

HEMCHNDRACHARYA NORTH GUJARAT UNIVERSITY
P A T A N - 3 8 4 2 6 5



NAAC Accreditation Grade - " B "



FACULTY OF SCIENCE

B. Sc. - BIOTECHNOLOGY
New Syllabus and Exam Scheme

Semester - I TO II
With Semester / CBCS / Grading Pattern

W. E. F. June - 2011.

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Date : 30 - 06 - 2011

TOTAL PAGE - 13



Hemchandracharya
North Gujarat University
PATAN – 384 265

Syllabus According To CBCS Semester pattern

B. Sc. (Biotechnology) Syllabus

(Semester I & II)

(With Effect From June 2011)

B . Sc. (Biotechnology)

(With effect from June 2011)

Semester I

Core Compulsory Course (CCC)

CBT 1-I Introduction to Biotechnology and Cell biology

Elective Course (EC) for Biotechnology

EBT 1 Biological evolution

EBT 1 Interdisciplinary relevance and Advancement of Biotechnology Semester II

Practical core course (PCC)

Semester II

Core Compulsory Course (CCC)

CBT 1-II Molecules of life

Elective Course (EC) for Biotechnology

EBT II Biodiversity

EBT 1I Biocomputing

Practical core course (PCC)

PAPER STYLE
Core Course Paper (Biotechnology)
70 marks question paper

Q.1 MCQ type questions (one mark each) **10 marks**
(In Q.1 there must be minimum two questions from each unit)

Q.2 Give very brief answers (Two marks each) **10 marks**
(In Q.2 there must be minimum two questions from each unit)

OR

Q.2 Give very brief answers(Two marks each) **10 marks**

Q.3 Short note type question (Attend any four out of eight) **32 marks**
(In Q.3 there must be minimum two questions from each unit)

Q.4 Detailed note type question (Attend any two out of four) **18 marks**
(In Q.4 there must be one question from each unit)

PAPER STYLE
Elective Course Paper (Biotechnology)
50 marks question paper

Q.1 MCQ type questions (one mark each) **10 marks**
(In Q.1 there must be minimum five questions from each unit)

Q.2 Short note type question (Attend any four out of eight) **24 marks**
(In Q.2 there must be minimum four questions from each unit)

Q.3 Detailed note type question (Attend any two out of four) **16marks**
(In Q.3 there must be minimum two questions from each unit)

Course pattern Subject :Biotechnology

Semester I
(First year B.Sc)

Semester	Paper	Instruction(hr per week)	Marks			Credits
			Internal	External	total	
	Core Course compulsory(CCC)					
1	Core course CCC-I-1	4	30	70	100	4
	Core course 2 CCC-II-1	4	30	70	100	4
	Core course 3 CCC-III-1	4	30	70	100	4
	Practical core course (PCC)					
	Practical core course (For biotechnology) PCC-I-1	4		50	50	2
	Practical core course2- PCC-II-1	4		50	50	2
	Practical core PCC-III-1	4		50	50	2
	Foundation Course (FC)					
	Foundation (Compulsory) course (Generic) - English (L.L.) FCG-1	2	15	35	50	2
	Elective Course (EC)					
	Elective (Generic) Course -I ECG-1	2		50	50	2
	Elective (Subject) Course -I ECS-1	2		50	50	2
		30	105	495	600	24

**Semester 2
(First year B.Sc)**

Semester	Paper	Instruction(hr per week)	Marks			Credits
			Internal	External	total	
	Core Course compulsory(CCC)					
2	Core course CCC-II	4	30	70	100	4
	Core course 2 CCC-II-II	4	30	70	100	4
	Core course 3 CCC-III-II	4	30	70	100	4
	Practical core course (PCC)					
	Practical core course (For biotechnology) PCC-I-II	4		50	50	2
	Practical core course2- PCC-II-II	4		50	50	2
	Practical core PCC-III-II	4		50	50	2
	Foundation Course (FC)					
	Foundation (Compulsory) course (Generic) - English (L.L.) FCG-II	2	15	35	50	2
	Elective Course (EC)					
	Elective (Generic) Course -I ECG-II	2		50	50	2
	Elective (Subject) Course -I ECS-II	2		50	50	2
		30	105	495	600	24

B.Sc Biotechnology

SEMESTER I

SMESTER 1

Core Course Compulsory (CCC I-I)

CBT I-I

Introduction to Biotechnology and Cell Biology

Unit 1

- 1.1. Introduction to Biotechnology
- 1.2. Domains of Biotechnology
- 1.3. Applications of Biotechnology.: Agriculture ,Pharmaceutical, Environment, Fermentation
- 1.4. State, national and international level commercial opportunities in Biotechnology sector.

Unit 2

- 2.1. Microscopy: Fundamental of microscope, light microscopy and specimen preparation Bright field microscopy, Dark field microscopy.
- 2.2. Morphology of Bacterial cell: Size, shape and arrangement of bacterial cells ,External structure: Flagella, Pili, Fimbriae, Prosthacate
- 2.3. Boundary layer: Capsule, cell wall , cell membrane
- 2.4. Dormant forms: Spores and cyst

Unit 3

- 3.1. General organization of eukaryotic cell External structures: Flagella, cilia The cell envelope: boundary layer: cell wall, cell membrane
- 3.2. Internal structures: Cytoplasm, cytoskeleton, nucleus and nucleolus
- 3.3. Endoplasmic Reticulum, Golgi apparatus, Mitochondria Lysosome, Micro bodies (Glyoxysome and Peroxisome) Chloroplast,.
- 3.4. Chromosome: Size, shape, types and basic structure of chromosome, euchromatin and heterochromatin Giant Chromosome: Polytene chromosome and lamp brush chromosome

Unit 4

- 4.1. Cell cycle and overview of its regulation.
- 4.2. Mitosis and meiosis
- 4.3. Cell -Cell interaction
- 4.4. Endocytosis and exocytosis

Elective Course (EC)
EBT 1
Biological evolution

Unit 1

- 1.1. Theories of evolution: Charles Darwin, Lamark and Wallace
- 1.2. Chemical and biological evolution.,
- 1.3. Five kingdom classification system.
- 1.4. Understanding Species: Concept of Species and Speciation, Morphological and Biological explanation for species, Types of Speciation, Rates of Speciation

Unit 2

- 2.1. Isolation: Concept of Isolation, Mechanism of Isolation, Factor responsible for isolation, Types of Isolation.
- 2.2. Reproductive isolation, Types of Reproductive isolation, Role of Reproductive isolation in species formation.
- 2.3. Adaptation: Concept of Adaptation, Types of Adaptation
- 2.4. Adaptation and predators, adaptation and population.

