian Edn. *Wayne Daniel* 2007.

GUJARAT VIDYAPEETH
M.Sc. Microbiology
Semester I
EC-101

IMMUNOLOGY

Unit-I

A) General principles of immunology: History of immunology: structure, composition and function of cells and organs involved in immune system. Immune response (humoral and cell mediated) innate immunity, acquired immunity; immune haematology, blood groups, blood transfusion and Rh-incompatibility

B) Antigens – antibodies: Antigens-structure and properties; types-iso and allo; haptens adjuvants, antigen specificity. Membrane receptors for antigens; immunoglobulins; structure-heterogeneity-types and subtypes-properties (physico, chemical and biological); theories of antibody production.

Unit-II

A) Antigen and antibody interactions: *In vitro* methods-agglutination, precipitation, complement fixation, immunofluorescence, ELISA, radio immunoassay; *in vivo* methods; phagocytosis, opsonization, neutralization.

B) Complement system; complement components. complement activation - pathways, regulation of complement system, biological consequences of complement activation, complement deficiencies

Unit –III

A) Immunogenetics**:** Structure, distribution and functions of histocompatibility antigens. Major histocompatibility gene complex (MHC) and the HLI-A system; gene regulation and immune response (IR) genes; HL-A and tissue transplantation- tissue typingmethods for organ and tissue transplantations in humans; graft versus host reaction and rejection.

B) Tumor immunology: Tumor immunology - tumor antigens, Host immune response to tumors, antibody dependent cell cytotoxicity (ADCC), tumor escape mechanisms Immuno diagnosis and therapy

Unit-IV

A) Immunopatholog**y**: Classification of immunopathological disorders. General account of immune deficiency disorders. Primary and secondary, phagocytic cell disorder. Gammopathies. Complement deficiencies. Hypersensitivity reactions: type I, II, III and IV the respective diseases, immunological methods of their diagnosis. Autoimmunity mechanism and diseases .General account of interferon's, Lymphokines and cytokines.

B) Immuno biotechnology: Active and passive immunization, Isolation of spleen cells, Myeloma cell lines used as fusion partner, fusion method, detection and application of monoclonal antibodies, recombinant antibodies, immunotoxins types of vaccines, whole - organism vaccines, recombinant vector vaccines, DNA vaccines, synthetic peptide vaccines, subunit vaccines, immunization procedures, adverse reactions to vaccines.

ગૂજરાત વિદ્યાપીઠ: અમદાવાદ

મ. દે. ગ્રામસેવા મહાવિદ્યાલય, સાદરા, તા.જિ.: ગાંધીનગર

વિજ્ઞાન પારંગત (સૂક્ષ્મજીવાણુવિજ્ઞાન) સત્ર-1

ગાંધીવિચાર (પુનઃપ્રાપ્ય ઊર્જાના સ્ત્રોતો)

(સિમેસ્ટર સિસ્ટમ આધારીત, જૂન -2011 થી અમલમાં)

UNIT – 1

- ઊર્જા એટલે શું ? તેના પ્રકારો

- ઊર્જા બચત શા માટે? રસોડામાં ઊર્જા બચત

- ઊર્જા બચતના અન્ય ક્ષેત્રો

- પુન: પ્રાપ્ય ઊર્જા સ્ત્રોતો

- પુન: પ્રાપ્ય ઊર્જા સ્ત્રોતોના વિવિધ ઉપયોગો

- સૌર ઊર્જા

સૂર્યફૂકર, સૌરબંબો, સોલરડ્રાયર, લાકડા સૂકવવા સૌર ભઠ્ઠી, સોલર સ્ટીલ (ક્ષાર રહિત પાણી માટે), સૌર તળાવ, સોલર ફોટોવોલ્ટીક સેલ

- પવન ઊર્જા

પવનચક્કી, પવન ઊર્જા થકી વીજ ઉત્પાદન, અનાજ દળવાની ઘંટી

- દરીયાઇ ઉષ્માઊર્જા

- ધરતીનાં પેટાળમાં રહેલી અગાધ ઊર્જા

- જીવભાર- બયોમાસ

સંદર્ભ પુસ્તિકા : સમયનો તકાદો : પુન: પ્રાપ્ય ઊર્જા,

પાંચમી આવૃત્તિ, જેડા, વડોદરા.

UNIT-2 બાયોગેસ :

- બાયોગેસ એટલે શું ?

- બાયોગેસના ઉપયોગો

- સેન્દ્રીય ખાતરના ઉપયોગો

- બાયોગેસ પ્લાન્ટ બનાવવાથી થતા ફાયદાઓ

- બાયોગેસ પ્લાન્ટના પ્રકાર અને કદ

- બાયોગેસ માટે જગ્યાની પસંદગી

- બાયોગેસ પ્લાન્ટનું નામ

- બાયોગેસ પ્લાન્ટ બનાવ્યા પછી તેને કેવી રીતે ચાલુ કરશો?

- બાયોગેસ કેવી રીતે ઉત્પન્ન થાય છે ?

- બાયોગેસ પ્લાન્ટ માટેનો જરૂરી કાચો માલ

- બાયોગેસ ઉત્પાદન પર અસર કરતાં પરિબળો

- બાયોગેસ પ્લાન્ટની જાળવણી

સંદર્ભ પુસ્તિકા :- બાયોગેસ લાભાર્થી પુસ્તિકા. ગૂજરાત વિદ્યાપીઠ, અમદાવાદ

Handbook of Biogas Technology : K.C. Khandelwal

UNIT-3

- વર્મિકમ્પોસ્ટનું મહત્વ

- વર્મિકમ્પોસ્ટના ફાયદાઓ

- વર્મિકલ્ચર પ્રક્રિયા

જગ્યાની પસંદગી, સેન્દ્રિય કચરાની લભ્યતા, અળસિયાની યોગ્ય જાતિની પસંદગી અને જાળવણી, પાયાના કલ્ચરની જાળવણી, બજાર વ્યવસ્થા, અનુકૂળ પ્રજાતિની જાળવણી, અળસિયાની પ્રજાતિની સેન્દ્રિય કચરાની પસંદગી

- વર્મિકમ્પોસ્ટ બનાવવાની રીત

- તૈયાર થયેલ વર્મિકમ્પોસ્ટ ખાતર અલગ કરવા માટેની રીત

- વર્મિકમ્પોસ્ટ ખાતરના ગુણધર્મો

- વર્મિકમ્પોસ્ટ વાપરવાનું પ્રમાણ

સંદર્ભ પુસ્તિકા :-બાયોટેકનોલોજી દ્વારા ઉત્પાદિત સેન્દ્રિય ખાતર

કૃષિ ઋષિ બાયો ફાર્મ્સ, આણંદ

MIC 201 Enzymology (Detailed Syllabus)

1. Introduction to Enzymes (History, naming and classification of Enzymes)
2. Specificity of Enzyme action (Active site of enzymes; The Fischer's 'Lock and Key' hypothesis; The Koshland 'Induced fit' hypothesis; and hypothesis involving strain or transition-state stabilization)
3. Kinetics of Single-substrate-enzyme catalysed reactions:
   - 3.1 Derivation and significance of the 'Henri and Michaelis-Menten' equation
   - 3.2 The 'Briggs-Haldane' modification of the 'Michaelis-Menten' equation
   - 3.3 Derivation of the 'Line Weaver-Berk' equation and plots
   - 3.4 The 'Eadie-Hofstee' and 'Hanes' plots
   - 3.5 The 'Eisenthal and Cornish-Bowden' plots
   - 3.6 Derivation of the 'Haldane' relationship for reversible reactions
   - 3.7 Rapid-Reaction kinetics:
     - 3.7.1 Pre-steady state kinetics
     - 3.7.2 Relaxation kinetics
   - 3.8 procedure to determine Rate equation for a reaction sequence involving two and three enzyme species
4. Kinetics of Multi-substrate-enzyme catalysed reactions:
   - 4.1 Introductory knowledge of Ping-Pong bi-bi mechanism; Random-order mechanism; and Compulsory-order mechanism
   - 4.2 Steady-state kinetics:
     - 4.2.1 Derivation of the 'General Rate Equation' of Alberty
     - 4.2.2 Plots for mechanisms which follow the 'General Rate Equation
     - 4.2.3 The 'General Rate Equation' of Dalziel
     - 4.2.4 Rate constants and the constants of Alberty and Dalziel
   - 4.3 Investigation of Reaction Mechanisms using Steady-state methods:
     - 4.3.1 The use of Primary plots
     - 4.3.2 The use of inhibitors which compete with substrate for binding sites
   - 4.4 Investigation of Reaction mechanisms using non-steady-state methods:
     - 4.4.1 Isotope exchange at equilibrium
     - 4.4.2 Rapid-reaction studies
5. Sigmoidal Kinetics and Allosteric Enzymes:
   - 5.1 The 'Monod-Wyman-Changeux (MWC) Model':
     - 5.1.1 Derivation of MWC equation
     - 5.1.2 MWC model and cooperative effects
     - 5.1.3 MWC model and Allosteric regulation
     - 5.1.4 MWC model and Hill equation
   - 5.2 The 'Koshland-Nemethy-Filmer (KNF) Model':
     - 5.2.1 The KNF model for a dimeric protein
     - 5.2.2 The KNF model for any oligomeric enzyme
     - 5.2.3 The KNF model and Allosteric regulation
   - 5.3 Differentiation between models for cooperative binding in proteins
   - 5.4 Sigmoidal kinetics in the absence of cooperative binding:
     - 5.4.1 Ligand-binding evidence versus Kinetic evidence
     - 5.4.2 The 'Ferdinand' mechanism
     - 5.4.3 The 'Rabin and Mnemonical' mechanisms
6. Significance of Sigmoidal Behavior:
   - 6.1 Allosteric enzymes and Metabolic regulation:
     - 6.1.1 Characteristics of Steady-state metabolic pathways

