MOTHER TERESA WOMEN'S UNIVERSITY,

KODAIKANAL - 624 102
Tamil Nadu.

SYLLABUS FOR

B.SC BIOTECHNOLOGY

From 2018 – 2019 Onwards

MOTHER TERESA WOMEN'S

UNIVERSITY

KODAIKANAL

Common Course structure for

UG Programmes under CBCS

B.Sc Biotechnology

From 2018 – 2019 Onwards

MOTHER TERESA WOMEN'S UNIVERSITY, KODAIKANAL

ALLOCATION OF PAPERS AND CREDITS (SEMESTER-WISE) FOR B.Sc. BIOTECHNOLOGY PROGRAMMES AS PER THE TANSCHE RULES 2018-2019 ONWARDS

B.Sc. Biotechnology Course Structure under Choice Based Credit System (CBCS)

P. No.	Paper Code	Course Title	Hours	Credits	Continuous Internal Assessment (CIA)	End Semester Exam (ESE)	Total
	Semester - I						
1.	ULTA 11	Part –I - Tamil	6	3	25	75	**100**
2.	ULEN 11	Part – II - English	6	3	25	75	**100**
3.	UBTT1 1	Core I (Theory) Microbiology	5	4	25	75	**100**
4.	UBTT1 2	Core II (Theory) Genetics	5	4	25	75	**100**
5.	UBTA 11	Allied Theory I Ancillary Chemistry	5	4	25	75	**100**
6.	UVAE 11	Value Education	3	3	25	75	**100**
Total Credits			**30**	**21**			**600**
	Semester - II						
7.	ULTA 22	Part –I - Tamil	6	3	25	75	**100**
8.	ULEN 22	Part – II - English	6	3	25	75	**100**
9.	UBTT2 1	Core III (Theory) - Cell & Molecular Biology	6	4	25	75	**100**

10.	UBTP21	Practical I - Lab in Microbiology	5	4	40	60	**100**
11.	UBTA21	Allied Practical I - Lab in Chemistry	5	4	40	60	**100**
12.	UEVS21	Environmental Studies	2	2	25	75	**100**
Total Credits			**30**	**20**			**600**
	Semester - III						
13	ULTA33	Part –I - Tamil	6	3	25	75	**100**
14.	ULEN33	Part – II - English	6	3	25	75	**100**
15.	UBTT31	Core IV(Theory) - Immunology & Immunotechnolgy	5	4	25	75	**100**
16.	UBTA32	Allied Theory II Biomolecules	5	4	25	75	**100**
17.	UBTE31	Elective I – Choice 1 Taxonomy& Plant physiology Choice2:Seed Technology	4	3	25	75	**100**
18.	UBTN31	Non Major Elective course I - Computer Applications	2	2	25	75	**100**
19.	UBTS31	Skill based Studies I - Vermi and Mushroom Technology	2	2	25	75	**100**
Total Credits			**30**	**21**			**700**
	Semester - IV						
20.	ULTA44	Part I Tamil	6	3	25	75	**100**
21.	ULEN44	Part II English	6	3	25	75	**100**
22.	UBTT41	Core V (Theory) Principles of Genetic Engineering	4	4	25	75	**100**
23.	UBTP42	Practical II - Lab in	4	4	40	60	**100**

		Genetic Engineering & Immunotechnology					
24.	UBTA42	Allied practical II Lab in Biochemistry	3	4	40	60	**100**
25.	UBTE42	Elective II – Option 1- Biophysics Option 2- Biodiversity conservation	3	3	25	75	**100**
26.	UBTN42	Non Major Elective II - Medical lab technology	2	2	25	75	**100**
27.	UBTS42	Skill based Elective - II Food processing technology	2	2	25	75	**100**
Total Credits			**30**	**Total Credits**			**800**
	Semester - V						
28.	UBTT51	Core VI (Theory) - Developmental Biology	5	4	25	75	**100**
29.	UBTT52	Core VII (Theory) - Animal Biotechnology	5	4	25	75	**100**
30.	UBTT53	Core VIII (Theory) - Bio process technology	5	4	25	75	**100**
31.	UBTT54	Core IX (Theory) Biostatistics	5	4	25	75	**100**
32.	UBTT55	Core X (Theory) Environmental Biotechnology	5	4	25	75	**100**
33.	UBTE53	Elective III – Option 1Biotechnology and health Choice2:Bioremediation	3	3	25	75	**100**
34.	UBTS53	Skill based studies III Introduction to medicinal & aromatic plants	2	2	25	75	**100**
Total Credits			**30**	**Semester – VI**			**700**

	Semester – VI						
35.	UBTT61	Core XI (Theory) – Plant Biotechnology	5	4	25	75	**100**
36.	UBTT62	Core XII (Theory) Bioinformatics	5	4	25	75	**100**
37.	UBTT63	Core XIII (Theory) Bioinstrumentation	5	4	25	75	**100**
38.	UBTP63	Core Practical III Lab in Microbial Technology	5	4	40	60	**100**
39.	UBTP64	Core Practical IV Lab in Plant tissue culture	5	4	40	60	**100**
40.	UBTE64	Elective IV Option 1Biosafety & IPR Option 2 General Biology	3	3	25	75	**100**
41.	UBTS64	Skill based Studies Biofertilizer	2	2	25	75	**100**
42.	UEAS61	Extension Activities	-	3		100	**100**
Total Credits			**30**	**28**			**800**
Total Credits				**140**			**4200**

Regulations:

1. Qualification for Admission:

i. Candidate should have passed the Higher Secondary Examination conducted by the Board of Higher Secondary Examination, Govt. of Tamilnadu or any other Examination accepted by the syndicate as equivalent there to with atleast one of the following subject.

ii. Biology/Botany/Zoology

iii. Candidate should have secured atleast 55% in the above subject and above in the aggregate.

iv. A relaxation of 10% in the total percentage will be given to SC, ST candidates.

v. Candidates sponsored by industries/hospitals/Clinical laboratories may be considered for admission.

2. **Duration of the course:**

The students will undergo the prescribed course of study for a period of not less than three academic years (Six semesters).

3. Medium of Instruction: English

4. Subject of Study: As given in Appendix A

5. Scheme of Examination: As given in Course Structure

6. Eligibility of the degree:

(i) Candidates will be eligible if they complete the course with the required credits and pass in the prescribed examinations.

(ii) The candidate requires 75% of attendance to attend the semester exam.

(iii) The passing minimum is 40 percent (both in internal and external separately) in each paper.

(iv) The internal marks will be divided as 5 for assignment, 5 for attendance and 15 for written tests. One or two assignments can be given and a consolidate can be taken for the evaluation.

(v) To complete the course the students should gain the prescribed credits i.e. 140 credits.

SEMESTER I

CORE I – THEORY –MICROBIOLOGY – UBTT11

Objectives **Hours : 5** **Credit : 4**

- The objectives of this course are to introduce the students to the field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host-microbe interactions.
- Students should be able to Identify the major categories of microorganisms and analyze their classification, diversity, and ubiquity.
- Students should gain knowledge about to Identify and demonstrate the structural, physiological, and genetic similarities and differences of the major categories of microorganisms.
- Students should know about to demonstrate and evaluate the interactions between microbes, hosts and environment.

UNIT 1:

History of Microbiology, Basic Principles in microscopy, Types of Microscopes – Light, Compound, Phase contrast and Electron microscope (TEM and SEM). Prokaryotic and Eukaryotic microorganisms. Classification of microorganisms.

UNIT II:

General structure, growth and reproduction of Bacteria, Fungi, Algae, Virus and Protozoa. Structure and organization of bacterial cell wall: Gram positive and Gram negative cell wall.

UNIT III:

Nutritional requirements of Microorganisms – Autotrophs, Heterotrophs, Photoautotrophs, Chemotrophs. Culture media – Solid and Liquid – Types of media – Semi-synthetic, synthetic, Enriched, Enrichment, Selective and Differential media. Macro nutrients, growth factors

UNIT IV:

Factors influencing and affecting microbial growth, Growth and death kinetics, Sterilization and Disinfection – Methods of sterilization- Physical methods- Dry heat – Moist heat, Radiation – Chemical sterilization – antimicrobial chemo therapy.

UNIT V:

Gene transfer in microbes, conjugation, Transformation, Transduction, Transfection sexfactor.