Elective Course (EC)
EBT 1

Interdisciplinary relevance and Advancement of Biotechnology

Unit-1

- 1.1 What is interdisciplinary areas?
- 1.2 Biotechnology and relevance with Chemistry, Physics and Maths
- 1.3 Biotechnology and relevance with Agriculture, Medical, Pharmaceuticals
- 1.4 Advantage of Interdisciplinary subject

Unit-2

- 2.1. Advancement of Biotechnology in Crop Improvement for edible Vaccine and biopesticide.
- 2.2. Advancement of Biotechnology in Fermentation for organic acids
- 2.3. Advancement of Biotechnology in Health care for vacci
- 2.4. Advancement of Biotechnology in Sustainable development for Environment

Semester I

Practical Core course (PCCI-I)

1. Introduction to lab environment-Safety measures and introduction to lab equipments, glass wares and accessories ,Disposal of laboratory waste and cultures
2. Microscopy : Simple, compound and phase contrast; Basic components of microscope and their working principle
3. Staining techniques :Simple-Monochrome and Negative Differential- Grams and Special-Capsule, Spore, Cell wall.
4. Study of Bacterial Motility
5. Micrometry: Measurement of given biological sample
6. Use of Hemacytometer and determination of cell densities of Yeast cell
7. Preparation of permanent slides showing different stages of cell division – Meiosis and Mitosis

B.Sc Biotechnology SEMESTER II

SRMESTER II

Core Compulsory course (CCC I-II)

CBT I-II
Molecules of life

Unit 1

- 1.1. Overview of major elements involved in formation of biomolecules: C,N,P,S,O,H Water: chemical composition, role of hydrogen bonds, interactions with polar and non polar molecules, Water as reactivate, ionization of water, Solvent properties of water and importance
- 1.2. Buffers: Buffer systems and buffer system of blood, weak acid and weak base, dissociation constant of weak acid and base ,
- 1.3. pka values and their importance, pH and pH scale, acid dissociation constant pka and titration curve, Handerson-Hasselbalch equation
- 1.4. Structure of atoms and molecules and chemical bonds (covalent, ionic, Hydrogen, van der waal's, hydrophobic).

Unit 2

- 2.1. Carbohydrates Monosaccharides: Nomenclature and Classification, Hawarth and fischer projection.
- 2.2. Monosaccharide as reducing agent, stereoisomerism
- 2.3. Disaccharides formation and its biological importance.
- 2.4. Poly saccharide : types and biological importance

Unit 3

- 3.1. Amino acid: Classification and properties.
- 3.2. Proteins: Primary and secondary structure of proteins, tertiary and quaternary structure of proteins
- 3.3. Vitamins: water soluble and fat soluble vitamins and their biological significance.
- 3.4. Lipids: Classification, properties and biological importance.

Unit 4

- 4.1. Nucleotides: structure, chemical properties and functions,
- 4.2. Structure of DNA double helix
- 4.3. Alternative forms of DNA.
- 4.4. Types, structure and biological functions of RNA.

Elective Course (EC2)
EBT II
Biodiversity

Unit 1

- 1.1. Definition, Introduction
- 1.2. Types of biodiversity Genetic Diversity ,Species Diversity ,Ecological diversity and functional diversity
- 1.3. overview of microbial diversity
- 1.4. overview of plant diversity

Unit 2

- 2.1. Importance if biodiversity Applications of internet in society.
- 2.2. Biodiversity conservation
- 2.3. Loss of biodiversity.
- 2.4. Role of biotechnology in biodiversity conservation.

Elective Course (EC2)
EBT II
Biocomputing

Unit 1

- 1.1. Introduction to computer science.
- 1.2. History and generations of Computer.
- 1.3. Basics of Hardware components of computer.
- 1.4. Basics Software components of computer

Unit 2

- 2.1. Concepts of internet.
- 2.2. Applications of internet in society
- 2.3. Concept of HTML,HTTP,URL,Domain,Search engine
- 2.4. Computer and Internet in Biotechnology

Semester II

Practical Core Course(PCCI-II)

1. Preparation of standard solutions and buffer solutions
2. Preparation of buffer solutions
3. Operation of pH meter and measurement of pH
4. Qualitative tests for carbohydrates
5. Qualitative tests for Amino acids
6. Titration curve of amino acids and determination of pI, pK1 and pK2
7. Estimation of reducing sugar.
8. Estimation of non reducing sugar.



પરિપત્ર ક્રમાંક- ૦૧/૨૦૧૨

Minal Trivedi
૦૬/૦૪/૨૦૧૨

વિષય : બી.એસસી.-બાયોટેકનોલોજી ના સેમસ્ટર-૩ અને ૪ ના નવા અભ્યાસક્રમ/સ્કીમ અંગે..

આ યુનિવર્સિટીના લાઈફ સાયંસ ડીપાર્ટમેન્ટના અધ્યક્ષશ્રી તથા સંલગ્ન સાયંસ કોલેજોના આચાર્યશ્રીઓને જણાવવાનું કે, બાયોટેકનોલોજી વિષયની અભ્યાસ સમિતિએ ભલામણ કર્યાનુસાર બી.એસસી.-બાયોટેકનોલોજી નો સેમસ્ટર-૩ અને ૪ નો સેમસ્ટર/ સીબીસીએસ/ ગ્રેડીંગ પેટર્નનો સામેલ પરિશિષ્ટ પ્રમાણેનો અભ્યાસક્રમ/ સ્કીમ જૂન-૨૦૧૨ થી ક્રમશઃ અમલમાં આવે તે રીતે એકેડેમિક કાઉન્સિલ વતી માન.કુલપતિશ્રીએ મંજૂર કરેલ છે. જેનો અમલ થવા સારૂ સંબંધિતોને જાણ કરવામાં આવે છે.

આ બાબતની અધ્યાપકશ્રીઓ તથા વિદ્યાર્થીઓને આપના સ્તરેથી જાણ કરવા વિનંતી છે.

બિડાણ : ઉપર મુજબ.