- 6.1.2 Regulation of Steady-state metabolic pathways by control of enzyme activity
- 6.1.3 Allosteric enzymes of metabolic regulation (availability of coenzymes; cellular compartmentation; active and inactive forms of enzymes)

7. Enzyme Inhibition:
   - 7.1 Competitive Inhibition
     - 7.1.1 Characteristics of competitive inhibition
     - 7.1.2 Michaelis-Menten and Lineweaver-Burk plot showing the effect of a competitive inhibitor
     - 7.1.3 Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalysed reaction in the presence of a Competitive inhibitor
   - 7.2 Uncompetitive inhibition
     - 7.2.1 Characteristics of Uncompetitive inhibition
     - 7.2.2 Lineweaver-Burk plot showing the effect of a uncompetitive inhibitor
     - 7.2.3 Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalysed reaction in the presence of a uncompetitive inhibitor
   - 7.3 Non-competitive inhibition
     - 7.3.1 Characteristics of non-competitive inhibition
     - 7.3.2 Lineweaver-Burk plot showing the effect of a non-competitive inhibitor
     - 7.3.3 Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalysed reaction in the presence of a non-competitive inhibitor
   - 7.4 Mixed inhibition
     - 7.4.1 Characteristics of mixed inhibition
     - 7.4.2 Lineweaver-Burk plot showing the effect of a mixed inhibitor
     - 7.4.3 Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalysed reaction in the presence of a mixed inhibitor
   - 7.5 Partial inhibition
   - 7.6 Substrate inhibition and Michaelis-Menten and Lineweaver-Burk plots showing the effects of substrate inhibition
   - 7.7 Allosteric inhibition
   - 7.8 Irreversible inhibition
8. The investigation of active site structure:
   - 8.1 Identification of binding sites and catalytic sites:
     - 8.1.1 Trapping the enzyme-substrate complex
     - 8.1.2 Use of substrate analogues
     - 8.1.3 Enzyme modification by chemical procedure affecting amino acid side chains
     - 8.1.4 Enzyme modification by treatment with proteases
     - 8.1.5 Enzyme modification by site-directed mutagenesis
     - 8.1.6 Effect of changing pH
   - 8.2 Investigation of the Three-dimensional structures of active sites
9. Chemical nature of enzyme catalysis:
   - 9.1 Metal activated enzymes and metalloenzymes:
     - 9.1.1 Definitions of metal-activated enzymes and metalloenzymes
     - 9.1.2 Activation by alkali metal cations (Na^+ and K^+)
     - 9.1.3 Activation by alkaline earth cations (Ca^{2+} and Mg^{2+})
     - 9.1.4 Activation by transition metal cations (Cu, Zn, Mo, Fe and Co cations)
   - 9.2 Involvement of Coenzymes in enzyme-catalysed reactions:
     - 9.2.1 Nicotinamide nucleotides (NAD^+ and $NADP^+$)
     - 9.2.2 Flavin nucleotides (FMN and FAD)
     - 9.2.3 Adenosine phosphates (ATP, ADP and AMP)
     - 9.2.4 Coenzyme A (CoA-SH)
     - 9.2.5 Thiamine pyrophosphate (TPP)

9.2.6 Pyridoxal phosphate
9.2.7 Biotin
9.2.8 Tetrahydrofolate
9.2.9 Coenzyme B_{12}

10. Protein-ligand binding and cooperativity
    10.1 General considerations of binding of a ligand to a protein having a single ligand-binding site
    10.2 Types of cooperativity
    10.3 Positive homotrophic cooperativity and derivation of the 'Hill' equation
    10.4 General considerations of binding of a ligand to a protein having two binding sites and derivation of 'Adair' equation under no interaction between the binding sites; under positive homotropic cooperativity; under negative homotropic cooperativity
    10.5 Derivation of Adair equation for the binding of a ligand to a protein having three and four binding sites for that ligand
    10.6 Investigation of cooperative effects by:
        10.6.1 Measurement of the relationship between
        10.6.2 Measurement of the relationship between
        10.6.3 The Scatchard plot and equilibrium dialysis techniques
    10.7 Explanation of binding of oxygen to hemoglobin in terms of cooperativity
11. Enzymes as Analytical Reagents:
    11.1 Advantages and disadvantages of using enzymes as analytical reagents
    11.2 Principles of enzymatic analysis:
        11.2.1 End-point methods
        11.2.2 Kinetic methods
        11.2.3 Immunoassay methods
    11.3 Handling of enzymes and coenzymes to maintain their activity
12. Enzyme utilization in Industry:
    12.1 Application in Food and Drink industries
    12.2 Application in Artificial kidney machines
    12.3 Application in other industries (pharmaceutical industry; washing powder manufacturing industries)
13. Preparation, properties and applications of Immobilized enzymes
    13.1 Preparation of immobilized enzymes by-
        13.1.1 Physical adsorption
        13.1.2 Ionic binding
        13.1.3 Covalent binding
        13.1.4 Peptide bonds formation
        13.1.5 Entrapping (in gel; within the semi-permeable membrane of a microcapsule; formation of liposomes)
    13.2 Properties of immobilized enzymes compared to free enzymes:
        13.2.1 Change in stability
        13.2.2 Change in pH
        13.2.3 Change in apparent Km
    13.3 General applications of immobilized enzymes

Reference Book for whole syllabus

Trevor Palmer (2004) *Enzymes Biochemistry, Biotechnology, Clinical Chemistry*. Affiliated East-West Press Pvt Ltd, New Delhi

Department of Microbiology

M.D. Gramseva Mahavidyalaya, Sadra, Dist: Gandhinagar

Paper MIC202: Molecular Biology and Microbial Genetics

M.Sc. SEMESTER-2 (Detailed syllabus) (45 Hours)

Unit	Topics	Hours
1	**(A) Structure and organization of bacterial genome and Replication:**	**12**
	i. Structure of DNA- DNA is usually a double helix, Complementarities of two chains, Tautomeric forms of each base, DNA denatures as well as renatures Viruses have 1S (single stranded) DNA chromosomes, 1S (single stranded) DNA has compact structure	**7** 3
	ii. Crystallographic proof of double helix in DNA Alternative forms of right-handed DNA, 'Z' form of DNA Methylation of 'C' & 'A' in DNA & its effects on the forms of DNA, Spontaneous deformation of double helix in solution Sequence specific bending & Kinking of DNA	2
	iii. Bacterial DNA replication	2
	(B) Transcription and translation of bacterial genes:	**5**
	i. The structure and function of RNA- types of RNA, RNA precursors, RNA structure, RNA processing and modification	1
	ii. Transcription- Molecular mechanism; Bacterial RNA polymerase, Transcription Initiation, Polymerization reaction, Transcription Termination	1
	iii. Translation- Protein structure, Ribosome structure, the Genetic code, Translation initiation, elongation and termination, Polycistronic mRNA	2
	iv. Post translational modification and Protein folding- Mechanism of post translational modification of protein, Protein folding mechanism- Chaperones, Protein disulfide isomerases, Membrane proteins	1
2	**(A) Mutations and DNA repair:**	**12**
	i. Phenotypic classes of mutants, genotypic classes of mutants, conditionally lethal mutations, Silent mutations and its reasons, leaky mutations, methodology for the detection and selection of Auxotrophic mutants- phenotypic lag & phenomic lag, Suppressor mutations and its types.	**7** 2
	ii. Mutagenesis: U.V. (physical mutagenic agent), Chemical mutagen- Base Analogues (5 Bromo Uracil & 2 Amino Purine), Oxidative deaminating agents (Nitrous acid, Hydroxyl amine), Alkylating agents and Intercalating agents.	2
	iii. Repair: Direct repair-Photoreactivation and Removal alkyl group by Alkyl Transferases; Indirect repair- SOS repair, Mismatch repair, Excision repair, Adaptive response to alkylating agents; Post-replicative repair.	3