REFERENCES:

1. Microbiology- M.J. Pelczar, Jr., E.C.S. Chang and N.R. Krieg, McGraw Hill

Company, Newyork (1986).
2. Microbiology-concepts and applications, M.J. Pelczar, Jr., E.C.S. Chang and N.R. Krieg, McGraw Hill Company (1993).
3. Microbiology – L.M. Prescott, J.P. Hareley D.A. Klein – Wm.c. Brown publishers. Dutique, Jawa, Melbourne. 1993.
4. Modern Microbiology – wayne w. Umbreit – W.H, Freeman and company, son franscislcod London (1962).
5. Basic and Practical Microbiology – Ronald M. Atlas, Mac.Milleen Company, Newyork (1986).

CORE II- THEORY –GENETICS – UBTT12

Objectives **Hours : 5** **Credit : 4**

- To know about the basics of genetics and classical genetics encompassing prokaryotic/phage genetics to yeast and higher eukaryotic domains.
- To acquire knowledge about the classical concepts of Mendelian genetics across these life-forms.
- The students will be exposed to the concepts of population genetics, quantitative genetics encompassing complex traits, clinical genetics and genetics of evolution.
- Student will be able to know the fundamental molecular principles of genetics and to understand the relationship between phenotype and genotype in human genetic traits.

UNIT – I

Classical genetics – Mendelian laws – monohybrid, dihybrid inheritance – pedigree analysis – complete, incomplete and codominance – lethal factor – allelic and non allelic gene interaction – complementary and supplementary genes – epistasis – pleotrophism.

UNIT - II

Multiple alleles and blood groups antigens. Quantitative inheritance Sex chromosomes and sex linked inherited disorders – X – linked, Y – linked inheritance.

UNIT - III

Chromosome organization – linkage and crossing over-theories and types.,maternal inheritance.

UNIT - IV

Mutation – gene mutation – molecular basis of mutation – chromosomal abnormalities – deletion, duplication, translocation, inversion – number: autosomal-down's syndrome, Edward's syndrome-sex chromosomal-turner's syndrome, klenefelters syndrome.

UNIT - V

Genetic recombination bacteria: conjugation, transduction, transformation – population genetics.

REFERENCES:

1. Lewis, R.2001. Human genetics – concepts and application. 4th edition.
2. Griffiths, Miller, J. H. Suzuki. D. T. Lewentin – introduction to genetics analysis.
3. Gardner E. J. – principles of genetics.
4. Microbial genetics – David Friefelder.
5. 1. Maloy, S.R., J.Egronan and D.Friefelder.1994. Microbial Genetics. . Jones and
6. Bartlett Publishers, Sudbury, MA, USA.

7. 2. Dale, J.W. 1994. Molecular Genetics of Bacteria. John Wiley and Sons, Hoboken,NJ,
8. USA.
9. 3. Klug, W.S. and M.R. Cummings. 1997. Concepts of Genetics. Prentice Hall, NJ, USA.

ALLIED – I- THEORY- ANCILLARY CHEMISTRY – UBTA11

Objectives **Hours : 5 Credit : 4**

- The course aims at elucidating principles of applied chemistry in industrial systems, water treatment, engineering materials and analytical techniques.
- The Students will be able to analyse trends in periodic table with electronic and atomic structure.
- The Students will be able to interpret phase diagrams of pure and binary substances and demonstrate the working of electrodes and their applications.
- The Students will be able to calculate various parameters defining water and fuel quality and also to carry out basic experimental procedure and to emphasize need for safety and safety procedure in laboratory

UNIT – I

Bonding

V.B Theory – postulates of V.B Theory – application to the formation of simple molecules like H2 and O2 – overlap of atomic orbitals – s-s , s-p and p-p overlap – principle of hybridization – sp,sp2 and sp3 hybridization.

M.O Theory: Formation of M.O's – bonding, anti-bonding and non-bonding M.O's – M.O diagram for H2, He and F2.

UNIT – II

Chemical kinetics

Reaction rate – order and molecularity of a reaction – zero order and first order. First order rate equation and half life period – derivation. Examples of first order reactions and second order reactions. Enzyme catalysis – Michaelis and menton mechanism – Significance of K_m.

UNIT – III

Electro chemistry

pH – Definition-simple calculation of pH . Molarity,Normality, PPM. pH of acid and bases-common ion effect-and its application in analytical chemistry-buffer solution-definition-theory of buffer action-application.

Acid- base indicators-working range – commercial cells and batteries – primary and secondary cells.Weston – cadmium cell,lead storage cell, electroplating – principle and methods.

UNIT – IV

Stereo isomerism: Chiral centre – optical activity of compounds containing one or two chiral centers – R-S notation – diastereoisomers – racemisation - resolution.

Geometrical isomerism of maleic and fumeric acids – E-Z notation of geometrical isomers.

UNIT –V

Adsorption: Definition , difference between adsorption and absorption – adsorbate, adsorbent – physical adsorption and chemical adsorption – differences between these two types – factor influencing adsorption – adsorption isotherm – Langmuir isotherm (no derivation statement) – adsorption of gases on solid surface.

Reference:

1.Modern inorganic chemistry – R.D. Madhan
2.Advanced organic chemistry – Bahl & Arun Bahl
3.Physical chemistry – Y.R. Puri & Sharma

SEMESTER II

CORE III –THEORY- CELL AND MOLECULAR BIOLOGY – UBTT21

Objectives **Hours : 6** **Credit : 4**

- To the understand the various biological processes and molecular structure and functions of cells and molecules such as DNA, RNA and proteins.
- To understand storage of genetic information and its translation at molecular level in prokaryotic and eukaryotic systems.
- Student should be equipped to understand the fundamental aspects in biological phenomenon.
- Students will be able to know the properties of genetic materials and storage and processing of genetic information.

UNIT – I

The plant cell: Structure and function of cell wall, membrane, chloroplast, mitochondria, ribosomes, peroxisomes, golgi apparatus, nucleus, nucleolar organizer and ER.

UNIT – II

Cell cycle – mitosis and meiosis, pairing, crossing over and cytokinesis. Transposons and Plasmids.

UNIT – III

Chromosomes: Morphology and chemistry ,Chromatin organization – C- value paradox. DNA replication and enzymes involved, DNA damage and repair,

UNIT – IV

Transcription, RNA splicing – post transcriptional modification. Enzymes involved in transcription. Translation, post translational modifications – targeting of proteins to different cellular components

UNIT – V

Mitochondrial genome and Chloroplast genome – import of protein into Mitochondria and chloroplast. RNA editing. Plastome – structure and function.

REFERENCES:

1. Pawar. Cell Biology, Himalaya Publishing House, Mumbai.
2. De Robertis E.D. and De Robertis E.M.F. 2002. Cell and Molecular Biology. 8th Edition. Lee and Fab International edition, Philadelphia.
3. Cooper G. 1996. The cell – A molecular approach. ASM Press, Washington
4. Buchanan B.B. Gruissem W., Jones R.L. 2008. Biochemistry and Molecular Biology. American Society of Plant Physiologist, Maryland, USA.
5. Sheeler P and Binachi D. 2004. Cell and Moecular Biology, Third edition, Wiley New York, USA.
6. Lewin, B. 2000. Gene VII. Oxford University Press, New York, USA.

CORE PRACTICAL I –LAB IN MICROBIOLOGY – UBTP21

Objectives **Hours : 5** **Credit : 4**

- Students should know about the safe practices in a microbiology laboratory.
- Students should able to correctly demonstrate use of the scientific method
- Demonstrate proper usage, identify the parts/functions of the following microscopes: bright field and stereoscopic.
- To demonstrate proficiency and use of the following in the laboratory: streak plate isolation technique; bacterial staining techniques; wet mounts; and proper culture handling.

1. Maintenance of hygienic conditions in the laboratory-rules and regulations.
2. Microscope and its functions,
3. Preparation of culture media and sterilization methods.
4. Staining techniques, simple, grams, spore and capsular.
5. Enumeration of microorganisms – Spread and Pour plate method.
6. Pure Culture Technique – Streaking techniques.
7. Motility of bacteria, Growth studies.
8. IMVIC test.
9. Characterization biofertilizer microbes.

REFERENCE:

2. Cappuccino, G. James. And Natalie Sherman, Gram stain, Microbiology A Lab. Manual, 1999.

2. Atlas, M. Ronald, Alfred E. Brown. And Lawrence C. Parks, Gram stain, Experimental Microbiology, 1995.
3. Handbook of Microbiological Media – HiMedia.
4. Biochemical Methods – Wilson & Walker.