કુલસચિવવતી

નં.-એ કે/અસ/૨૦૧૨/૨૦૧૨
યુનિવર્સિટી રોડ, પો.બો. નં.-૨૧
પાટણ. -૩૮૪૨૬૫. (ઉ.ગુ.)
તારીખ : ૦૪/૦૪/૨૦૧૨

પ્રતિ,

૧. અધ્યક્ષશ્રી, લાઈફ સાયંસ ડીપાર્ટમેન્ટ, હેમ. ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ.
૨. સંલગ્ન સાયંસ કોલેજોના આચાર્યશ્રીઓ
૩. ડો. એમ. બી. પ્રજાપતિ (ડીનશ્રી-વિજ્ઞાન વિદ્યાશાખા) ગણિતશાસ્ત્ર ડીપાર્ટમેન્ટ, હેમ. ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ.
૪. પરીક્ષા નિયામકશ્રી, હેમચંદ્રાચાર્ય ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ. (પાંચ નકલ)
૫. ગ્રંથપાલશ્રી, હેમચંદ્રાચાર્ય ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ. (વિદ્યાર્થીઓના ઉપયોગ સારૂ રેકર્ડ ફાઈલ માટે)
૬. ઈન્ચાર્જશ્રી, કોમ્પ્યુટર(રીઝલ્ટ) સેન્ટર, હેમ.ઉ.ગુ.યુનિવર્સિટી, પાટણ. તરફ પરિણામ માટે તથા વેબ સાઈટ પર મૂકવા સારૂ.
૭. કુલપતિશ્રી/કુલસચિવશ્રીનું કાર્યાલય, હેમચંદ્રાચાર્ય ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ.
૮. પ્રવેશ પ્રશાખા (એકેડેમિક), હેમ. ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ.
૯. મહેકમ શાખા, હેમ. ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ. તરફ - પરિપત્રની ફાઈલ અર્થે.

HEMCHNDRACHARYA NORTH GUJARAT UNIVERSITY
PATAN - 384 265



NAAC Accreditation Grade - " B "



FACULTY OF SCIENCE

B. Sc. PROGRAMME

BIOTECHNOLOGY
Syllabus / Scheme

SEMESTER - III & IV

- WITH SEMESTER / CBCS / GRADING PATTERN

W. E. F. JUNE - 2012 (In Continuation)

TOTAL PAGE - 13.

DATE : 25-04-2012

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B.Sc. Biotechnology
Semester- 3 and 4
(With Effect from June 2012)

		Instruction hrs/week	Internal exam	Uni. Exam	Total	Credit
Semester-IV						
Core Compulsory Course (CCC)						
CCC-I-5	Core Course-I (Paper-5) (Biotechnology)	3	30	70	100	3
CCC-I-6	Core Course-I (Paper-6) (Biotechnology)	3	30	70	100	3
CCC-II-5	Core Course-II (Paper-5)	3	30	70	100	3
CCC-II-6	Core Course-II (Paper-6)	3	30	70	100	3
Practical Core Course (PCC)						
PCC-I-5	Practical Core Course-I (Paper-5) (Biotechnology)	3		50	50	1.5
PCC-I-6	Practical Core Course-I (Paper-6) (Biotechnology)	3		50	50	1.5
PCC-II-5	Practical Core Course-II (Paper-5)	3		50	50	1.5
PCC-II-6	Practical Core Course-II (Paper-6)	3		50	50	1.5
Foundation Course (FC)						
FCG-4	Foundation (Compulsory) course (Generic) - English (L.L.)	2	15	35	50	2
Elective Course (EC)						
ECG-4	Elective (Generic) Course - I	2		50	50	2
ECS-4	Elective (Subject) Course - I	2		50	50	2
		30	135	615	750	24

B.Sc. Biotechnology
Semester- 3
Core compulsory Course- I Paper 3
Paper: Cellular metabolism-I

Unit-1 Bioenergetics and Thermodynamics

1. Bioenergetics: Definitions of System, universe, Enthalpy, Entropy, Endothermic and Exothermic reactions, Gibbs Free energy, Equilibrium constant & its biological significance.
2. Laws of thermodynamics, Relationship between standard free energy change, free energy change and equilibrium constant.
3. ATP as a universal energy currency of biological systems.
4. Biological oxidation: Redox reactions and Reduction potential, standard reduction potential E° Free-Energy Change

Unit-2 Basics of Enzyme

1. Enzymes: Enzyme as a biocatalyst, coenzyme, cofactor, Nomenclature and Classification of enzyme, Basic concept of enzyme substrate reaction.
2. Factor affecting on enzyme catalyze reaction
3. Overview of catalytic mechanisms of enzyme:
4. Enzyme kinetics: : M-M kinetics , Double reciprocal plot

Unit-3 Enzyme kinetics and regulation

1. Inhibition of enzyme.
2. Quaternary structure of protein: Hemoglobin
3. Regulations of enzymes- allosteric and Covalent regulation:
4. Basic concept of metabolism.

Unit-4 Glucose Metabolism

1. Glycolysis and fate of pyruvate (Alcohol and lactic acid fermentation.)
2. TCA cycle
3. Pentose phosphate pathway
4. Gluconeogenesis.

B.Sc. Biotechnology

Practical Core Course (PCC-I-3 & PCC-I-4)

(Course I (Paper 3 and 4))

Semester- 3

Practical

Estimation of Protein & Sugar

1. Quantification of protein using by Biuret test
2. Quantification of protein using by Folin-Lowary assay.
3. Quantification of protein using by Bradford's method
4. Estimation of Reducing Sugar by DNSA method

Assaying of various enzymes (any three):

5. Amylases.
6. Phosphatases
7. Invertase.
8. Proteolytic enzymes.
9. Lipases

Enzyme Kinetics:

10. Effect of Substrate concentration (Determination of K_m and V_{max}).
11. Determine temperature optima of the enzyme.
12. Effect of pH on enzyme activity.
13. Effect of enzyme concentration

Analytical techniques

14. To determine maximum absorption spectra of colored solution.
15. Paper Chromatography of Amino acids
16. TLC Chromatography of Amino acids

B.Sc. Biotechnology
Semester- 4

B.Sc. Biotechnology
Semester- 4
Core compulsory Course-I (Paper 6) :
Paper: Fundamentals of Microbiology

Unit-1 Introduction to Microorganisms

1. **Bacteria:** Major Characteristics of microorganism. Taxonomic group, General methods of classifying bacterial. Nomenclature, Introduction to Bergey's manual.
2. **Fungi:** General characteristics and Economic importance of fungi.
3. **Algae & Protozoa :** Biological and economical importance
4. **Virus:** General characteristics, structure and Classification of Bacteriophage. Lytic cycle and lysogenic cycle.