	(B) Recombination models: Requirements and Molecular Models of Recombination- Holiday double stranded DNA molecules, single stranded invasion model, Molecular basis for Recombination in *E.coli- chi* sites and RecBCD Nuclease, Synapse formation and RecA protein, Ruv protein	**5**
3	**(A) Conjugation** • Mechanism of DNA transfer during Conjugation in Gram –ve bacteria- Transfer *tra* genes, the *oriT* sequence, function of plasmid primases in transfer, Mobilizable plasmids • Chromosome transfer by plasmids- Formation of Hfr strains, transfer of chromosomal DNA by integrated Plasmids, chromosome mobilization and Prime factors • Transfer systems of Gram +ve bacteria- Plasmid attracting Pheromones **(B) Transformation** • Natural Transformation • Competence • Uptake of DNA during Natural Transformation • Mechanism of DNA uptake during Transformation • Genetic evidence for single strand uptake • Role of Natural Transformation • Artificially induced competence- Calcium ion induction and Electroporation **(C) Transduction** • Phage λ and lysogeny • cII gene product • Maintenance of lysogeny • Regulation of repressor synthesis • Induction of λ • Competition between lytic and lysogenic cycles **(D) Tetrad analysis and parasexual cycle**	**13** **4** **3** **4** **2**
4	**(A) Extra chromosomal inheritance** • Nomenclature & classification of Plasmids, Plasmid structure, phenotypic traits encoded by Plasmids. • Properties of Plasmids: Replication-theta and rolling circle mechanism; Functions of *ori* region- Regulation of copy number, Host range of Plasmids; Mechanisms to prevent curing of Plasmids- Resolution of multimeric Plasmids & Partitioning; Incompatibility- due to replication control and partitioning. • Plasmids as Cloning Vectors: Desirable features of Plasmid Cloning Vectors & Broad Host range Cloning Vectors Plasmid pBR322 and Ti Plasmid	**8** **3**

	(B) TRANSPOSITON • Structure of Transposons • Types of bacterial Transposons- IS elements, Composite transposons, Non-composite transposons • Assays of transposition- suicide vectors, Mating-out assay • Molecular models for transposition- Replicative trtansposition, Cut and paste transposition, Relationship between replicative and cut and paste transposition and their target regulation **(C) Control** • Lac operon- Positive control, Negative control, Catabolite repression and role of CAP • Tryptophan operon- Attenuation control	**3** **2**

GUJARAT VIDYAPEETH

M.Sc. Microbiology
Semester II
MIC-203

RECOMBINANT DNA TECHNOLOGY

Unit – 1 Elements of rDNA Technology

Core techniques and essential enzymes used in recombination: restriction endonucleases, type I, II, III, recognition sequences, properties, nomenclature, classification of type II endonucleases, their activity. DNA ligase: Properties and specificity, S1 nuclease, DNA polymerase, polynucleotide kinase, phosphatase, reverse transcriptase its activity and mode of action. Chemical synthesis of DNA. Restriction digestion, ligation and transformation.

Unit – 2 Vectors

Properties, incompatibility, isolation and purification techniques, plasmid vectors and their properties, PBR 322 – its construction and derivatives, single stranded plasmids, promoter probe vectors, runaway plasmid vectors.

Bacteriophage lambda as a vector: Essential features, organization of genome, general structure, rationale for vector construction, improved vectors, gt series, EMBL vectors, invitro packaging, cosmids, phasmids, filamentous phage vectors, zap, blue print vectors.

Unit- 3 Specialized cloning strategies

Expression vectors, promoter probe vectors, vectors for library construction, genomic DNA libraries, chromosome walking and jumping, cDNA libraries, short gun cloning, directed cloning,
phage display. Recombinant DNA technology with reference to cloning and production interferon and insulin. Miscellaneous applications of Genetically engineered micro organisms (GEMS) / genetically modified organisms (GMO's).

Unit – 4 Molecular mapping of genome

PCR methods and Applications DNA sequencing methods, Dideoxy and Chemical method. Sequence assembly. Automated sequencing.

Genetic and physical maps, physical mapping and map –based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, Chromosome microdissection and microcloning, molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes,
Application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc. animal trafficking and poaching: Germplasm maintenance, taxonomy and Biodiversity.

References

1. Principles of Gene Manipulations 1994 by Old and Primrose Blackwell Scientific Publications.
2. DNA Cloning: A Practical Approach by D.M. Glower and B.D. Hames, IRL Press, Oxford. 1995.
3. Molecular Biotechnology 2nd Edition by S.B. Primrose. Blackwell Scientific Publishers, Oxford. 1994.
4. Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes by S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford 1998.
5. PCR Technology - Principles and Applications for DNA Amplification by Henry A. Erlich (Ed.) Stockton Press. 1989.
6. Biotechnology: A Guide to Genetic Engineering by Peters.
7. Genetic Engineering – 2000 by Nicholl.
8. Recombinant DNA and Biotechnology: Guide for Teachers. 2nd Edition by Helen Kreuz. 2001.ASM Publications.
9. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 2 nd Edition. 1998 by Bernard R. Glick and Jack J. Pastemak, ASM Publications.
10. From genes to clones by Winnaker.
11. Manipulations and expression of recombinant DNA by Robertson.
12. Gene targeting – A practical approach by Joyner.

Department of Microbiology

M.D. Gramseva Mahavidyalaya, Sadra, Dist: Gandhinagar
Paper EC201: Bioinformatics (Currently taught)
M.Sc. SEMESTER-2 (Detailed syllabus) (45 Hours)

Unit	Topics
1	1. **Bioinformatics Resources:** Major Bioinformatics resources; Open access Bibliographic database resources and Literature database; Sequences database; Structure database. 2. **Sequence Analysis :** Sequences File format; Concepts of similarity; Scoring matrices; Database search; Pair wise alignment; Multiple alignment; Taxonomy and phylogeny.
2	1. **Structure Analysis:** Protein structure analysis; 3D structure visualization; Classification and comparison of protein 3D structure; Secondary structure predication; Tertiary structure prediction 2. **Genomics:** Genome database; Computational Gene prediction; Metagenomics; DNA Microarray; Comparative genomics; Functional genomics **3. Proteomics:** Laboratory and Computational methods for identification of protein; Protein array; Protein- Protein interactions
3	1. **Modeling Biological systems:** Systems biology, Metabolic network 2. **Bioinformatics for drug discovery:** Computer aided Drug design; Vaccine design. 3. **Computational technology for Bioinformatics :** Introduction to database and various Database management system; Introduction to web development, Fundamental and application of Perl and Bio perl and Biojava
4	1. **Agro informatics:** Introduction and overview of agro informatics; Resources available for agro information; Challenges and Opportunities in Agro informatics; Database development. 2. **Village Information system:** Overview of Village information system, Concepts tools and application of Geo informatics; Remote sensing technology for agriculture.