ALLIED PRACTICAL – I –LAB IN CHEMISTRY – UBTA21

Objectives **Hours : 5** **Credit : 4**

- To familiarize the solubility nature of organic substances of different functional group and know about the volumetric analysis different chemical compounds.
- To familiarize the systematic producers organic substances analysis.
- To familiarize the test involving indentification of special elements.
- To learn the conformatory test for various functional groups and knows the proper procedures and regulations for safe handling and use of chemicals and can follow the proper procedures and regulations for safe handling when using chemicals.

1. **Organic analysis**

   Analysis of the following function group – Acids, phenols, aldehydes, ketones, esters, amines, amides, anilides, glucose and fructose. No preparation of solid derivatives.

2. **Volumetric Analysis**

   Acidimetry and alkalimetry

   a) Titration between a strong acid against NaOH

   b) Titration between a strong acid against Na_2CO_3.

   c) Titration between sodium hydroxide against oxalic acid.

   Permanganometry

   a) Titration between $KmnO_4$ against oxalic acid.

   b) Titration between $KmnO_4$ against ferrous sulfate

   c) Titration between $KmnO_4$ against Mohr's salt (ferrous ammonium sulfate)

   Iodometry

   a) Titration between sodium thiosulfate and potassium dichromate

   b) Titration between sodium thiosulfate and copper sulfate

Estimation: Only one question has to be set either from Unit I or Unit II (Random choice)

SEMESTER-III

CORE IV- THEORY – IMMUNOLOGY & IMMUNOTECHNOLOGY- UBTT31

Objectives **Hours : 5** **Credit : 4**

- To get knowledge on the basic principles and definitions of immunology, its modern achievements and practical ways of implementation
- Students will acquire skills and competence in specialized immunological techniques in the diagnosis and management of health related disorders.
- Acquire knowledge and understanding of research methods employing immunological techniques for application in biomedical and clinical research.
- Students should know the skills to analytically, critically and systemically analyze and evaluate information related to immunotechnologies.

UNIT I:

Introduction, History and Scope of immunology. Types of immunity, Antigen-Antibody- immunoglobulin's – Structure, types, distribution and functions.

UNIT II:

. Lymphoid tissues – Primary and secondary lymphoid organs – thymus, bone marrow, spleen, mucosal associated lymphoid organs. Ontogeny and physiology and immune system. T & B Cells – receptors – activation and function.

UNIT-III

Hypersensitivity reactions, HLA Tissue typing& MHC transplantation immunity.

UNIT IV

Autoimmunity, Tumour immunology and Immunodeficiency disorders.

UNIT-V

Antigen-antibody interactions: precipitation – diffusion –radial and ounse diffusion – agglutination – Haemoagglutination, Passive agglutination. Immuno diagnostics – precipitation, agglutination, ELISA and FISH. General introduction to monoclonal antibodies and vaccines

REFERENCE:

3. Immunology by I.M. Roitt, J. Brostoff and D.K. Male (1993) Gower medical publishing, London.

2. Immunology by J.Jube (1991) freeman and company.

3. Immunology – A short course by E. Benzamini, G. Sunshine and Leskpwitz, Willy – Liss 1996.

4. Introduction to medical Immunology by Gabrial Virellce, Marcel Dekkar 1993.
5. Donald M.Weir, John steward, 1993.Immunology VII edition. ELBS, London.
6. Richard M.Hyde. 1995. Immunology III edition. National Medical series, Williams and Wilkins. Harward publishing company.

ALLIED-THEORY – II – BIOMOLECULES – UBTA32

Objectives **Hours : 5** **Credit : 4**

- Students should learn the elements present in biomolecules and the different monomers and polymers.
- Students will able to identify their chemical elements and the difference between simple sugars and complex carbohydrates.
- To acquire knowledge to identify the chemical elements and functional groups and to recognize the structure of an amino acids..
- Students should able to identify the chemical elements and components of a nucleotide and also able to describe the function of DNA.

UNIT – I

Carbohydrates: Classification of Carbohydrates .structural elucidation of glucose and fructose. Properties, structure and biological functions of mono, di, oligo and polysaccharides. Homoglycans and Heteroglycans.

UNIT – II

Amino acids: Structure, classification, physical and chemical properties. Peptides, peptide bond, biologically important peptides.

Proteins: classification and Biological importance. Primary structure, Secondary, tertiary and quaternary structure.

UNIT – III

Nucleic acids: Components of mono nucleotides, pyrimidines and purines. Polynucleotide's: DNA and RNA. Composition and structure- their biological importance

UNIT – IV

Lipids: nomenclature, classification and Biological significance. Simple lipids: types of fatty acids, triglycerides, waxes, steroids, prostaglandins and their properties. Compound lipids: Phospholipids, sphingolipids and glycolipids.Lipoproteins.

UNIT – V

Vitamins. Source, structure, biological role, daily requirement and deficiency manifestation of the fat soluble vitamins A,D,E & K. Water soluble vitamins-Ascorbic acid, thiamine, riboflavin, pyridoxine, niacin, pantothenic acid, lipoicacid, biotin, folic acid and vitamin B12.

REFERENCES

1. Principles of Biochemistry – Lehninger
2. Textbook of Biochemistry-West & Todd.
3. Harper's Biochemistry 25th edn, Mc Graw Hill.
4. Fundamentals of Biochemistry – O.P. Agarwal.
5. Essentials of Biochemistry – M.C. Pant.
6. Essentials of Biochemistry – A.I. Jain.

Option 1

ELECTIVE – THEORY –I – TAXONOMY & PLANT PHYSIOLOGY – UBTE31

Objectives **Hours : 4 Credit : 3**

- To acquire the basic knowledge needed for proper understanding of plant functioning. .
- Students should gain the knowledge of Plant Kingdom and understanding of the taxonomic hierarchy.
- Students should identify and describe the different types of plant cells and tissues, their structure and function.
- Students should able to determine the role and function of specific vegetative parts of the plant and the role and function of the reproductive parts of the plant.

UNIT I

Terminology of flower and floral parts- Morphology – Inflorescence – types- racemose, cymose, mixed and special types. Descriptive Fruit-classification. Details of simple , fleshy,dry dehiscent and dry indehiscent, aggregate and multiple fruits.

UNIT II

Taxonomy:- Binomial nomenclature. Systems of classification-Bentham & Hooker.. A detailed study of the following families and their Economic Importance- Annonaceae, Leguminosae, Asclepiadaceae, Caesalpinoideae (Caesalpiniaceae) & Mimosoideae (Mimosaceae), Cucurbitaceae, Apiaceae, Gramineae (Poaceae).

UNIT IIII

Water relation: significance, - osmotic and non-osmotic uptake of water. Ascent of sap-cohesion theory: root pressure, transpiration, physiology of stomatal Action, Translocation of solutes and assimilates. Mineral uptake: Passive and active. Role of major and Minor elements, mineral deficiency symptoms.

UNIT IV

Photosynthesis: role of pigments enhancement effect, photosystems I & II Photosynthetic electron transport, Photophosphorylation, Carbon Assimilation: Calvin cycle Hatch & Salck pathway, CAM pathway.

UNIT V

Plant Growth: regulatory substances; auxins, kinins, gibberellins, abscissic acid and their function. Photoperiodism, phytochrome-vernalization.

REFERENCES

Porter, C.L. ( ) : Taxonomy of flowering Plants
Eurasia Publishing House, New Delhi.
Lawrence, G.H.M. (1953) : Taxonomy of Vascular Plants
Oxford & IBH Publishers, New Delhi, Calcutta-823pp.,23
Mitra, J.N. (1964) : An Introduction to Systematic botany & Ecology
The World Press (P) Ltd., Calcutta –694pp.,
Jefferey, C. (1968) : An Introduction to Plant Taxonomy
J.A. Churchill, London-142pp.,

Option 2-SEED TECHNOLOGY

Objectives **Hours : 4** **Credit : 3**

- Students should know the basic knowledge of seed development and structures and apprise students with its relevance to production of quality seed.
- Students should know about the basic priciples of quality seed production and physiological processes governing seed quality and its survival.
- Students should gain knowledge in principles and practices of seed health testing and management of seed borne diseases.
- To impart knowledge on the principles and techniques of seed processing for quality upgradation and of storage for maintenance of seed quality.

UNIT I

Seed processing – Importance of seed processing in the pathway of seed improvement, physical characteristics used to separate seeds. Preparing seeds for processing. Licensing of machines.