Unit-2 Microbial physiology

1. **Types of bacteria** based on Carbon , energy, electron sources and pH, temperature, and O₂ requirement
2. **Culture media** and its types, Methods of isolation of bacterial
3. Reproduction in bacteria, Bacterial growth curve.
4. Methods Measurement of bacterial growth

Unit-3 Control of microbial growth

1. Introduction of terms: Sterilization, Disinfection, Antiseptic, Germicide, Chemotherapy, Antibiotic etc.
2. **Physical agent:** Mode of action and application of Temperature. Radiation and Filtration.
3. **Chemical agent:** Mode of action and application of Phenol, alcoholic and halogen compounds.
4. **Chemical agent :** Mode of action and application of Heavy metal and Gaseous agent

Unit-4 Microbial Diseases and prevention

1. Overview on Origin of Chemotherapy.
2. **Antibiotics:** Class of antibiotics based on mode of action, Antifungal & Antiviral antibiotic
3. **Introduction of terms:** infection, pathogen, virulence, carrier, nosocomial and opportunistic infections, sepsis, septicemia, septic shock, virulence factors etc.
4. **Microbial pathogenesis:** Representative diseases to be studied in detail are
Bacteria: cholera, typhoid, tuberculosis, **Viruses :** AIDS. **Fungi:** mycoses.
Protozoa: amoebiasis,

B.Sc. Biotechnology
- Elective Course(EC)
Biotechnology(Subjective)
Semester- 4

Paper: introduction of System specific Diseases of human

Unit -1 : General

1. **Respiratory Tract infection** : Rhinitis (common cold), Pertussis, Tuberculosis, Pneumonia
2. **Urogenital Tract infection** : Vulvovaginitis, Gonorrhea, Syphilis
3. **Infection of Digestive Glands and Peritoneum** : hepatitis, Yellow fever (liver)
4. **Eyes and ears infection** : Conjunctivitis/scleritis, Otitis media

Unit -2

1. **Gastrointestinal Tract infections** : Shigellosis (dysentery) Cholera, Salmonellosis, Amebosis
2. **Infections of Nervous System** : Meningitis, Tetanus, Botulism
3. **Infections of Hematopoietic and Lymphoreticular System** : Plague, HIV infection, Malaria
4. **Infections of Skin and Subcutaneous Connective Tissue** : Smallpox, Herpes, Measles

Elective Course(EC)
Biotechnology(Subjective)
Semester- 4

Paper: Plant Hormones

Unit -1 Plant hormones-I

1. Definition, General Functions, Types of Plant Hormones :
2. Auxins
3. Gibberellins
4. Cytokinins (= Kinins),

Unit -2 Growth Inhibitors

1. Absciscic Acid
2. Morphactins
3. Oligosaccharins and Other Natural Growth Hormones In Plants
4. Plant Hormones Versus Animal Hormones

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परिपत्र क्रमांक - ९९५ / २०१३

વિષય : વિજ્ઞાન વિદ્યાશાખામાં સ્નાતક કક્ષાના સેમેસ્ટર/ સીબીસીએસ/ ગ્રેડીંગ પેટર્નના સેમેસ્ટર-૫ અને ૬ ના અભ્યાસક્રમ/ સ્કીમ મોકલવા અંગે..

આ યુનિવર્સિટી સંલગ્ન વિજ્ઞાન કોલેજોના આચાર્યશ્રીઓને જણાવવાનું કે, આ યુનિવર્સિટીમાં વિજ્ઞાન વિદ્યાશાખામાં સ્નાતક કક્ષાએ જૂન-૨૦૧૧ થી દાખલ કરવામાં આવેલ સેમેસ્ટર/ સીબીસીએસ/ ગ્રેડીંગ પેટર્ન અન્વયે એકેડેમિક કાઉન્સિલે તેની તારીખ : ૧૪/૦૫/૨૦૧૩ ની સભામાં પાછળ દર્શાવેલ વિગતે વિવિધ વિષયોના સામેલ પરિશિષ્ટ પ્રમાણેના સેમેસ્ટર-૫ અને ૬ ના અભ્યાસક્રમ/ સ્કીમ જૂન-૨૦૧૩ થી ક્રમશઃ અમલમાં આવે તે રીતે મંજૂર કરેલ છે. જે સંબંધિત સર્વેની જાણ તથા અમલ સારું આ સાથે મોકલવામાં આવે છે.

આ બાબતની અધ્યાપકશ્રીઓ તથા વિદ્યાર્થીઓને આપના સ્તરેથી જાણ કરવા વિનંતી છે.

નોંધ : (૧) સામેલ અભ્યાસક્રમોની યાદી પાછળ સામેલ છે. વિદ્યાર્થીઓની જરૂરીયાત માટે તમામ અભ્યાસક્રમોની એક નકલ આપની કોલેજના ગ્રંથાલયમાં મૂકવાની રહેશે.

(૨) આ તમામ અભ્યાસક્રમો યુનિવર્સિટીની વેબ સાઈટ www.ngu.ac.in પર પણ ઉપલબ્ધ કરવામાં આવનાર છે.

બિડાણ : ઉપર મુજબ.

कुलसेचिववती

નં.-એ કે/અ x સ/ 3233/૨૦૧૩
તારીખ : ૧૨/૦૬/૨૦૧૩

प्रति,

૧. સંલગ્ન વિજ્ઞાન કોલેજોના આચાર્યશ્રીઓ

૨. ડૉ.એમ.બી. પ્રજાપતિ (ડીનશ્રી-વિજ્ઞાન વિદ્યાશાખા) મેથેમેટીક્સ ડીપાર્ટમેન્ટ, યુનિવર્સિટી કેમ્પસ, હેમ. ઉ. ગુ.યુનિવર્સિટી, પાટણ.