Reference Books:

1. Bioinformatics: Rastogi.
2. Introduction to Bioinformatics: Arthur M. Lesk.
3. Bioinformatics: Principles and applications, Ghosh and Mallick.
4. Bioinformatics: Genes, Proteins and Computer, C. A. Orengo.
5. Bioinformatics: A practical guide to the analysis of genes and proteins. 2nd Edition. John Wiley & Sons, New York. *Baxevanis, A. D. and Ouellette, B. F. F.* (2001)
6. GIS For Dummies (For Dummies (Computer/Tech)) by: Michael N. DeMers
7. GIS Basics by: Stephen Wise
8. GIS for Environmental Decision-Making (Innovations in Gis) by: Andrew A. Lovett, Katy Appleton
9. Textbook of Remote Sensing and Geographical Information Systems by: Reddy, M. Anji
10. Agrometeorology: Principles and Applications of Climate Studies in Agriculture by: Harpal S., Ph.D. Mavi, Graeme J. Tupper
11. Developing Bioinformatics Computer Skills by: Cynthia Gibas
12. Bioinformatics and Functional Genomics, 2nd Edition by: Jonathan Pevsner
13. Bioinformatics: Sequence and Genome Analysis (Genome Analysis) by: David W. Mount
14. Bioinformatics Biocomputing and Perl: An Introduction to Bioinformatics Computing Skills and Practice by: Michael Moorhouse, Paul Barry,
15. An Introduction to Bioinformatics Algorithms (Computational Molecular Biology)by: Neil C. Jones Pavel A. Pevzner
16. Bioinformatics: From Genomes to Drugs by: Thomas Lengaue
17. Essential Bioinformatics by: Jin Xiong
18. Bioinformatics: Genomics and Post-Genomics by: Frédéric Dardel, François Képès
19. Foundations of Comparative Genomics by: Arcady R. Mushegian
20. Principles of Proteomics (Advanced Text Series) by: R. M. Twyman
21. Proteomics for Biological Discovery by: Timothy D. Veenstra John R. Yates
22. Virtual Screening in Drug Discovery

EC 202: Nanotechnology

Unit	Topics and Contents
1	**Introduction Nanotechnology:** i. Definition of nano scale with reference to biosystems, Scope and future prospects. ii. Scanning probe instrument, spectroscopy, electron microscopy, molecular resolution of bio/in-organic materials, chemical imaging by scanning force microscopy, the quantification of adhesion forces between molecules, positioning signal atoms using proximal probes and finally either destructive or constructive molecular manipulations
2	**Nanotechnology:** i. Manipulation of matter at the molecular level to create new products with atom by – atom precision. Molecular synthesis, Self assembly, Polymerization, Nano scale lithography, e-beam lithography, ii. Heterogeneous nano structure and composites, nanoscale biostructres. Atomic force microscopy, DNA-scaffolds, polymer nano-electronics and Nano-colloids.
3	**Microorganisms, Bionanocomposites:** i. Microorganisms for synthesis of nanomaterials and for toxicity detection, Use of microorganisms for nanostructure formation
4	**Nano particles:** i. DNA as functional template for nanocircuitry; Protein based nanocircuitry; Neurons for network formation. DNA nanostructures for mechanics and computing and DNA based computation; DNA based nanomechanical devices, ii. Biosensor and Biochips, Nanoparticles for bioanalytical applications

References: EC 202: Nanotechnology

1 Bionanotechnology: Lessons from Nature by *David S. Goodsell.*

2.Nanomedicine, Vol. IIA: Biocompatibility by *Robert A. Freitas*

3.Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology - *Hari Singh Nalwa*

4. Nanobiotechnology; ed. *C.M.Niemeyer, C.A. Mirkin.*

5. Nanocomposite Science & Technology *Ajayan, Schadler & Braun*

6. BioMEMS (Microsystems) - *Gerald A. Urban*

7. Introduction to Nanoscale Science and Technology (Nanostructure Science and Technology) - *Massimiliano Di Ventra*

8. Nanosystems: Molecular Machinery, Manufacturing, and Computation - *K. Eric Drexler*

9. Springer Handbook of Nanotechnology - *Bharat Bhushan*

10. Nanobiotechnology; ed. C.M.Niemeyer, *C.A. Mirkin.*

11. Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. *Challa S., S. R. Kumar, J. H. Carola.*

12. Nanomedicine, Vol. I: Basic Capabilities

13. Nanomedicine, Vol. IIA: Biocompatibility - *Robert A. Freitas*

14.Principles of Tissue Engineering - *Robert Lanza, Robert Langer, and Joseph P*

MIC EC 203: Biostatistics

Unit	Topic and Contents
1	Quantitative methods in biology, sampling methods, scales and variables, data organization, tabulation, graphical representation.
2	Descriptive statistics, Probability, Survey design
3	Applications in Microbiology, Significance tests: *t*- Test; *Chi*- Square-Test, Regression and Correlation
4	Introduction to multivariate analysis: multiple regressions, ordination, principal component analysis, ANOVA and F- test

References

1. Sampling Techniques, Wiley estern Ltd, New Delhi. *Cochran W.*
2. Introduction to probability theory and its applications, Asia Publishing House, Mumbai. *Fellller W.*
3. An introduction to Biostatistics. McGraw-Hill , N.Y. *Glover T. and Mitchell K.* 2002.
4. Fundamentals of statistics. World Press, Kolkota. *Goon, Gupta and Dasgupta* Irfan Ali Khan and Atiya Khanum,
5. Fundamentals of Biostatistics. 2nd Ed. Ukaaz Publications, Hyderabad.
6. Design and analysis of experiments, John Wiley and Sons. *Montgomery D. C.*
7. Sampling methods, Indian Statistical Institute, Kolkota. *Murthy M.N.*
8. Biostatistics, a foundation for analysis in the health Sciences, Edn. 7, Wiley-Indian Edn. *Wayne Daniel* 2007.

GUJARAT VIDYAPEETH
M.Sc. Microbiology
Semester III
MIC-301

BIOMETHANATION

Unit 1 Historical overview, Modern Era, 1950, 1960, Microbial Basis, Methyl Cobalamine era, Serine Era, Esolution of methanobacillus omilanskii, 1970 to present.

Diversity of Methanogens, Classification of Methanogens, Taxa of methanogens, Methanobacteriales, Methanococcales, Methanomicrobiales, Methaosarcinales, Methanopyrales.

Unit 2 Physiology of Methaogens: Substrate range of Methanogens,

Physiological Adaptations (Salinity, temperature, pH, Oxygen, Genetic and Metabolic Regulations, Motility and Gas vesicles reserve materials)

Microbial Interactions: Competition for methanogenic substrates: General considerations, Competition for hydrogen, Competition for acetate, Competition for other methanogenic Substrates, Facultative Interspecies H_2 formate transfer, Obligate Interspecies H_2 formate transfer, Interspecies acetate transfer.

Methods to study Methanogens in Natural Habitats: Cultural Methods, Microscopic, immunological, Molecular Biology, Activity measurement, Stable isotopes.

Methanogenic Habitats: Anaerobic Digesters, Fresh water sediments and soils, marine habitats, Animal GIT, Geothermal habitats, Other habitats

Biotechnological Uses of Mixed Methanogenic Cultures: Novel Substrates and Anaerobic bioreactor Configurations, Thermophilic Anaerobic Digestion, Anaerobic dehalogination.

Unit 3: Biochemistry of Methanogenesis:

Reactions and Enzymes involved in Methanogenesis From CO_2 and H_2: Hydrogenotropic methanogenesis and Bioenergetics, Transition metals required for growth on H_2 and CO_2, Activation of molecular H_2, F420 reducing and Non reducing hydrogenases, H_2 forming methylene tetrahydromethanopterin dehydrogenase, CO_2 reduction to MFR, Mo and Tungstun containing dehydrogenases, Formyl Gr transfer to H_4MPT, Conversion to N^5, N^{10}- Methenyl- H_4MPT, reduction to N^5, N^{10}- Methylene- H_4MPT, reduction to N^5 Methyl- H_4MPT, Methyl transfer to COM, MCR, HDR.

Conversion of Methanol and Methylamine to Methane and CO_2: Metylotropic methanogenic bacteria, substrates utilized by Metylotropic methanogenic bacteria, Route of methanol reduction, reduction of CoM, Route of methanol oxidation, Methyl Gr oxidation to CO_2, Reduction of HDS, Proton translocation and electron transport, Methanogenesis from Methyl amines and Methyl sulphides, Metabolic regulation.

Fermentation of Acetate: Ecology of Acetotrops, Growth and Physiology (Metahnosarcina and Methanothrix), Activation of acetate, C-C and C-s bond cleavage, CODH enzyme complex, Methyl transfer and reductive demethylation of CH_3-COM, electron transport and bioenergetics.

Unit 4: Biosynthesis of Co-enzymes: Methanofuran, Tertahydromethanopterin, HSHTP, COM

Anabolic pathways: Central Anabolic pathways (Acetyl CoA, Pyruvate, Incomplete TCA cycle), Precursor Biosynthesis, Carbohydrate biosynthesis.

Reference: Methanogenesis: Ecology, Physiology, Biochemistry & Genetics. James G. Ferry.