UNIT II

Seed drying : Importance and advantages of seed drying ,moisture content and methods of seed moisture measurements, Theory of seed drying (wet dry seeds),advantages of mechanical drying equipments dehumidification and drying of heat sensitive seeds , relative humidity and equilibrium, moisture content of seeds.

UNIT III

Seed processing machines : Principle, construction, working, adjustments, cleaning and uses of seed processing machines viz. i) Air screen cleaner cum grader ii) Specific gravity separator, aspirators, pneumatic aspirators, stoner iii)Roll mill iv) Magnetic separators v) Spiral separators, dropper best separator, electrostatic separators

UNIT IV

Seed Treatment: Principle, construction, working, adjustments and uses of slurry seed treater mist –o- matic seed treated, storage and labeling of treated seeds, seed users safety.
Seed conveyors and elevators

UNIT V

Seed storage – structures and their management: Packing and marketing of seeds, bagger weigher, bag closing ,portable and conveyor type of bag closer, labeling and maintaining lot identify, lot numbers, seed pellets, handling and stacking, maintenance of seed processing record.

REFERENCES

1. K.A. Jeffs, (1986), Seed treatment, CIPAC Publishers,
2. D.S. Bindra- Plant Protection and equipments.
3. Billy R. Gregg, Alvin G.Law,S.S. Virde,J.S. Balis-Seed Processing. Published by National Seeds Corporation, New Delhi, and Mississipi State University and USAID.
4. S.M. Henderson & R. Perry, (1976), Agricultural process Engineering, Avi Publishing Co Inc.; 3rd Revised edition
5. Carl W. Hall, (1967), Drying Farm crops, Agricultural Consulting Associates; 6th printing edition
6. A Chakravarty, (1989), Post Harvest Technology & cereals , oil seeds. Pulses & Oxford & IBH Publishing Co Pvt.Ltd
7. Waren L.Melabe,Julien C. Smith & Peter Harviot , (2004), Unit operation in chemical engineering. McGraw-Hill Education; 7 edition

8. ICAR, (1961), Handbook of Agriculture, Directorate of Information and Publication of Agriculture (DIPA),
9. Hunt D, (1977), Farm power & machinery management, Iowa State University Press.
10. Prem Singh and Arya – Vegetable breeding and seed production; Kalyani Publ.Ludhiana.

NON MAJOR ELECTIVE COURSE I – THEORY – COMPUTER APPLICATION – UBTN31

Objectives **Hours : 2** **Credit : 2**

- Students should gain knowledge in fundamentals of Microsoft Office, Microsoft Windows XP, and browsing and searching the World Wide Web.
- Students should acquire knowledge with the proper procedures to create documents, worksheets, databases, and presentations suitable for coursework, professional purposes, and personal use.
- To improve reading, literacy, and numeracy, developing strategies and ideas to address literacy and numeracy issues improving the reading level of students.
- Students will also perform activities using intergrated software programs.

UNIT I

History of computers, Types of Computers, Basic computer concepts

UNIT-II

Parts of a computer-input (key board, Mouse) and Output devices (Monitors, Printers), computer memory (RAM,ROM), Storage Devices (Floppy disk, Compact disk, Hard disk), Central Processing Unit, Software, Hardware, Computer peripherals – Mouse, Modem.

UNIT III

Computer Network (LAN,WAN), DATA-Representation- Number systems- Binary, arithmetic, Organizing information- the database – definition-Data entry indexing – storage – retrieval – Operating systems – WINDOWS 2000

UNIT IV

Word Processing software MS-Office.

DESKTOP PRINTING (DTP)- Application software like- ADOBE Pagemaker, Corel Ventura and Microsoft Publisher and their uses.

UNIT-V

A Basic knowledge of Networking-Internet-email facilities, terminology connected with them and their uses in Biotechnology

SKILL BASED STUDIES I –THEORY- VERMI & MUSHROOM TECHNOLOGY – UBTS31

Objectives **Hours : 2** **Credit : 2**

- To providing basic knowledge about vermi and mushroom Technology .
- Students will able to gain the knowledge of Mushroom cultivation, composting and cultivation of different types of edible Mushroom .
- Students should know the methods of harvesting of Mushroom and the methods of grading, packing and storing and value added products out of Mushroom.
- Students will be able to compost in a limited space and describe the decomposing process and they will also turn towards organic farming and get the knowledge of biodiversity of local earthworms.

UNIT-I

History and scope of vermi composting - Role of Earthworm in fertilizer preparation. Types of Earthworm – Epigeics, Anecic and Endogeics – vermicast, coccons. Requirement for ounseling ting, vermitech – Economic importance of vermicompost.

UNIT-II

Bins-small scale-Large scale- Starting off-Bedding. Feeding –Harvesting. Vermicomposting properties- problems. Commercially available ounseling ting systems-vermicomposting for small farms-vermicompost & Plants.

UNIT-III

History of mushroom cultivation-Food value of mushroom-morphology of mushroom-Life cycle in brief.

UNIT-IV

Fungal nutritional habitat-spawn preparation, casting and casting methods, cropping and harvesting.

UNIT-V

Cultivation of mushroom-mushroom disease and control measures.

REFERENCE:

1.Invertebrate zoology- Dr.Veer bala rastogi- Kedernath Ramnash publications

2. Biology of invertebrates- Jan A.Penchenik-Tata McGraw Hill Edition.

3.Biofertilizers and organic farming – S.V.Vyas ,Sameer vyas,

SEMESTER – IV

CORE V – THEORY – PRINCIPLES OF GENETIC ENGINEERING – UBTT41

Objectives **Hours : 4 Credit : 4**

- To understand the basic theoretical concepts and techniques of genetic engineering.
- Students should know about the different types of vectors of genetic engineering.
- Students will gain knowledge about the applications of recombinant DNA technology
- Student will acquire knowledge about the DNA sequencing and amplification and its importance in the Genetic engineering.

UNIT- I

Outline process of genetic engineering and recombinant DNA technology, Isolation of genes, exonuclease & endonuclease, Concept of restriction and modification – Restriction endonucleases, DNA modifying enzymes, Ligases.

UNIT- II

Different Kinds of Vectors – Plasmids, Phage vectors, Cosmids, Phagemids, Virus vectors, Shuttle vectors and expression vectors- YAC, BAC- *S. cerevisiae* system as a model.

UNIT –III

Host-vector system – Cloning vectors for *E. coli*., Cloning vectors for Eukaryotes- Cloning strategies, construction of genomic libraries and cDNA Libraries.

UNIT –IV

DNA amplification using polymerase chain reaction (PCR): key concepts, Analysis of amplified products. Sequencing (chemical degradation; chain termination and automated sequence.

UNIT – V

Applications of recombinant DNA technology in agriculture – Ti plasmids and their uses in pharmaceuticals, Insulin, Aminoacids, protein engineering and drug design – transgenic plants, animals and microbes – biohazards and biosafety.

REFERENCES

1. Cell and molecular biology, 3rd edition, Philip Sheeler, Donal E Bianchi, John Wiley
2. Molecular biology of cell, Alberts et al
3. Molecular cell biology, Lodish, Baltimore, Scientific American books, 1994
4. Molecular and cell biology, Stephen L Wolfe, Wordsworth Publishing company 1993
5. Cell biology. Sadava

CORE PRACTICAL II- LAB IN GENETIC ENGINEERING AND IMMUNOTECHNOLOGY – UBTP42

Objectives **Hours : 4** **Credit : 4**

- Students should understand the basic techniques of genetic engineering and immunology.
- Students will acquire knowledge about to isolation of DNA from bacteria, plant and animals different electrophoresis techniques and it applications.
- To learn the antigen-antibody reaction and blood grouping techniques and its application in immunotechnology.
- To understand the working principles and applications of PCR and ELISA.