૩. પરીક્ષા નિયામકશ્રી, હેમચંદ્રાચાર્ય ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ. (પાંચ નકલ)

૪. ગ્રંથપાલશ્રી, હેમચંદ્રાચાર્ય ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ. (વિદ્યાર્થીઓના ઉપયોગ સારૂ રેકર્ડ ફાઈલ માટે)

પ. ઈન્વાર્જશ્રી, કોમ્પ્યુટર(રીઝલ્ટ) સેન્ટર, હેમ.ઉ.ગુ.યુનિવર્સિટી, પાટણ. તરફ ⇒ પરિજ્ઞામ માટે તથા વેબ સાઈટ પર મૂકવા સારું.

૬. માન.કુલપતિશ્રી/ ઉપકુલપતિશ્રી/ કુલસચિવશ્રીનું કાર્યાલય, હેમચંદ્રાચાર્ય ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ.

૭. પ્રવેશ પ્રશાખા (એડેડેમિક), હેમચંદ્રાચાર્ય ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ.

૬. મહેકમ શાખા, હેમચંદ્રાચાર્ય ઉત્તર ગુજરાત યુનિવર્સિટી, પાટણ. તરફ \Rightarrow પરિપત્રની ફાઈલ અર્થે.

Wind
2/6/13.

વિજ્ઞાન વિદ્યાશાખામાં સ્નાતક કક્ષાએ જૂન-૨૦૧૧ થી અમલી સેમેસ્ટર/ સીબીસીએસ/ ગ્રેડીંગ પેટર્ન પ્રમાણેના એકેડેમિક કાઉન્સિલની તારીખ : ૧૪/૦૫/ ૨૦૧૩ ની સભાએ મંજૂર કરેલ સેમેસ્ટર-૫ અને ૬ ના અભ્યાસક્રમ :

SR NO	ACADEMIC COUNCIL [Dated : 14/ 05/ 2013, Resolution Nos.]	SUBJECT	SYLLABUS & SCHEME	SEMESTER
1	2	3	4	5
1	28	Chemistry	B. Sc.	Sem. - 5 & 6
2	29	Mathematics	B. Sc.	Sem. - 5 & 6
3	31	Biotechnology	B. Sc.	Sem. - 5 & 6
4	32	Zoology	B. Sc.	Sem. - 5 & 6
5	33	Botany	B. Sc.	Sem. - 5 & 6
6	34	Micribiology	B. Sc.	Sem. - 5 & 6
7	35	Physics	B. Sc.	Sem. - 5 & 6
8	25	Statestics	B. Sc.	Sem. - 3 & 4

HEMCHNDRACHARYA NORTH GUJARAT UNIVERSITY
P A T A N - 3 8 4 2 6 5



NAAC Accreditation Grade - " B "



FACULTY OF SCIENCE

B. Sc. PROGRAMME

BIOTECHNOLOGY

Syallbus / Scheme

SEMESTER - V & VI

WITH SEMESTER / CBCS / GRADING PATTERN

W. E. F. JUNE - 2013 (In Continuation)

TOTAL PAGE - 2.

DATE : 25-09-2012

HEMCHANDRACHARYA NORTH GUJARAT UNIVERSITY, PATAN

B.Sc. Programme with 144 credits

CBCS-Semester-Grading Pattern

Part/Class	Subject code	Study components	Instructions Hrs / week	Examination			Credit
				Internal	University Exam	Total	
Sem-V B.Sc.		Semester V					
		Core compulsory (CC) Course					
	CC-I-7	Core Course-I (Paper-7)	3	30	70	100	3
	CC-I-8	Core Course-I (Paper-8)	3	30	70	100	3
	CC-II-9	Core Course-II (Paper-9)	3	30	70	100	3
	CC-II-10	Core Course-II (Paper-10)	3	30	70	100	3
		Practical Core (PC) Course					
	PC-I-7,8,9 & 10	Practical Core Course-I (Paper-7,8,9 & 10)	12		200	200	6
		Foundation Course (FC)					
	FC-31	Compulsory English (L.L.)	2	15	35	50	2
		Elective Course (E)					
	EG-31	Elective (Generic) Course	2		50	50	2
	ES-3	Elective (Subject) Course	2		50	50	2
			30	135	615	750	24

Part/Class	Subject code	Study components	Instructions Hrs / week	Examination			Credit
				Internal	University Exam	Total	
Sem-VI B.Sc.		Semester VI					
		Core compulsory (CC) Course					
	CC-I-11	Core Course-I (Paper-11)	3	30	70	100	3
	CC-I-12	Core Course-I (Paper-12)	3	30	70	100	3
	CC-II-13	Core Course-II (Paper-13)	3	30	70	100	3
	CC-II-14	Core Course-II (Paper-14)	3	30	70	100	3
		Practical Core (PC) Course					
	PC-I-11,12,13 & 14	Practical Core Course-I (Paper-11,12,13 & 14)	12		200	200	6
		Foundation Course (FC)					
	FC-32	Compulsory English (L.L.)	2	15	35	50	2
		Elective Course (E)					
	EG-32	Elective (Generic) Course	2		50	50	2
	ES-32	Elective (Subject) Course	2		50	50	2
			30	135	615	750	24

CC-I-7

PAPER-7

BIOPROCESS AND BIOCHEMICAL ENGINEERING

UNIT-1

- Primary and secondary screening.
- Strain Improvement : Nature of mutation, mutagenesis, isolation of mutants.
- Strain Improvement : Application of recombinant DNA technique in strain construction.
- Techniques for preservation and storage of cultures.

UNIT-2

- Fermenter and bioreactor : Design and types of various fermenters.
- Introduction to Aeration and agitation.
- Basic concept of growth.
- Batch, fed-batch and continuous culture operations, chemostat and turbidostat.
- Starter culture, its importance and preparation.

UNIT-3

- Introduction and types of fermentation media
- Raw materials used in fermentation media.
- Media optimization.
- Sterilization of media, air and equipments.

UNIT-4

- Overview of downstream processing.
- Fermentation economics.
- Fermentation process of alcohol.
- Fermentation process of antibiotic (penicillin).

REFERENCES

- L.E. Casida. Industrial Microbiology by.
- Stanbury and Whitaker. Principles of fermentation technology.
- Sikyta. Methods in Industrial microbiology. Ellis Hardwood Ltd.
- Krysman. Product recovery in bioprocess technology.
- T.K. Ghose. Bioprocess computation in biotechnology, Ellis Hardwood Ltd.
- Demain et al. (ED) 1999. Manual of industrial Microbiology and Biotechnology. Asin Press.