MIC 302: Environmental Biotechnology

Unit	Topics and Content
1	**Waste treatment** Principles of waste treatment, sampling and analysis of wastes. Waste treatment methods and modification of existing processes. Removal of nitrogen and phosphorous. Sludge treatment and disposal.
2	**Waste Treatment Processes:** **Suspended Growth Technology:** Activated Sludge, Oxidation Ditches, Aerated Lagoons, Waste Stabilization ponds. **Fixed Film Technology:** Rotating Biological Contractor (RBC), trickling filters Packed-Bed Reactors, Waste stabilization ponds, Anaerobic Digestion.
3	**Biodegradation of Biomass:** i. Biodegradation of Ligno - cellulosic biomass. ii. Biodegradation of starch. iii. Biopulping and Biobleaching.
4	**Biodegradation of Xenobiots:** i. **Hydrocarbons:** Simple aliphatic, aromatic and **PAHs**: Biodegradative pathways for Naphthalene; Anthracine; Phenanthrine. ii. **Dyes:** Reactive; aerobic; anaerobic degradation. iii. **Pesticides:** Methyl Carbamates: Parathion.

Reference: MIC 302: Environmental Biotechnology

1. Waste water treatment for pollution control, 2nd edition. *Arceivala.*
2. Environmental Microbiology. *R.M. Maier, I. L. Pepper & G.P. Gerba.*
3. Comprehensive Biotechnology Vol-4, *Murray Moo Young.*
4. Biotechnology. *Rehm and Reid.*
5. Industrial pollution Vol. I *E. Joe middle brooks.*
6. Waste water treatment *M. N. Rao & A. K. Datta*
7. Water and water pollution handbook Vol. I, *Leonard, L. Ciaccio.*
8. Industrial pollution, *N. Iruving sax, Van Mostrand Rein hold company.*
9. Encyclopedia of environmental science & tech. Vol. II *Ram Kumar.*

Department of Microbiology, Gujarat Vidyapeeth, Sadra,
Syllabus of **MIC 303 "Industrial Microbiology"**
M.Sc. – IIIrd Semester

UNIT- I Food and Dairy Microbiology

Bread

- Methods of bread production (Sponge dough method; straight dough method; continuous mix method; and liquid ferment method)
- Flavour development
- Dough maturing

Dairy products

- Biochemistry of starters
- Propagation and Management of starters
  - General procedure for preparation of concentrated starter culture
  - Control of starter-culture-inhibition (Presence of Bacteriophage; milk factors)
- General manufacturing principles
- General Process steps used to manufacture fermented dairy products-
  - Procurement of milk
  - Centrifugal clarification and separation
  - Mix preparation for standardization
  - Heat treatment
  - Homogenization
  - Inoculation and incubation
  - Cooling, incorporation of fruit and flavoring and packaging
  - Storage and distribution
  - Manufacture of semi-solid products (Cultured or sour cream; yoghurt; unripened soft cheeses)
- Nutritional properties of fermented dairy products
- Direct acidification

Single cell protein (SCP)

- Microorganisms used for single cell protein production (Algae, yeast, fungi and bacteria)
- Factors affecting SCP production
- Composition of SCP
- Metabolism for SCP production-
  - CO_2 Metabolism
  - Hydrocarbon metabolism (oxidation of aliphatic and aromatic hydrocarbons)
  - Metabolism of one-carbon (C-1) compounds (metabolism of C-1 compounds by bacteria and yeasts)
  - Metabolism of ethanol and glycerol
  - Metabolism of carbohydrates (metabolism of hexose, disaccharides and polysaccharides)
- Types of biomass production (Batch culture; Continuous culture; and Fed-batch culture)
- Examples of biomass production-
  - Carbohydrate substrates (Molasses, whey, fermented whey, sulfite-waste liquor and starch)
  - Non-carbohydrate substrates (Lipids, methanol and alkanes)
  - Carbon dioxide

Single cell oil

- Sources

Composition of fat (Yeast's fat and Mold's fat)
Biosynthesis of triacylglycerols –
Synthesis of fatty acids (Transportation of acetyl CoA from mitochondria to cytosol; elongation of acetyl CoA; and synthesis of unsaturated and long chain fatty acid)
Formation of triacylglycerols (Glycerol formation and fatty acid acylation)

Edible mushroom

History of mushroom cultivation
Importance and uses of mushrooms
Life cycle of mushroom
Line improvement in edible cultivated mushrooms –
Selection techniques (Mono or single spore selection; selection from multi-spore cultures)
Hybridization or cross-breeding
Steps in mushroom growing
Selection of mushroom
Spawn
Spawning (Culture media preparation, culturing and preservation; Preparation of mother spawn and commercial spawn)
Compost preparation (Long and short methods of composting)
Casing
Bottle necks in mushroom production
Fungal diseases
Moulds
Bacterial diseases
Insects-pests (Flies and springtailes)
Mites
Viral diseases
Nematode problems
Abiotic disorders
General guidelines for management of mushroom diseases

References-

1. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology, Volume II Editors- Joshi, V.K. and Pandey, A. Educational Publishers and distributors, New Delhi.
2. Comprehensive Biotechnology: The Principles, Applications and regulations of Biotechnology in Industry, Agriculture and Medicine, Volume III "The Practice of Biotechnology: Current Commodity Products" Editor-in-Chief:- Murray, Moo-young Volume editors- Blanch, H.W.; Drew, S. and Wang, D.I.C. Pergamon Press, Oxford.
3. Industrial Microbiology, Second Edition (2002) By- Prescott, S.C. and Dunn, C.G. Agrobios Publication, Jodhpur.
4. Mushroom Production and Processing Technology, By- Pathak, V.N.; Yadav, N. and Gaur, M. Agrobios Publication, Jodhpur.
5. Biotechnology, 2nd Edition, Volume-9, By- Rehm, H. J. and Reed, G., VCH publication.
6. Biotechnology, Volume-4 "Microbial products-II" Editors- Rehm, H.J. and reed, G. VCH Publication.

UNIT - II Biofertilizers and Biocides

Biofertilizers

Biological Nitrogen Fixers

Rhizobium biofertilizers (Classification of rhizobium on various basis; Ecology and genetics of rhizobium; Cultural and biochemical characteristics of rhizobium; Nodule formation; Nitrogen fixation; Isolation of rhizobium from nodules; Cultivation and mass production of rhizobium biofertilizers- strain selection, preparation of broth, checking the broth, carrier, mixing of broth with carrier and, packing, incubation and storage)

Azolla (Inoculum production and application)

Azotobacter (Isolation, identification, classification and physiology of Azotobacter; Mechanism of nitrogen fixation)

Azospirillum (Isolation, enumeration and identification of Azospirillum)

Blue-green algae (Isolation of Blue-green algae; Mechanism of nitrogen fixation; Production of algal biofertilizer)

Phosphate Solubilizing Microorganisms (Isolation of Phosphate Solubilizing Microorganisms; Quantitative measurement of phosphate solubilization in culture medium)

Composting

Microbiology of composting (Mesophilic stage; Thermophilic stage; Cooling down stage; and Maturing stage)

Factors affecting composting (Separation; particle size of waste material; Nutrients; Other additives; Moisture content; Aeration; Agitation; and Heap size)

Composting of urban wastes and sewage-sludge

Bioinsecticides and Biofungicides

Biological control agents (Predators; Parasitoids; and Pathogens)

Approaches of biocontrol (Classical and inundative biocontrol)

Bacteria (*Bacillus thuringiensis*- Mode of action, limitations in using Bt toxins, and modification methods; *Bacillus sphaericus*; *Paenibacillus popilliae* and *P. lentimorbus*; *Serratia entomophila*)

Fungi (Mode of action; limitations to use of fungi as biocontrol agents)

Viruses (Mode of action; limitations to use viral insecticides; remedy measures)

Production methods for biopesticides (Use of living host; liquid culture fermentation; biphasic spore production; solid substrate fermentation)

Biopesticide stabilization (Drying and freezing)

Storage environment

Commercialization of biopesticides

Mycorrhiza

Types of mycorrhiza and their features (Ectotrophic mycorrhiza; Vesicular-arbuscular mycorrhiza; Ericoid mycorrhiza; Arbutoid mycorrhiza; Orchidaceous mycorrhiza)

Ectomycorrhiza (ECM)

Mechanism of ECM formation

Synthesis of mycorrhiza

Cultural study

Sources of ECM inoculum
Techniques of ECM inoculation (Broadcast and Bending below seeds)

Vesicular-Arbuscular Mycorrhiza (VAM)
Classification
Isolation and identification of VAM spores
Inoculum production and application

Difference between ECM and VAM

References-

1. Biofertilizers In Agriculture and Forestry, Third Revised Edition By- Subba Rao, N.S.
2. Biological Nitrogen Fixation, By- Subba Rao, N.S.; Venkataraman, G.S. and Kannaiyan, S.
3. Biofertilizers and Organic Farming, By- Vyas, S.C.; Vyas, S. and Modi, H.A.
4. Soil Microbiology and biochemistry, By- Payl, E.A. and Clark, F.E.
5. Comprehensive Biotechnology: The Principles, Applications and regulations of Biotechnology in Industry, Agriculture and Medicine, Volume IV "The Practice of Biotechnology: Specialty Products and Service Activities" Editor-in-Chief:- Murray, Moo-young Volume editors-Robinson, C.W. and Howell, J.A. Pergamon Press, Oxford.
6. Biological Control of Environmental Pollution, By- Kumar, P.
7. *Bacillus thuringiensis* as a Biocontrol Agent, By- Kadu, B.B.
8. Basic and Agricultural Biotechnology, By- Purohit, S.S.; Kothari, P.R. and Mathur, S.K.
9. Biotechnology of Filamentous Fungi: Technology and Products, Edited By – Finkelstein, D.B. ; Ball, C. and Worth, B.
10. Soil Microbiology, Fourth Edition of "Soil Microorganisms and Plant Growth" By- Subba Rao, N.S.