1. Isolation of genomic DNA – bacteria
2. Isolation of genomic DNA – Plant
3. Isolation of genomic DNA – Animal
4. Agarose Gel Electrophoresis
5. Isolation of Plasmid DNA
6. Restriction digestion
7. SDS-PAGE
8. Western blotting – Demo
9. Southern blotting – Demo
10. PCR – Demo

IMMUNOLOGY

1. Antigen-anti body reactions
2. Immuno diffusion (Single radial, double and rocket)
3. Blood grouping
4. Preparation of serum from blood
5. ELISA- Demonstration

REFERENCES:

1. Sambrooke E.F.Fritsch. 1989. Molecular cloning lab manual. Volume I, II, III.
2. Asubel F.M., Brent R., Kinstein RE, Moore DD, Seidmen JG. 2000. Current Protocols in molecular biology. Volume XVII

3. Harwood A. J. 1994. Protocols for gene analysis

4. Weir. 1988, Hand book of experimental Immunology. Vol I & II. Blackwell scientific publishing.

5. Hudson L & Hay H.C. 1980, Techniques in clinical immunology –Blackwell scientific publishing.

6. Thompson R.A. 1997, Techniques in clinical immunology –Blackwell scientific publications.

ALLIED PRACTICAL II- LAB IN BIOCHEMISTRY – UBTA42

Objectives **Hours : 3** **Credit : 4**

- Students should gain knowledge about fundamental approaches for investigating biochemical estimations.
- Students should learn about the chromatography techniques and its applications.
- Students acquire knowledge about the principles and application of colorimetric techniques.
- To learn about the basic procedure for preparation of solutes.

1. Estimation of Protein – Lowry's method.
2. Estimation of DNA by DPA Method
3. Estimation of RNA by Orcinol method
4. Estimation of Sugars by Benedict method
5. Estimation of total free amino acids – Sulfovanicillin method.
6. Estimation of Lipids
7. Analysis of Oils- Iodine Number- Saponification Value –Acid Number.
8. Estimation of Vitamin C.
9. Paper Chromatography.
10. Preparation of Buffer- Phosphate, Acetate, Tris.
11. Principles of Colorimeter, Spectrophotometer and pH.
12. Determination of Normality, Molarity, Molality, Percent Solution

REFERENCES

1. David T. Plummer, An introduction to practical bio-chemistry.
2. Pattabiraman, Laboratory manual in bio-chemistry.

3. J.Jayaraman, Practical bio-chemistry.

Option 1

ELECTIVE II- THEORY – BIOPHYSICS – UBTE42

Objectives **Hours : 3** **Credit : 3**

- Students should know about the physical laws (laws of Physics) are valid in biological systems.
- Students should able to explore the biophysics of signaling and movement at the cellular level.
- To learn the relationship between structure and function at the molecular level.
- To prepare students for higher courses in environmental and medical biophysics, genomics and proteomics

UNIT-I

Scope and methods of biophysics-level of molecular organization-

Detailed structure of protein molecule at – primary ,secondary, tertiary, and quaternary structural levels.

UNIT-II

Protein – protein interaction and protein –nucleic acid interaction-structure and chemical nature of polysaccharide.

UNIT-III

Radiation Biophysics

Introduction-nucleus and it's radiation-half lives-rate of decay- units of measurement-interaction of radiation with matter-measurement of radio activity-GM counter, scintillation counter-uses of radioactivity.

UNIT-IV

Methods of cell study:

Introduction-cellculture-fixation-dehydration-embedding-sectioning-staining-mounting-measurement of cell.

UNIT-V

Structure of nerve cell-action potential of the nerve-impulse transmission-EEG-structure of musle- muscle contraction-energetics of muscle contraction-ECG-Structure of ear-mechanism of hearing.

REFERENCE:

4. Basic Biophysics for Biologists – Daniel. H
5. Principles of Biophysics – Palanichamy. S
6. Laboratory manual in Biochemistry – J. Jayaraman.

Option 2

Option 2 – BIODIVERSITY AND CONSERVATION

Objectives **Hours : 3** **Credit : 3**

- To provide students with basic knowledge of biodiversity conservation as bases for sound ecotourism and wildlife resource management.
- To provide students with opportunities for goal oriented research in biodiversity conservation and management for ecotourism and wildlife development.
- Students should able to identify the variety of our enormous biological resources in relation to their various ecological settings.
- Students should able to understand the functioning of the ecological systems and their driving force.

Unit 1

Biodiversity and Conservation: Catergories of biodiversity – species concepts: keystone, flagship, dominant and co-dominant species – Biogeography: Major terrestrial biomes – theory of island biogeography – Biogeographical zones of India – Principles and approaches of conservation – In-situ conservation: National parks, Wildlife Sanctuaries, Biosphere reserves – Ex-situ conservation: Botanical and herbal gardens, zoological parks, seed orchards and gene banks.

Unit II

Values of biodiversity-ecosystem services- screening plants for medicines- New agricultural and industrial products from the tropics- identifying and protecting the origin of food crops. Speciation- species area relationship: productivity- diversity relationship – Biodiversity hot spot.

Unit III

The effect of global climatic change on natural communities- IUCN categories of extinction-red data book – causes for species extinction – impact of exotic species on native species – GMOs and biosafety – Intellectual property rights- GATT,WTO, farmers and breeders rights-Bodiversity act -2002.

Unit IV

Remote sensing : Introduction-Analysis techniques-Digital image processing Role of remote sensing in biodiversity management-GIS and biodiversity, landscape elements Oceans colour and fishery, water security. Environment assessment and monitoring.

Unit V

Conservation: In situ and Ex situ conservation methods- conservation of biological diversity in Botaniocal gardens- Information management for the conservation of biodiversity. Cryobiology-Agro ecology and in situ conservation of native crop diversity- International development and the protection of biodiversity

References:

7. Stiling, P. 2002. Ecology – Theory and applications. Prentice-Hall of India Pvt. Ltd., New Delhi.
8. Gurevitch,J.,Scheiner S.M and Fox G.A. 2002. The Ecology of Plants. Sinauer Associates Inc Publishers, Massachusetts.
9. Cunningham, W.P. and Cunningham, M.A.2002. Principals of environmental science. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
4. Agarwal, K.C. 2000 Biodiversity. Agrobios (India). Jodhpur.
5. Odum, E.P. 1971 Fundamentals of Ecology. W.B. Saunders Company, London.
6. Colinvaux, P.1986. Ecology John Wiley and sons, Singapore.
7. Krishnamoorthy, K.V. 2004 An advanced Text Book of Biodiversity. Oxford & IBH Publishing Co, Pvt. Ltd., New Delhi.
10. Meffe, G.K. and Carrol, R.C. 1994. Principles of Conservation of Biology, Sinauer Associates, Inc., Publishers, Saund
11. Jeffries, M.J. and M.J. Jeffries. 2005. Biodiversity and Conservation, Routledge Taylor & Francis Group, UK.

NON MAJOR ELECTIVE COURSE II THEORY- FOOD PROCESSING TECHNOLOGY – UBTS42

Objectives **Hours : 2** **Credit : 2**

- To gain knowledge and understanding about food systems in the production, processing and consumption of food and an appreciation of their impact on society.
- To have a knowledge and understanding about the nature of food and human nutrition and an appreciation of the importance of food to health.
- Students should understand the sources and processing techniques of meat , dairy products,edible fats and Oils
- Students should able to know about principles of food preservation, packaging and its ethics.

UNIT – I

Carbohydrate, fat and protein rich foods, vitamins, minerals and fiber. Milk and milk Products –Fluid milk & some of its derivatives, Ice cream & related products, cheese, Yoghurt milk powder, paneer, Indian dairy products – kheer, khoa / mawa, khurchan, Rabri, kulfi / Dahi, Ghee, Lassi, Makkhan.

UNIT – II

Food preservation: Food Irradiation, microwave heating & cosmic heating preparation of cakes-methods. Assessment of Quality Factors in foods: - Appearance factors, Textural factors, flavor factors, quality standards.

UNIT – III

Food detoriation and its control: Shelf life & dating of foods, principles of food preservation, control of microorganisms. Beverages: Carbonated non alcoholic beverages, beer, wine, coffee, tea. Causes of spoiling and their control methods.

UNIT – IV

Confectionaries: Confectionary SS chocolate products: Sugar based Chocolates, Ingredients, confectionery manufacturing practices.

UNIT – V

Food Safety, Risks Hazards: Food processing & the environment, principles of food packaging. Governmental regulation of food & nutrition labeling for jam, jelly, squash, pickle. General characteristic of milk, milk products.

REFERENCES

1. Food science – Fifth Edition – Normal N.Potter, Joseph H. Hotchkiss.
2. Outlines of Dairy technology – Sukumar De.
3. Modern technology of milk processin & Dairy products – NIIR Board of dairy technology
4. Nutrition & Dietetics – Shubhangini A.Joshi.