④ ②
B.Sc.

- Doran (D). Bioprocess Engineering Principles; Academic Press, 1998.
- Cooney, A.E. Humphrey, Comprehensive Biotechnology : The principles and Regulation of Biotechnology in Industry, Agriculture and Medicine. Vol.2, Pergamon Press, 1985.

CC-I-8

PAPER-8

MOLECULAR GENETICS

UNIT-1

- Overview of nucleic acids.
- Alternative forms of DNA.
- Genomic organization of prokaryotic and eukaryotic cells.
- DNA as genetic material : Experimental evidences - Transformation principles, Viruses, Watson and Crick Model.
- Concept of central dogma.

UNIT-2

- Enzymes involved in DNA replication.
- Process of replication : Initiation, Elongation and Termination.
- Replication of entire DNA molecule; Distinguishing features of DNA replication between prokaryotes and eukaryotes.

UNIT-3

- Types of RNA molecules.
- Transcription-Initiation; RNA polymerase; elongation and termination, the distinguishing features of the processes in prokaryotes and eukaryotes.
- RNA Processing
- The genetic code

UNIT-4

- Translation-Initiation, elongation and termination of translation.
- Post translational modifications.
- Regulation of gene expression, lac-operon.
- Transposable elements : Structure and mechanism of transposition, and Transposable elements.
- RNA interference : a mode of gene regulation.

⑤ ③
B.S.C

REFERENCES

- Lewin B. (2000) Gene VII IRL Press, Oxford University Press Oxford.
- Watson, J.D., Hopkins, Roberts, Stiez, Weiner. (1987) Molecular Biology of the Gene. (4th Ed) The Benjamin/Cummings Publishing Co. Inc. California.
- Davis, D.B. Dulbecco, R., Risen, H.N, Ginsberg. H.S., (1990) Microbiology, (4th Ed) Harper & Row Publishers, Singapore.
- T.A. Brown Genome.
- S.B. Primrose Principle of gene manipulation.

H. N. G. U.

④

B.Sc. - ~~Arts~~ *Biotechnology*

CC-I-9

PAPER-9

Principles of Biotechnology Applied to Plants

UNIT-1

- Principles of tissue culture : Historical perspectives and development of plant tissue culture techniques.
- Cell growth and differentiation – morphogenesis.
- Concepts of totipotency of cells.
- Laboratory requirements for tissue culture.

UNIT-2

- Culture media : preparations / constituents and concepts of sterilization.
- Preparation, Isolation and selection of explants.
- Liquid cell suspension cultures; Pollen culture and protoplast culture production and uses of haploids.

UNIT-3

- Gene transfer techniques using Agrobacterium.
- DNA mediated gene transfer, basics of GMO.
- Transgenic plants.
- Crop improvement (viral resistance, insect resistance, microbial resistance, herbicide, tolerance and stress resistance).

UNIT-4

- Preservation techniques of germplasm.
- Plant tissue culture and secondary metabolite production.
- Production of synthetic seeds.
- BT cotton.

REFERENCES

- H.S. Chawla. Introduction to Plant Biotechnology
- Iganacimatha. Basic biotechnology.
- Das and Mookerjee. Outline of biology.
- David Bourgaize. Biotechnology, Demystifying the concepts. Alp. 2000.
- Eric. S. Grace. Biotechnology unzipped : Promises and realities.



- Cohn and Stumph. Outline of Biochemistry, Wiley eastern.
- Miglani. Dictionary of plant genetics and molecular biology. Viva Books.
- Iganacimatha. Appl. Plant Biotechnology.
- K.K. De. Plant tissue culture.
- Radint and Bhojwani. Plant and tissue culture.
- Dixon and Gonzales. Plant cell culture. A practical approach. IRL press.
- Verpoorte, R. (Ed.) 2000. Metabolic engineering of plant secondary methabolism.
- Bernard, R. Glick and Pasternak. Molecular biotechnology.
- Bulter and Dawson. Cell culture.

CC-I-10

PAPER-10

Principles of Biotechnology Applied to Animals

UNIT-1

- Animal Tissue Culture: History and Scope of Animal Tissue Culture.
- Culture media, Natural and chemically defined media, Serum and Serum free media, other supplements in media and their use.
- Primary cultures: Primary Cultures, Cell lines and Its Maintenance.
- Finite and Continuous cell lines, Tissue Disaggregating by Mechanical and Enzymatic methods, Subculturing.

UNIT-2

- Secondary Culture – transformed animal cells and continuous cell lines.
- Organ Culture : Methods of Organ culture, utility of organ culture, Culture of adult organs.
- Cryopreservation and transport of animal tissue and cell lines.
- Bioreactors: Bioreactor for large scale culture of cells.

UNIT-3

- Expression vector for Animal cell.
- Expression of Cloned proteins in animal cell.
- Overproduction and downstream processing of the expressed proteins.
- Cloning : Overview, Methods of Cloning, Application and Ethics, *In vitro* fertilization and embryo transfer, Application.

UNIT-4

- Hybridoma Technology : Hybridoma and monoclonal antibodies, Production, Methods, Types of Monoclonal Antibodies & Applications.
- Vaccines: Production of Vaccines in animal Cells, Methodology, Application and limitation.
- Transgenic animals: Techniques for the production of Transgenic Mice, Fish and ship, Products produced from Transgenic Animals.
- Stem Cell Technology: Overview and Types of Stem Cell, Characteristics of Stem Cell, Application of Stem cell in Therapy.

REFERENCES

- Iganacimatha. Basic biotechnology.
- Das and Mookerjee. Outline of biology.

- Roy and De. Cell biology.
- David Bourgaize. Biotechnology, Demystifying the concepts. Alp. 2000.
- Eric. S. Grace. Biotechnology unzipped : Promises and realities.
- Jan kav. Introduction to Animal physiology. Viva Books.
- Babinnk and philips. 1989. Animal Biotechnology. Pergamonn.
- Gibert. Developmental biology.
- Jenklus N. 1999. Animal cell biotechnology. Methods and protocols Humana press.
- Butler and Walter, 1997. Animal cell cultures and technology : The basics. IRL press.
- Masters JRW (ED.) Animal cell culture : A practical approach. 2000. OUP.
- Elements of Biotechnology : P.K. Gupta.
- Molecular biotechnology : Bernard, R. Glick and Pasternak.
- Animal cell culture : Morgan.
- Cell culture : Bulter and Dawson.