UNIT- III Primary and Secondary Metabolites

Organic Acids

Acetic acid

Production technology
Microbiology
Production processes (Earlier and recent processes)

Biology of acetic acid producers (Aerobic and Anaerobic fermentation)

Recovery and purification (Distillation, solvent extraction, combination of these two methods, extractive distillation and carbon adsorption methods)

Citric acid

Uses

Production process (Media, yield, surface and submerged fermentations)

Biochemistry of citric acid fermentation

Recovery (Classical and solvent extraction methods)

Amino Acids

Lysine (Biosynthesis, Recovery, and Enzymatic production)

Glutamic acid

Culture conditions (Carbon source; N- source and pH; growth factors; oxygen supply)

Microbial physiology

- Pathway of glutamic acid production
- Regulatory mechanisms of L-glutamic acid biosynthesis
- Genetic improvement of L-glutamic acid producing microorganisms
- Fermentation process

Vitamins

- **B-12** (Properties, sources, synthesis, production and isolation)
- **Ascorbic acid** (Properties, sources, biosynthesis and production)

Enzymes

- **Protease**
  - Uses
  - Production and extraction of proteases
  - Properties of proteinases
  - Commercial applications
    - Improvement of functional and taste properties of proteins
    - Protein hydrolysis (Soy protein hydrolysis; production of soy sauce; gelatin hydrolysis; casein and whey protein; meat protein recovery; fish protein hydrolysis; meat tenderization)
    - Protein synthesis
    - Detergent enzymes
    - Dairy industry
    - Brewing
    - Baking
    - Leather
- **Lipases**
  - Production
  - Substrate specificity
    - Positional specificity
    - Fatty acid specificity
    - Specificity for the hydrolysis of partial glycerides
    - Phospholipase and Lipoprotein lipase activity
  - Properties
  - Industrial applications
    - Hydrolysis of oils and fats
    - Interesterification of oils and fats
    - Esterification of fatty acids
    - Flavor development in dairy products
    - Washing and cleaning products

Antibiotics

- **Streptomycin** (Mode of action; physico-chemical properties; identification methods; biosynthesis; fermentative production and recovery)
- **Tetracycline** (Mode of action; Structure; biosynthesis; fermentative production and recovery)

References-

1. Comprehensive Biotechnology: The Principles, Applications and regulations of Biotechnology in Industry, Agriculture and Medicine, Volume III "The Practice of Biotechnology: Current Commodity Products" Editor-in-Chief:- Murray, Moo-young Volume editors- Blanch, H.W.; Drew, S. and Wang, D.I.C. Pergamon Press, Oxford.
2. Biotechnology, Volume-4 "Microbial products-II" Editors- Rehm, H.J. and reed, G. VCH Publication.
3. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology, Volume II Editors- Joshi, V.K. and Pandey, A. Educational Publishers and distributors, New Delhi.
4. Biotechnology of Industrial Antibiotics, By- Vandamme, E.J.

UNIT- IV Industrial Products and Chemicals

Industrial Chemicals

2,3 Butanediol (Biochemistry; Chemistry; Fermentation and recovery)

Acetone-Butanol (Microorganisms used; fermentation mechanism; culture maintenance; fermentation; recovery of product)

Ergot Alkaloids

Life cycle

Fungal stages (Conidia formation; alkaloid production- proliferation, differentiation, accumulation and lysis)

Detection of ergot alkaloids

Pharmacology and therapeutic uses

Genetics of ergot fungus

Biosynthesis of ergot alkaloids

Industrial production of ergot alkaloids

Parasitic cultivation of *Claviceps* strains on host plants

Saprophytic cultivation in liquid nutrient media

Isolation, separation and purification

Alcoholic Beverages

Beer (Composition; brewing process; and defects)

Wine (Chemical composition; wine manufacturing process; and defects)

Whisky (Production process and recovery)

Steroid Transformation

Bioconversions

Bioconversions of practical importance (11- hydroxylations; 1-dehydrogenations; and 16-α-hydroxylations)

Bioconversions of limited/potential practical importance (progesterone side chain cleavage; ring A aromatization; and 17-α and 21-hydroxylations)

Alternative bioconversion methods (Use of acetone dried cells; spores; and immobilization of enzymes using a cross-linked polyacrylamide gel)

Sterol degradation

Steroid solubility

Recovery of steroids (Split process; whole-beer process; and cake-extraction process)

Exo-polysaccharides

Dextran

Pullulan (Structue and uses)

Microbial biosynthesis of exopolysaccharides (use of whole cell and use of cell-free system)

Fermentation process (medium composition and other factors)

Recovery of exopolysaccharide products

Objectives of recovery

Common operations of recovery (Cell removal; Isolation of exopolysaccharides; Dewatering and drying; Milling and packaging; Additional processing)

Bioplastics

Types of plastics

Degradation of plastics (Photo-degradation; Heat-degradation and; Microbial degradation)

Biosynthesis of PHA and PHB

Production of bioplastics by anaerobic digestion of biological wastes

Biodegradability tests (Warburg test; ASTMD- 5338; Microbial testing; Biodegradation on solid medium; Biodegradation on broth; Radiocarbon ^{14}C studies; Soil burial method; Visual rating; Ammonia production; Non-biological methods)

Markets for biodegradable polymers

References-

1. Comprehensive Biotechnology: The Principles, Applications and regulations of Biotechnology in Industry, Agriculture and Medicine, Volume III "The Practice of Biotechnology: Current Commodity Products" Editor-in-Chief:- Murray, Moo-young Volume editors- Blanch, H.W.; Drew, S. and Wang, D.I.C. Pergamon Press, Oxford.
2. Biotechnology, Volume-4 "Microbial products-II" Editors- Rehm, H.J. and reed, G. VCH Publication.
3. Fermented Beverage Production, Editors-Lea, A.G.H. and Piggott, J.R.
4. Industrial Microbiology, Fourth Edition (2002) By- Prescott, S.C. and Dunn, C.G. Agrobios Publication, Jodhpur.
5. Encyclopedia of Microbiology, Second Edition Volume 1 Editor-in-Chief- Lederberg, J. Academic Press.
6. Journal of Scientific and Industrial Research, Volume 59, June 2000.