SKILL BASED STUDIES II-THEORY MEDICAL LAB TECHNOLOGY – UBTN42

Objectives **Hours : 2** **Credit : 2**

- Students should know about the storage and handling of chemicals and waste management the clinical laboratory.
- Students should able to know about basic knowledge of cells, tissues, blood, physiological functions of the body.
- To acquire knowledge about basic study and understanding of the various disorders as well as their laboratory investigations.
- To learn about the basic molecular diagnostics equipments and it applications in the disease diagnosis.

UNIT – I

Clinical Laboratory records. Common Lab accidents and ways for its prevention, First aid in the clinical laboratory. Storage and handling of dangerous chemicals. Waste disposal in the labs.

UNIT – II

Blood Analysis – anticoagulant, hemoglobin, RBC, Packed cell volume, ESR, WBC total, differential normal and abnormal hametopathy – anemia, bone marrow smear, leukemia and myelodysplastic syndromes, diagnostic significance of PB smear, hemorrhagic disorder, L.E. cell phenomenon

UNIT – III

Urine analysis – collection – physical, chemical and microscopic examination of urine.

UNIT – IV

Faeces: Collection and preservation, examination of motion for color, mucus, consistency, ova, ameba, cysts, parasites, puscells, RBC and crystals.

UNIT – V

Molecular Diagnostics – Blood banking, Transplantation, ELISA, RIA, FACS, PCR. Computers in lab.

REFERENCES:

1. Handbook of medical lab technology – Ed; V.H.Talib, CBS publication
2. Clinical Chemistry by Willium J.Marshall (Fifth edition, Mosby Publications).
3. An Illustrated color text of Clinical Biochemistry by Allen Gaw, Robert A.Cowan, illustrated by Robert Britton (1999, second edition, Churchill Living stone press).
4. Marks' Basic Medical Biochemistry: A Clinical Approach (2nd Edition), by Colleen M. Smith, Allan D. Marks and Michael A. Lieberman.
5. Medical Microbiology by Jawetz.

SEMESTER – V

CORE VI – THEORY – DEVELOPMENTAL BIOLOGY – UBTT51

Objectives **Hours : 5** **Credit : 4**

- Students should able to understand the different phases of the embryo development and associated medical implications.
- Students will acquire knowledge to analyze and interpret the principles of early and late embryonic development .
- To compare and comprehend the development of model organisms like C. elegans, amphibians, Aves .
- To demonstrate the medical implications of developmental biology.

UNIT – I

Gametogenesis: Definition-primordial germ cells-origin-spermatogenesis-physiological ripening of sperm-oogenisis-previtellogenesis-vitellogenesis.

UNIT – II

The egg: Size-shape-egg membranes,tertiary membranes,organization of the egg yolk, pigments, egg cortex, polarity, oriin of polarity, types of eggs. Cleavage-Definition, morula, blastula, types of blastula, molecular changes, planes of cleavages, types of cleavage, factors affecting cleavage, cleavage laws, adhesion of blastomeres during cleavage, nuclei of cleaving cells, cytoplasm of cleaving cells.

UNIT – III

Gastrulation: Definition, exogastrulation, metabolism and molecular changes during gastrulation, gene activities during gastrulation. Morphogenic movements- Definition, types epiboly, emboly mechanism of morphogenic movements.

UNIT – IV

Organogenesis: Definion, tabulation, neurogenesis, spermatogenesis, growth and differentiation derivatives of ectoderm and mesoderm.

UNIT – V

Regeneration: Definition – Types, Human Reproduction puberty, Menstrual cycle.Menopause, Pregnancy and related problems parturition and lactation.

REFERENCE:

1. Verma.S and Agarwal V.K. 2000. Chordate Embryology S.Chand & Co. New Delhi.
2. Berrill.N.J., 1986 Developmental Biology Mc.Graw Hill, New Delhi.
3. Patten, B.M., (1958) Foundations of Embryology Mc.Graw Hill, New Delhi.
4. Saunders.J.W (1982) Developmental Biology – Pattern and Principles, Macmillan New York.
5. Principles of Embryology – Waddington.
6. Embryology by Brath.

CORE VII – THEORY – ANIMAL BIOTECHNOLOGY – UBTT52

Objectives **Hours : 5 Credit : 4**

- The objectives of this course is to introduce students to the principles, practices and application of animal biotechnology
- Students to develop basic skills for vertebrate cell culture, maintenance of cell lines and in vitro application of cell and molecular techniques.
- Students should understand the principles of animal cloning and its applications.
- Students will be able to acquire knowledge in animal cloning and its applications

UNIT –I

Animal cell culture: Fundamentals. Facilities and Applications. Media for Animal cells.Types of cell culture: Primary cell culture, secondary culture, cell transformation, cell lines, Insect cell lines,stem cell cultures, cell viability and cytotoxicity.

UNIT –II

Biology of cultured cells, measurement of growth, cell synchronization, senescence and apoptosis Organ culture. Cryopreservation.

UNIT –III

Genetic engineering in animals: methods of DNA transfer into animal cells- calcium phosphate co precipitation, micro-injection, electroporation, Liposome encapsulation, Biological vectors. Hybridoma technology, Vaccine production.

UNIT –IV

Gene therapy, mapping of human genome. RFLP and applications. DNA finger printing and Forensic Science. Molecular diagnosis of Genetic disorders.

UNIT –V

Transgenics: Transgenic animals. Production and recovery of products from animal tissue cultures: cytokines, Plasminogen activators, Blood clotting factors, Growth hormones.- Transgenic animals – Merits and demerits –Ethical issues in animal biotechnology.

REFERENCES:

1. Freshney, E. D.2000. Animal Cell Culture: A practical approach. John Wiley Pub.,New York.

2**.** Mather, J.P. and Barnes, D. (Eds.). 1998. Animal Cell Culture Methods (Methods in Cell Biology. VOL. 57). Academic Press**,** London.

3. Butler, M. (Ed.). 1990. Mammalian Cell Biotechnology- A Practical Approach. Oxford Univ. Press, Oxford.
5. E.J. Murray (Ed) .1991. Gene Transfer and Expression Protocols – Methods in Molecular Biology Vol.7. Humana Press,Totowa, NJ.
7. Watson, J.D., M. Gilman, J. Witkouski and M.Zoller.1992. Recombinant DNA. Scientific American Books, New York
8. Puller, A. (Ed) .1993. Genetic Engineering of Animals. VCH Publishers, New York.

CORE VIII – THEORY – BIOPROCESS TECHNOLOGY – UBTT53

Objectives **Hours : 5** **Credit : 4**

- This course will provide a comprehensive understanding of media formulations, microbial growth kinetics, bioreactor selection, upstream & fermentation processes, and its role in manufacturing bio-products..
- To learn about how microorganisms and biochemical processes can be applied in engineered systems..
- Students should gain knowledge about microbial growth & cultivation, various bioreactor components, and types of bioreactor used in biotechnology industries.
- To learn important microbial/enzymatic industrial processes in food and fuel industry.

UNIT –I

Introduction to industrial microorganisms: Isolation, Preservation and Maintenance of Industrial Microorganisms .Kinetics of microbial growth and death. Media for industrial fermentation. Air and Media Sterilization.

UNIT- II

Types of fermentation processes: Analysis of batch, Fed-batch and continuous bioreactors; components of bioreactor- Measurement and control of bioprocess parameters.

UNIT –III

Downstream Processing: Introduction, Removal of microbial cells and solid matter, foam removal, precipitation, filtration, centrifugation, cell disruption, liquid-liquid extraction chromatography, Membrane process, Drying and Crystallization. Effluent treatment:BOD and C.O.D. treatment and disposal of effluents.

UNIT- IV

Industrial Production of Chemicals: Alcohol (Ethanol), Acids (Citric), Antibiotics (Penicillin), Amino acids (lysine), Single Cell Protein (algae/fungi).

UNIT- V

Introduction to Food Technology: Food Preservation – methods. Enzyme technology-biosensor, immobilization of enzymes. Commercial production of enzymes-techniques and applications.

REFERENCES:

1. Stanbury, P.F. and Whitaker, A.,(Eds). 1984. Principles of Fermentation Technology. Pergamon Press, Oxford.

2. Arnold L Demain and Julian E.Davies. 1999. Manual of Industrial Microbiology and Biotechnology, III edition .ASM press, Washington DC.

3. Frazier, W.C. and Dennis, C. Westhoff. 1995. Food Microbiology, Tata McGraw Hill Publlishing Company, New Delhi.

12. Casida, L.E. 2003. Industrial Microbiology. New Age International (P) Ltd., New Delhi.

5.Michael Shuler and Fikret Kargi. 2002. Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ.