B.Sc. BIOTECHNOLOGY**Elective Course (EC)(Subjective)****Semester- 5****Paper : ECOLOGY AND ECOSYSTEMS****UNIT-1**

- Terrestrial Biomes – Grasslands and Forests.
- Aquatic Biomes – Freshwater and Saline water.
- Biogeochemical Cycles – Carbon and Nitrogen cycle.
- Interaction Within, Between and Among Populations.

UNIT-2

- Experimental Ecosystem Models – Batch system, Flow-Through system.
- Experimental Ecosystem Models – Microcosms.
- Microbes within Macro-communities.
- Structure and Function of some Microbial Communities.

B.Sc. BIOTECHNOLOGY

Elective Course (EC)(Subjective)

Semester- 5

Paper : INDUSTRIAL BIOTECHNOLOGY

UNIT-1

- Fermentation processes of Amylase.
- Fermentation processes of Protease.
- Fermentation processes of Citric acid.
- Fermentation processes of Streptomycin.

UNIT-2

- Fermentation processes of L-Lysine.
- Fermentation processes of Vitamin-B₁₂.
- Mushrooms.
- Single Cell Protein.

B.Sc. BIOTECHNOLOGY
PRACTICAL CORE COURSE
(PAPER-7, 8, 9 & 10)
SEMESTER-5

LIST OF EXPERIMENTS

1. Isolation, Screening and characterization of Amylolytic microbes and Enzymes.
2. Isolation, Screening and characterization of Proteolytic microbes and Enzymes.
3. Isolation, Screening and characterization of Lipolytic microbes and Enzymes.
4. Screening of antibiotic producing microorganisms by Crowded Plate Technique.
5. Screening of antibiotic producing microorganisms by Wilkin's method.
6. Bioassay of Penicillin.
7. Optimization of medium parameters for the production of Biomass.
8. Optimization of medium parameters for the production Enzyme (Amylases).
9. Typical fermentation of Alcohol.
10. Typical fermentation of Gluconic acid.
11. Isolation of antibiotic resistant mutant(s) bacterium by direct selection (Gradient Plate Technique)
12. Isolation of antibiotic resistant mutant(s) bacterium by indirect selection (Replica Plate Technique)
13. Sterility testing.
14. Sterilization and related techniques used in tissue culture.
 - Autoclaving
 - Hot Air Oven
 - Filter Sterilization
 - Surface sterilization
 - Laminar Air Flow.
15. Preparation of Media and media composition.
16. Introduction of explants for Callusing.
17. Characterization of Callus.
18. Sub culturing of Callus.
19. Isolation of genomic DNA from bacterial cells.
20. Isolation of plasmid DNA.

CC-I-11

PAPER-11

Fundamentals of Immunology

UNIT-1

- Innate and Acquired immunity.
- Interrelationship between Innate and Acquired immunity.
- Characteristics of the immune response.
- Cells & Organs involved in the immune response.

UNIT-2

- Antigens : Foreignness, High molecular weight, Chemical complexity, Degradability, Haptens.
- Antigens : Primary and Secondary responses.
- Antigenicity and Antigen binding site, Epitopes recognized by B-cells and T-cells.
- Major classes of antigens, Immunogenic adjuvant.

UNIT-3

- Antibody structure and functions.
- Structural features and biological properties of IgG, IgM, IgA, IgD & IgE.
- Generation of antibody diversity.
- Monoclonal antibody.

UNIT-4

- Antigen-antibody Interactions : Lattice Hypothesis, Agglutination and Precipitation.
- Antigen-antibody interactions : *In vivo* and *In vitro* interactions between Ag & Ab.
- T-Cell generation, activation and differentiation.
- B-Cell generation, activation and differentiation.

REFERENCES

- IM Roitt, J. Brostoff and DK Male (1993). Immunology. BMP, London.
- J. Kuby (1991). Immunology. Freeman and company.
- A.K. Abbas, A.H. Uchtman, J.S. Pober (1994). Cellular Molecular immunology - W.B. Saunders Co. Philadelphia.

- V.R. Muthukkaruppan, S. Baskar and F. Sinigaglia (1986). Hybridoma techniques : A Laboratory Course - Macmillan India Limited.
- V.E. Cells (1994). Cell Biology Vol-I Immunology to III - Academic Press.
- Jacqueline Sharon. Basic Immunology by.

CC-I-12

PAPER-12

GENETIC ENGINEERING

UNIT-1

- Mechanisms of gene transfer (Processes gene recombination); Transformation, Transduction and Conjugation.
- Proteins and enzymes involved in r-DNA technologies.
- Cloning vectors : Plasmids, Phages, Cosmids, YACs.
- Application of linker, adaptor and homopolymer tail in joining diverse DNA molecules.

UNIT-2

- Sanger's method for DNA sequencing.
- Automated DNA sequencing.
- Pyrosequencing.
- Microarray based sequencing.
- Chemical and automated DNA Synthesis.

UNIT-3

- Southern blotting, Western blotting, Northern blotting.
- Colony blotting, Dot blotting.
- Hybridization and detection of probe using autoradiography (FISH).
- Cloning strategies: Construction of genomic and cDNA library.
- Screening of Gene in library.

UNIT-4

- Introduction to genome mapping: use of RFLP, SNP and AFLP.
- Chromosome walking.
- Applications of rDNA technology: Gene therapy, Expression of therapeutic proteins, Forensic science.
- Polymerase chain reaction techniques: Basic PCR technique, Variation of PCR techniques and Applications of PCR.

REFERENCES

- Lewin B. (2000) Gene VIL IRL Press, Oxford University Press Oxford.
- Watson, J.D., Hopkins, Roberts, Stiez, Weiner. (1987) Molecular Biology of the Gene. (4th Ed) The Benjamin/Cummings Publishing Co. Inc. California.
- Davis. D.B. Dulbecco, R., Risen, H.N, Ginsberg. H.S., (1990) Microbiology, (4th Ed) Harper & Row Publishers, Singapore.