EC 301 Bioprocess Technology

Unit-I: Elements of Bioprocess

1. Isolation of Industrially important microorganisms

1.1 Principles involved in isolation methods:

- 1.1.1 Isolation methods based on selection of desired characters
  - (a) Enrichment liquid culture technique for batch culture
  - (b) Continous enrichment culture technique
  - (c) Use of solidified media
- 1.1.2 Isolation methods based on selectivity not utililizing desired character
  - (a) Screening for the production of antibiotics
  - (b) Screening for pharmaceutically active compounds
  - (c) Screening for production of growth factors

1.2 Secondary Screening

1.3 Future Potential and needs of Microbial Screening

1.4 Classical Strain improvement by Mutation:

- 1.4.1 Occurrence of Mutations::
- 1.4.2 Expression of Mutations
- 1.4.3 Types ,Practical Implications and isolation of microbial mutants

1.5 Directed Selection

- 1.5.1 Isolation of Auxotrophic Mutants
- 1.5.2 Isolation of Mutants requiring no Inducer (Constitutive Mutants)
- 1.5.3 Isolation of Mutants resistant to End Product Repression
- 1.5.4 Isolation of Mutants resistant toCatabolite Repression

1.6 The selection of Mutants Producing high yield of Primary Metabolites

1.7 The Selection of Secondary Metabolite Producing Mutants

1.8 Classical Strain improvement by Recombination:

- 1.8.1 Strain Improvement: Recombination in Strain Construction
- 1.8.2 Fungal Parasexuality
- 1.8.3 Protoplast Fusion

Unit-II: Upstream Processing

2.0 Fermentation Media Formulation

2.1 Criteria used for an ideal fermentation media

2.2 Types and composition of fermentation Media

2.3 Medium Formulation

2.4 Medium Optimization using Statistical Experimental Designs

- (a) Need for Statistical Experimental designs
- (b) Plackett-Burman Design
- (c) Response Surface Methodology
- (d) Simplex Search Method

2.5 Sterilization of Fermentation Media and Fermenter

- 2.5.1 Steam Sterilization of Media
  - 2.5.1.1 Principle,Del factor
- 2.5.2. Classical Techniques of Steam Sterilization
  - 2.5.2.1 Batch Sterilization of Media by Steam
  - 2.5.2.1.1 Batch Sterilization in Fermenter or Bioreactor
  - 2.5.2.1.2 Batch Sterilization in Cooker or Separate Vessel

2.5.3 Continous Sterilization of Media by Steam
2.5.3.1 Working Design of Continuous Sterilization Process
2.5.3.2 Types of Continuous Sterilizers
2.5.4 Media Sterlization by Filter,Chemical Agents,Radiation
2.5.5 Sterilization of the Feeds, Liquid Wastes and Fermentor (Bioreactor)

2.6 Air Sterilization
2.6.1 Types of Air Sterilization
2.6.2 Sterilization of Air by Fibrous Materials
2.6.3 Classification of Air Filters and their Industrial level Aplications
2.6.4 Sterilization of Ferment Exhaust Air

2.7 Inoculum Development
2.7.1 Criteria for an Ideal Inoculum
2.7.2 Principles and Various Aspects of inoculum Development
2.7.3 Inoculum preparation procedures
2.7.3.1 Traditional Procedures
2.7.3.2 Lincolon procedures
2.7.3.3 Recovery of Culture from the preserved State

2.8 The Development of Inocula for-
(a)Bacterial Processes – vitamin B12
(b)Yeast - Brewing
(c)Mycelial Processes
(I) Sporulation on Solidified Media
(i) Penicillin
(ii) Clavulanic Acid
(II) Sporulation on Solid Media
(i) Streptomyces aureofaciens (Chlortetracycline)
(III) Sporulation in Submerged Culture
(i) Penicillim notatum (Penicillin)
(ii) Penicillin patulum (Griseofulvin)

2.9 Aeration And Agitation
2.9.1 Structural Components involved in Aeration Agitation System Impeller, Stirrer glands, Bearings, and Aseptic Seals,Baffles,Sparger
2.9.2 Theory of Oxygen Transfer
2.9.3 Factors Affecting KL and Oxygen Transfer Rate
2.9.3.1 Effect of Dissolved Oxygen Concentration
2.9.3.2 Other Factors
2.9.4 Methods for Determination of Aeration Capacity
2.9.5 Mixing (Agitation)
2.9.5.1 Agitators
2.9.5.2 Gas Supply Underneath the Stirrer
2.9.5.3 Dimensionless Criteria and Geometrical Similarity
2.9.5.4 Bubble hold up in an Aerated Mixing Vessel
2.9.5.5 Turbine Impellar Hydrodynamics
2.9.5.6 Flow pattern in a Mixing Vessel during Aeration
2.9.5.7 Homogenisation Time

2.10 Fluid Rheology
2.10.1 Rheological Behaviour
2.10.2 Rheological variables
2.10.3 Correlations of Rheological variables
2.10.4 Advancement in Viscosity Measurement

2.11 Foam Formation And its Control
- 2.11.1 Mechanism of Foam Formation
- 2.11.2 Effects and Pattern of Foaming
- 2.11.3 Foam Breaking- Physical, Mechanical and Chemical Methods
- 2.11.4 Antifoam Agents and Foam Control

Unit-III: Downstream Processing

3.1 Solid-Liquid Separation
- 3.1.1 Solid-Liquid Separation Methods
- 3.1.2 Coagulation and Flocculation
- 3.1.3 Floatation
- 3.1.4 Filtration
  - 3.1.4.1 factors influencing the choice of filtration System
  - 3.1.4.2 Theory of Filtration
  - 3.1.4.3 The use of Filter aids
  - 3.1.4.4 Types of filtration and Filters
  - 3.1.4.5 Surface filtration
  - 3.1.4.6 Plate and Frame filters
  - 3.1.4.7 Pressure leaf filters
  - 3.1.4.8 Rotary drum vacuum filters
  - 3.1.4.9 Depth filtration
  - 3.1.4.10 Sieving filtration
- 3.1.5 Centrifugation
  - 3.1.5.1 Theory
  - 3.1.5.2 Batch and continuous centrifugation
  - 3.1.5.3 Types of centrifuges (Filter centrifuges and sieve type centrifuges; Decanter and sedimenting centrifuges)
- 3.1.6 Disintegration methods
  - 3.1.6.1 Mechanical methods
  - 3.1.6.2 Shear forces (Solid and liquid shear)
  - 3.1.6.3 Industrial disintegrators
    - (a) Ultrasonic disintegrators
    - (b) Mechanical disintegrators-dynomuhle
    - (c) High-pressure homogenizer
    - (d) Manton-Gaulin Homogenizer
    - (e) Hughes Press or X-press
  - 3.1.6.4 Non-mechanical methods
    - (a) Drying
    - (b) Cell lysis (Physical, chemical and enzymatic)
- 3.1.7 Concentration methods
  - 3.1.7.1 Evaporation
    - (a) Types of evaporators
    - (b) Pilot-plant evaporators
  - 3.1.7.2 Extraction
    - (a) Soild-liquid extraction
    - (b) Liquid-liquid extraction
    - (c) Industrial extractor
    - (d) Extraction of low-molecular weight products
    - (e) Extraction of proteins
  - 3.1.7.3 Ion-exchange processes
    - (a) Solid ion-exchangers
    - (b) Liquid ion-exchangers

(c)Adsorber resins

3.1.7.4 Membrane filtration

(a) Microfiltration and ultrafiltration

(b)Membrane adsorbers

(c) Pervaporation

(d) Perstraction

3.1.7.5 Precipitation

3.1.7.6 Freeze-concentration

3.1.7.7 Dialysis

3.1.7.8 Distillation for solvent recovery

3.1.8 Purification by chromatography

(a) Fundamental mechanism and theory

(b)Matrices used for large-scale chromatography

(c) Advantages and limitations

(d) Principles and applications of Adsorption, ion-exchange, Molecular Sieve, Affinity ,Hydrophobic, Partition, Covalent and Isoelectric focusing

3.1.9 Product Formulation

(a) Drying- Contact,convecton and Freeze dryers

(b) Crystallisation

(c) Whole –Broth Processing

(d) Evaluation of Separation processes

(e) Monitoring of down –stream processing

(f) Process Integration

Unit-IV: Quality Assuarance and Quality Control

4.1 Manufacture,Quality

4.2 Quality Control(QC)

4.3 In process Control

4.4 Quality Assurance(QA)

4.5 Good Manufacturing Practice(GMP)

4.6 Chemicals, Pharmaceuticals, Chemical and Pharmaceutical Production

4.7 The Five variables- raw Materials, In-process items, Finished Products, label and labeling Packaging Materials

4.8 Documentation, Regulations

4.9 General Aspects of Control of Microbial Contamination during manufacture

4.10 Manufacture of Sterile products

4.11 Clean and Aseptic Areas

4.12 Important Publications related to Quality Assurance

4.13 Sterilization Control and Sterility Assurance

(a) Bioburden determinations

(b) Environmental Monitoring

(c) Sterilization Monitors(Physical,Chemical and Biological indicators)

(d) Sterility Testing

4.14 LAL TEST

(a) Rabbit Pyrogen Test(RPT)versus LAL test

(b) Standardisation and Regulation

(c) Application of the Lal Test

EC 302: ANAEROBIC BIOREACTOR DESIGN

UNIT 1:

Introduction: Bioreactor function, utility, types of bioreactors. Modes of bioreactor operations. Main components of the bioreactor and their function.

Introduction, Methods of aeration , Surface aeration Shake flasks, Mechanical, stirred bioreactors.