6. Pauline M. Doran. 1995. Bioprocess engineering principles, 1 Edition, Academic Press

7. Bailey, J.E. and D.F Ollis. 1986. Biochemical Engineering Fundamentals, 2nd ed. McGraw-Hill Chemical Engineering Series, Berkshire, U.K.

8. Aiba. S., Humphrey, A.E.and Millis N.F. 1973. Biochemical Engineering. University of Tokyo Press, Tokyo

9. Aktinson B. 1974. Biochemical Reactors. Pion Ltd., London

10. Jackson, A.T . 1991. Process Engineering in Biotechnology. Prentice Hall, Engelwood Cliffs, NJ, USA. 26

11.Enfors, S. O. and Haggstrom, L.H. 1998. Bioprocess Technology – Fundamentals and Application. KTH, Stockholm.

CORE IX –THEORY – BIOSTATISTICS – UBTT54

Objectives **Hours : 5** **Credit : 4**

- The course will provide the fundamentals of statistics, methodology.
- Students will able to know the theory of statistics and their application for solving the problems in the field of life sciences.
- Students should classify the various types of data and apply basic statistical concepts
- Students should learn the use of concepts of probability, probability laws, probability distributions and apply them in solving biological problems and statistical analysis.

UNIT – I

Introduction to Basis of statistics – Definition – Statistical methods – kinds of Biological Data. Classification of Data, Meaning and definition, objectives of Classification of Data.

UNIT – II

Collection, Organization and Representation of Data.

Collection of Data, Types of Data- Primary Data and Secondary Data, methods of collecting Data. Sampling and sampling Designs – Meaning and Definition – Random and Non – Random sampling. Tabulation and representation of data – diagrammatic and graphical.

UNIT – III

Measures of central Tendency. Definition, Types of averages- Arithmetic mean, Median, Mode, Problems related to ungrouped data, simple grouped data – Continuous and discrete series.

UNIT – IV

Measures of Dispersion, Definition, Types of dispersion – Range, Mean deviation, Standard deviation and variance, problems related to measures of dispersion.

UNIT – V

Correlation analysis (Karl Pearson's and Spearman's Rank), Regression analysis – simple, linear. Tests of significance –'t'-test, Chi-square and goodness of fit, 'F' test, Analysis of variance (ANOVA): One-way & Two-way.

REFERENCES:

1. Sokal, R.R. and F.J. Rohlf. 1981. Biometry. W.K. Freeman. San Francisco.

2. Zar, J.H. 2003. Biostatistical Analysis. Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi.

CORE X – THEORY – ENVIRONMENTAL BIOTECHNOLOGY – UBTT55

Objectives **Hours : 5 Credit : 4**

- Students should understand how biotechnology can help in monitoring or removing the pollutants and developing an understanding of new trends such as biofuels, renewable energy sources, or microbial technologies which can minimize the harmful impact of pollutants in the environment.
- To learn comprehend fundamentals of biodegradation, biotransformation and bioremediation of organic contaminants and toxic metals.
- To acquire knowledge and apply biotechnological processes in waste water and solid waste management.
- Students will able to demonstrate innovative biotechnological interventions to combat environmental challenges

UNIT – I

Classification of natural resources-renewable and non-renewable, conservation of natural resources-water and soil resources. Environmental impact- production of biofuel and biogas.

UNIT – II

Bioremediation and Bio-leaching: Environmental impact of pollution and measurement methods – Composting of organic wastes, microbial bioremediation of oil spills; Waste water treatment – sewage treatment and common industrial effluent treatment ; Concepts of bioremediation (in-situ and ex-situ), Bioremediation of toxic metal ions – biosorption and bioaccumulation principles. Concepts of phytoremediation; Microbial biotransformation of pesticides and xenobiotics; Microbial leaching of ores – direct and indirect mechanisms.

UNIT – III

Biofertilizers: Biofertilizers and their importance in crop productivity; Algal and fungal (mycorrhizae) biofertilizers Bacterial biofertilizers (rhizobial, free living Nitrogen fixers and phosphate solublizing bacteria), their significance and practice.

UNIT –IV

Biopesticides : Bacterial (Bt pesticides), fungal (Trichoderma); Viral biopesticides – Baculovirus, NPV insecticides; Production of biofertilizers and biopesticides for large scale application.

UNIT –V

Genetic Engineering in Environmental Biotechnology:Genetically engineered microorganisms in environmental health-Genetically engineered plants and microorganisms in agriculture and productivity-Genetically engineered bacteria in bioremediation of organic pesticides, insecticides oil spills-Hazards of genetically engineered microorganisms, plants and animals-Policies of genetic engineering research.

REFERENCES

13. Alan Scragg. 1999. Environmental Biotechnology. Pearson Education Limited, England.

2 Jogdand, S.N. 1995. Environmental Biotechnology. Himalaya Publishing House, Bombay.

3. Technoglous, G., Burton,F.L. and Stensel, H.D. 2004. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy, Inc.,Tata Mc Graw Hill, NewDelhi.

4. De, A.K. 2004. Environmental Chemistry. Wiley Eastern Ltd. NewDelhi.

5. Allsopp, D. and K.J. Seal. 1986. Introduction to Biodeterioration. ELBS/Edward Arnold, London.

6. Athie, D. and C.C. Cerri. 1990. The Use of Macrophytes in Water Pollution Control, Pergamon Press, Oxford.

7. Chin, K.K. and K. Kumarasivam. 1986. Industrial Water Technology Treatment, Resuse and Recycling . Pergamon Press, Oxford.

8. Jenkins, D. and B.H. Olson(Eds). 1989. Water and Wastewater Microbiology. Pergamon Press, Oxford.

9. Fry, F.C., Gadd, G.M. Herbert, R.A. , Jones, C.W., and Watson-Craik,J.A.(Eds.) 1982. Microbial Control of Pollution . Cambridge University Press, New York.

10. Dart, R.K. and R.J. Stretton, 1994. Microbiological Aspects Pollution Control.Elsevier Pub.Co., Amsterdam: New York.

ELECTIVE III – THEORY: BIOTECHNOLOGY AND HEALTH – UBTE53

Objectives **Hours : 3** **Credit : 3**

- To learn about the classical genetics and transmission of characters from one generation to the next which will make foundation for the advanced genetics.
- To learn about the advanced genetic technology and terapy related to the human diseases.
- Students should able to develop innovative research ideas for curing genetic disorders in humans
- Students should know about the Social, Ethical and Legal Issues in Medical Biotechnology.

UNIT- I

Human Genetics and Human Genome: History and development of human genetics; organization of the human genome. – chromosome and gene organization –Inherited human diseases-single gene diseases,complex traits.

UNIT- II

Gene Therapy: Identification and isolation of disease genes –Cancer genetics – Genetic ounseling. Gene therapy. Infectious Diseases: Classification: fungal, protozoal, helminthic, bacterial and viral;Vaccines – types. Hospital-acquired infections (nosocomial), water-borne diseases.

Unit –III

Transplantation Technology: Introduction- types, transplantation immunology. Preventing methods, Immunosuppressive drugs.

Unit –IV

Embryonic Stem cells: Culture & Therapy. Artificial Blood. Aminocentosis. Biochemical and Molecular Diagnostics.

UNIT- V

Social, Ethical and Legal Issues in Medical Biotechnology: IPR: patents and copyrights. Human cloning. Pre-natal sex determination and foeticide.Genetically Modified Organisms.

REFERENCES:

1. Schacter, Bernice (Ed.). 2006. Biotechnology and Your Health: Pharmaceutical Applications. Chelsea House Publications, New York.

2. Dinesh, K.P. and Chetan, D.M. 2007. Health and Pharmaceuticals Biotechnology. Laxmi Publications (P) Ltd., India.

3. Crommalin, D.J.A., R.D. Sindeler and B.Meibohm (Eds). 2007. Pharmaceuticals Biotechnology: Fundamentals and Applications. Informa Health Care, London.

Option 2

Option 2- BIOREMEDIATION - UBTE53

Objectives **Hours : 3** **Credit : 3**

- Students should demonstrate an understanding of the nature and importance of bioremediation.
- Students should know about the influence of site characteristics: hydraulic conductivity, soil type, microbial presence, and groundwater properties.
- Students should understand the influence of contaminant characteristics to bioremediation (e.g. chemical structure, toxicity, and solubility).
- Students will able to use of course concepts to solve problems in real world applications.