- T.A. Brown. Genome.
- S.B. Primrose. Principle of gene manipulation.
- William Bains. Biotechnology from A to Z
- Molecular biotechnology, 2nd Ed. Blackwell
- Mickios and Freyer. DNA science. A first course in recombinant DNA
- Mittechell. Introduction to Genetic Algorithms. Prentice-Hall

CC-I-13

PAPER-13

Environmental Biotechnology

UNIT-1

- Pollution and contamination of natural components of environment: Define pollution and contamination; sources of pollutants.
- Transport and fate of contamination in the environment.
- Isolation and screening of microbes degrading contamination (pollutants) : selective and enrichment cultivation techniques.
- Biodegradation : Definitions-Ready biodegradability, Ultimate biodegradation, Inferential biodegradability, Recalcitrant compound, Anthropogenic compounds (Xenobiotics).

UNIT-2

- An overview of selected compounds : Petroleum hydrocarbons; Alkenes, Cycloalkanes, Aromatics, Polycyclic, Aromatics & Pesticides.
- Transformation of pesticides - DDT (Dechlorination) to DBP and Biomagnification.
- Reductive dechlorination of PCE & TCE.
- Reductive dechlorination of Petroleum hydrocarbons.

UNIT-3

- Water purification-Dwelling supply and Municipal Supply.
- Microbiological analysis of drinking water.
- Role of indicator organisms, W.H.O. microbiological standards for drinking water.
- Physical, chemical & Biological properties of Wastewater.

- Primary & Secondary treatment, (Biological oxidation processes) & Tertiary treatment process.
- Treatment of solid wastes (Anaerobic digestion and composting).

UNIT-4

- Bioremediation: types and overview of bioremediation of air, soil and water.
- Biofertilizers.
- Bioplastics.
- Bioremediation and MEOR (Microbially enhanced oil recovery).

REFERENCES

- Atlas, R.M. (1997) Principles of Microbiology. (2nd ed.). Win. C Brown Publishers. Dubuque.
- Prescott, L.M., Harley, J.P., Klein, D.A., (2002) Microbiology (5th Ed) McGraw Hill. International Ed.
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CC-I-14

PAPER-14

Analytical Techniques in Biotechnology

UNIT-1

- Concept of Good Laboratory Practice and Quality Management.
- Analysis: Steps of Analysis.
- Basic Aspects of Qualitative Analysis.
- Basic Aspect of Quantitative Analysis.

UNIT-2

- Mass Spectroscopy, MALDI.
- Light microscopy Differential interference contrast microscopy.
- Electron microscopy: TEM and SEM.
- Atomic force microscopy and Confocal scanning laser microscopy.

UNIT-3

- Introduction to Bioinformatics: History and Overview, Scope of Bioinformatics In Biotechnology, Bioinformatics and Internet.
- Components of Bioinformatics : Biological Databases (DNA Database, Protein Database), overview of Biological sequence analysis - (Pair wise and Multiple Alignment), Biological Software- Rasmol.
- Human Genome Project.
- Overview of Bioinformatics Application: Phylogenetic, Pharmacogenomics (Drug Discovery), Crop Genomics (Agroinformatics), Metabolomics , Chemoinformatics

UNIT-4

- Biosensors : Principles and definition, characteristics of Ideal biosensors.
- Basic measuring procedure, Biochemical components of biosensors.
- Applications of Biosensors.
- Immobilization: Basic concept of immobilization in biotechnology, Principles and mechanism of Immobilization, Methods of Immobilization.
- Bioreactor for Immobilization: Bioreactor and their Types.

REFERENCES

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- Sidman and Moore, 2000. Basic laboratory methods for biotechnology, Longman.
- Bioinformatics – Managing Scientific Data, Zoe' Lacroix and Terence Critchlow.
- Bioinformatics – Sequence, Structure and Databanks, Des Higgins & Willie Taylor.

B.Sc. BIOTECHNOLOGY**Elective Course (EC)(Subjective)****Semester- 6****Paper : DYSFUNCTIONAL IMMUNITY****UNIT-1**

- Primary Immunodeficiency : Severe Combined Immunodeficiency (SCID).
- Secondary Immunodeficiency : AIDS.
- Organ Specific Autoimmune Diseases : Grave's disease and Pernicious anemia.
- Systemic Autoimmune Diseases : Multiple sclerosis and Rheumatoid arthritis.

UNIT-2

- Immediate Hypersensitivity.
- Delayed Hypersensitivity.
- Oncogenes and Cancer Induction.
- Cancer Immunotherapy.



B.Sc. BIOTECHNOLOGY

Elective Course (EC)(Subjective)

Semester- 6

Paper : DAIRY BIOTECHNOLOGY

UNIT-1

- Nutritional value of Milk.
- Pasteurization of Milk.
- Biochemical Types of Microorganisms in Milk.
- Pathogenic Types of Bacteria in Milk.

UNIT-2

- Starter Cultures used in dairy industry.
- Fermented dairy products.
- Cheese production.
- Types of Cheese.

B.Sc. BIOTECHNOLOGY
PRACTICAL CORE COURSE
(PAPER-11, 12, 13 & 14)
SEMESTER-6

LIST OF EXPERIMENTS

1. To study water sampling techniques and sample preservation.
2. Determination of Total Solids (TS), Total Dissolved Solids (TDS) and Total Suspended Solids (TSS).
3. Estimation of Dissolved Oxygen (DO) from the given water sample.
4. Estimation of Biological Oxygen Demand (BOD) from the given water sample.
5. Estimation of $\text{PO}_4\text{-P}$ from the given water sample.
6. Estimation of $\text{NO}_3\text{-N}$ from the given water sample.
7. Estimation of $\text{NO}_2\text{-N}$ from the given water sample.
8. Estimation of Chloride from the given water sample.
9. Estimation of Sulfate from the given water sample.
10. Bacteriological analysis of water by Most Probable Number (MPN) technique.
11. Isolation of non-symbiotic nitrogen fixers from soil.
12. Isolation of symbiotic nitrogen fixers.
13. Study of air microflora.
14. Total count of White Blood Cells (WBCs).
15. Total count of Red Blood Cells (RBCs).
16. Differential Count of White Blood Cells (WBCs).
17. Estimation Hemoglobin by Sahli's Method.
18. Blood grouping
19. WIDAL test (Slide Test)
20. Agarose electrophoresis of DNA.
21. Preparation of competent cells and transformation of plasmid DNA.
22. Quantification of DNA by spectrophotometry.
23. Usage of NCBI resources for Biological Information.
24. Immobilization of enzyme.
25. Immobilization of cells.

===== X =====