Enzyme catalysis in CSTR. Cell death in batch reactor, endogenous metabolism, maintenance , Product and substrate inhibition on chemostat

UNIT 2:

Bioreactors and design features, Batch reactor, chemostat CSTR, Plug Flow Reactor, Fed batch reactor, Bubble column, bubble generation at an orifice, bubble coalescence and breakup, gas hold up, interfacial area, immobile and mobile gas liquid interface, regimes of bubbles, design of bubble columns, cascade reactor, air lift reactor, fluidized bed bioreactors, trickle bed reactors, Immobilized bioreactors, recycle bioreactors.

UNIT 3:

Gas –liquid mass transfer in cellular systems, basic mass transfer concepts, solubility of gases (O2, Co2) in biological media, mass balances for two phase bioreactor,

Mass transfer- introduction to mass transfer between phases, mass transfer in porous solids, quantifying mass transfer, mass transfer & experimental design.

Oxygen transfer- introduction, oxygen transfer process, factors affecting KL a, interfacial area and oxygen transfer, factors effecting the saturation concentration of oxygen, oxygen uptake.

UNIT 4:

Mass transfer in agitated tanks, correlations with KL a in Newtonian and non Newtonian liquid, Power number, experimental determination of KL a, Static method, dynamic method, chemical method and electrochemical method.

Power requirement for mixing in aerated and non aerated tanks, agitated and non agitated tanks for Newtonian and non Newtonian fluid.

Mixing time in agitated reactor, residence time distribution, non ideal reactor and multiphase bioreactor

EC 303: BIOENERGY

UNIT 1: Introduction to energy systems and resources

-- Energy ,sustainability and the environment
-- quantifying energy and the energy arithmetic
-- Heat to motive power
-- Electricity- a primer
-- Fossils Fuels –past , present and future
-- 5 remedies and alternatives for fossil fuels.
-- Energy efficiency and conservation.

UNIT 2: Bio Energy

-- Bio Energy resource Production and management
-- Biomass conservation Technologies
-- Bio Liquid fuels and Applications in Engines

UNIT 3: Biofuels

--Energy Source: fossil fuel, non -renewable sources of energy, non -conventional source of energy.
--Combustion of biomasses.
-- Biogas production
-- Bio ethanol production and improvements, bio ethanol production case study of india, Brazil and USA, production of bio hydrogen.
--Biodiesel production, blending , micro emulsification , pyrolysis and Trans esterification.
-- Remediation of pollutants from fuels emissions

UNIT 4: Biomass and Biofuels

--Overview
-- Biogas –anaerobic digesters.
-- Bioenergy from wastes.
-- Dedicated bioenergy crops.
-- Woody biomass
-- Liquid biofuels
--Ethanol –issues & future prospects.
--biodiesel- uses, production, processes.
--Biomass & Bioenergy wrap-up
-- Fuel cells

GUJARAT VIDYAPEETH : AHMEDABAD

Department of Microbiology

M.D. Gramseva Mahavidyalay, Sadra, Dist: Gandhinagar: Pin code- 382320

M.Sc. (Degree) Course with Microbiology subject

(Effective from June-2010) 2011-12

MIC – 101 Microbial Diversity
Practical Syllabus

1. Isolation of Amylase Producers.
2. Isolation of Phosphate Solubilizers.
3. Isolation of Lipase Producers.
4. Isolation of Cellulase Producers.
5. Isolation of Yeasts.
6. Isolation of identification of fungi.
7. Isolation of antibiotic producers.
8. Isolation of identification of unknown microorganism from sewage.

MIC 102 Microbial Physiology
Practical Syllabus

1. To study the antibiotic resistant strain in
   (1) Poor and rich media containing carbohydrate, Protein sources
   (2) High Salt concentration
2. Bacterial growth difference depending on media composition.
3. Yeast budding effects of various physiological parameters/factors.
4. To Study the metabolic diversity of bacteria especially of E. coli(3 different strains)
   i. Particularly on sugar utilization
   ii. Selective pH (optimum)
   iii. Temperature
   iv. Salinity

Semester – I
MIC – 103 Instrumentation and Biostatistic

(1) Estimation of carbohydrates by anthrone's method.
(2) Estimation of reducing sugar by DNSA method.
(3) Estimation of carbohydrate by Nelson somogyi's method
(4) Estimation of protein by folin lowry's method
(5) Paper Chromatography of amino acids
(6) Thin layer chromatography

Sem- I EC- 101 IMMUNOLOGY

(1) Ouchterlony double diffusion (Ab titration)
(2) Ouchterlony double diffusion (Antigen – Antibody titration)
(3) DOT ELISA
(4) Single radial Immuno diffusion
(5) Rocket immune electrophoresis
(6) RA test
(7) Immuno electrophoresis
(8) Quantitative precipitin assay
(9) Antibody labeling

Semester-II
Paper- MIC-201 "Enzymology"

1 Determination of Urease activity in soil by ammonium-N release method.
2 Determination of Urease activity in soil by urea remaining method.
3 Determination of Acid-Phosphatase activity in soil.
4 Determination of Alkaline-Phosphatase activity in soil

Paper MIC202: Molecular Biology and Microbial Genetics
M.Sc. SEMESTER-2 (Practicals)

Practicals:

1. Isolation of pigmentation mutants of *S.marcescens* using Ethidium Bromide/U.V.
2. Isolation of drug resistant mutants of *E.coli* by gradient plate technique.
3. Isolation of drug/biochemical mutants of *E.coli* by replica plating technique.
4. Fluctuation test.
5. Mutagenicity testing using *S.cerevisiae* D7. (Demonstration)
6.

MIC-203 RECOBINANT DNA TECHNOLOGY

(1) Agarose gel electrophoresis
(2) Ultrapure genomic DNA spin mini preps kit from bacteria.
(3) Restriction digestion
(4) Separation of genomic DNA extraction from whole blood.
(5) Separation of genomic DNA from plant (CTAB)
(6) DNA Amplification
(7) SDS PAGE

EC-201: Bioinformatics

(1) A visit to protein Data Bank, Ex PASy, NCBI.
(2) Study of Protein structures by Rasmol, Protein Explorer Deepview.
(3) Sequence alignment using FASTA and BLAST.
(4) Protein structure alignment.
(5) PCR primer designing.
(6) Phylogenetic tree construction.
(7) Use of ExPASy tools.
(8) Active site prediction.
(9) ORF prediction.

Semester-III

MIC - 301-BIOMEHTANATION

(1) Techniques for Anaerobic cultivation
(2) Most probable number of anaerobic bacteria or cultivation of Anaerobic bacteria.
(3) Cultivation of sulfate reducing bacteria by solid and liquid medium.
(4) Most probable number of sulfate reducing bacteria.
(5) Most probable number of hydrogenotrophs and acetotrophs.
(6) Solid cultivation in Anaerobic glove box.

(7) MIC-302 Environmental Biotechnology

(1) To determine total solids of the given water and waste water sample.
(2) To determine total dissolve solids of the given water and waste water sample.
(3) To determine total fixed & volatile solid of the given water and waste water sample.
(4) Determination of acidity of water and waste water sample by titration method.
(5) Determination of alkalinity of water and waste water sample by titration method.
(6) Determination of hardness by EDTA titrometric method in drinking and waste water sample
(7) Determination of chloride by Mohr's method in drinking and waste water sample
(8) Determination of sulphate in water and waste water sample by tubidometric method.
(9) Determination of orthophosphates in waste water and drinking water by vandomolybdoric-acid colorimetric method.
(10) To determine dissolve oxygen content of the given water and waster sample by azide modification method
(11) Determination of 5 day BOD of waste water sample.
(12) Determination of COD of water and waste water sample by open reflux method.
(13) Determination of Nitrogen in waste water sample by open kjeldahel method.

Paper- MIC-303 "Industrial Microbiology

1. Bacteriological analysis of milk by Standard Plate Count method.
2. Bacteriological analysis of milk by Methylene Blue Reduction Test.
3. Determination of Titrable Acidity of milk.
4. Determination of Saponification Number of oil.
5. Microbial Production of Alcohol and its assay.
6. Microbial Production of Single Cell Protein and its assay.
7. Microbial Production of Single Cell Oil and its assay.
8. Microbial Production of Amylase and its assay.
9. Microbial Production of Citrate, its recovery and assay.

EC 301 : Practicals for Bioprocess Technology

1.Determination of Oxygen Transfer rate (OTR)
2.Study of rheological changes of fermentation broth
3.Recovery of exopolysaccharide using acetone
4.Scale up
5. Penicillin Bioassay
6.Validation of Laboratory Instruments (Glasswares)