UNIT I

Bioremediation- Introduction, constraints and priorities, Biostimulation of Naturally occurring microbial activities, Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation.

UNIT II

Solid phase bioremediation - land farming, prepared beds, soil piles, Composting, Bioventing & Biosparging; Liquid phase bioremediation- suspended bioreactors, fixed biofilm reactors.

UNIT III

Hazardous Waste Management biotechnology application to hazardous waste management - examples– cyanide detoxification - detoxification of oxalate, urea etc. - toxic organics - phenols.

UNIT IV

Concept of bioremediation (in-situ & ex-situ), Bioremediation of toxic metal ions biosorption and bioaccumulation principles. Concepts of phytoremediation. Biosensors and Bioindicators.

UNIT V

Microbial leaching of ore-direct and indirect mechanisms. Mining and metal. Use of microorganisms in augmentation of petroleum recovery. Biotechnology-with special reference to Copper and Iron.

REFERENCES

1. Environmental Biotechnology by S. K. Agarwal
2. Biodegradation & Bioremediation (1999), Martin Alexander, Academic press.
3. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd.,
    a. 1987.
4. Environmental Biotechnology by A.K. Chatterjee
5. Environmental Biotechnology by S.N.Jogdand Himalaya Publishing

SKILL BASED STUDIES III-THEORY- INTRODUCTION TO MEDICINAL AND AROMATIC PLANTS – UBTS53

Objectives **Hours : 2** **Credit : 2**

- Students learn as they can on medicinal and aromatic plants in their local habitats and abroad, and gain useful knowledge on their cultivation and commercial production.
- Students should also know on medicinal and aromatic plants, their parts and products used in folk medicine and on groceries of these in local markets.
- Students able to obtain the active constituents of medicinal and aromatic plants and know their chemistry and values.
- Students know on methods of medicinal and aromatic plants preparations, formulations for marketing and healing properties.

UNIT - I

Pharmacognosy - Definition and History. A general account of different survey of Different systems of Medicines - Indian systems of medicine - Siddha Ayurveda and Unani systems.

UNIT - II

Classification of drugs (elementary). Chemistry of Drugs (Basics). Morphological and Histological studies - Chemical constituents.

UNIT - III

Therapeutic and other Pharmaceutical uses of Bark - Cinchona, Leaves - Adathoda and Eucalyptus, Flower - Clove. Root-vetivera zizonoids

UNIT - IV

Fruits and seed - Wood apple, Goosberry and Poppy seed, Underground stem - Ginger, Unorganized drugs. Gum - Acacia, Resin - Turpentine, Fixed oil - Castor oil.

UNIT - V

A brief account of the following: a) Drugs acting on the Central Nervous system b) Drugs used in the disorders of the Gastro Intestinal tract and c) Cardio Vascular drugs. (Five Plant examples for each mentioned above).

SEMESTER - VI

CORE XI – THEORY - PLANT BIOTECHNOLOGY – UBTT61

Objectives **Hours : 5** **Credit : 4**

- The Students will learn the fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.
- The Students will acquire knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.
- To acquire the knowledge about the techniques of Plant Tissue Culture, Lab. organization & measures adopted for aseptic manipulation and nutritional requirements of cultured tissues.
- To learn the techniques of culturing tissues, single cells, protoplasts & anther culture, germplasm conservation and cryobiology.

UNIT – I

Plant genome organization – structure of representative plant genes and gene families in plant – organization of chloroplast genome – organization of mitochondrial genome .

UNIT – II

Molecular biology and gene rearrangement – Agrobacterium and crown gall tumors – mechanism of T-DNA transfer to plant – Ti plasmid vectors and its utility – plant viral vectors – symbiotic nitrogen fixation in Rhizobia.

UNIT – III

Genetic engineering of plants – construction of genome libraries and cDNA libraries Molecular breeding – probe construction – recombinant DNA – Transgenic plant and applications – Edible vaccine.-vaccine from plant.

UNIT – IV

Plant hormones - Auxin , IAA. GA, Cytokinins and Absicisic acid (ABA) - molecular basis of action – phytochrome – role in photo – morphogenesis – regulation of gene expression - stress induced promoter switches in the control of gene expression – ethylene and fruit ripening.

UNIT V

Plant tissue culture – cells suspension cultures– haploid plants – cloning of hosts – micro propagation – somatic embryogenesis – protoplast isolation and applications.

REFERENCES:

1. Kojima, Lee, H. and Kun, Y. 2001 Photosynthetic microorganisms in Environmental Biotechnology. Springer – Verlag.

2. Trivedi, P.C.2000 Applied Biotechnology and plant genetics, Dominant publishers and distribution.

3. Ignacimuthu, 1996. Applied Plant Biotechnology. Tata McGraw – Hill.

4. Grierson and Convey, S.N. 1988. Plant molecular Biology. Backie.

5. Narayanaswamy. S. 1994. Plant cell and tissue culture. Tata McGraw Hill publishing company limited, New Delhi.

CORE XII - THEORY – BIOINFORMATICS – UBTT62

Objectives **Hours : 5** **Credit : 4**

- The objectives of this course are to provide students with the theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.
- Develop an understanding of the basic theory of these computational tools.
- Students should gain working knowledge of these computational tools and methods.
- Students gain knowledge to relevance for investigating specific contemporary biological questions and critically analyse and interpret the results of their study.

UNIT – I

History, development and types of computers. General awareness of computer systems – hardware and software (CPU and other peripheral devices, computer arithmetic, computer logic,

UNIT – II

Programming languages – machine language, assembly language, higher level languages). Introduction – Email – World Wide Web – surfing.

UNIT – III

Sequence analysis – need and importance – pair wise alignment – dynamic programming – Global (Needle man – Wunsch) and local (Smith Waterman) Alignment Concepts – Database searching tools – Entrez, BLAST, FASTA – Multiple alignment – clustal – construction of phylogentic trees.

UNIT – IV

Use of nucleic acid and protein data banks – NCBI, EMBI, DDBJ, SWISSPORT. 3D structural analysis of biomolecules – molecular visualization tools Rasmol, chemsketch and SPDBV – Protein Docking.

UNIT – V

Evolutionary analysis: Distance – clustering methods – Rooted and unrooted tree representation – Bootstrapping Strategies. Neutral Networks.

REFERENCE:

1. Bioinformatics – Principles and potential of a new multidisciplinary tool, TIBITE, 1996.
2. Computer for biologists. – A. Fielding i985. Benjamin / cuming publ.co
3. Sequence Analysis in Molecular Biology – G. Von Heijine.
4. Sequence Analysis – A Pioneer - Devereux and Gtribskov.

5. Introduction of Bioinformatics – Attwood Tand Parry, D. 2002. Pearson Education Asia.

CORE XIII - THEORY – BIOINSTUMENTATION – UBTT63

Objectives **Hours : 5** **Credit : 4**

- Students should know the basics and advanced principles, concepts, and operations of medica devices.
- Students should learn brief study of different medical instrument and their use in physiological measurements
- This course is to familiarize the students with the analysis and design of different instrument like HPLC and GC.

UNIT - I

Acid & Bases: Acid-Base theories, Mole concept, Molarity, Molality & Normality, pH, Buffers, Oxidation –Reduction, Types of electrodes.

UNIT - II

Microscopy – parts and their function, resolving power, aperture – simple, compound, light and dark field, electron and phase contrast microscopes – their applications.

UNIT - III

Colorimetry – parts and their functions – Beer Lambert's Law – Spectroscopy – pH metry.

UNIT - IV

Chromatography techniques – Principles and types – paper, TLC, Column, HPLC and GC. Centrifugation techniques – principle, centrifuges and their uses, separation methods. Ultracentrifugation – applications.

UNIT - V

Electrophoretic techniques – principle, electrophoresis of proteins and nucleic acids. Capillary electrophoresis.

REFERENCES

1. Keith Wilson and John Wilson. 2004. Practical Biochemistry. Fifth edition

2. Palanivelu P. 2001Analytical Biochemistry & Separation Techniques. 2nd edition.

3. Alexander. J Ninfa, Fundamental Laboratory & Approach for Biochemistry & Biotechnology –2nd edition.

CORE PRACTICAL III – LAB IN MICROBIAL TECHNOLOGY – UBTP63

Objectives **Hours : 5** **Credit : 4**

- To acquire basic techniques in microbiology and microbial physiology.
- Students should understand the different types of media used in microbial isolation and also understand the methods used for characterization of microorganisms
- To learn and understand the basic techniques of microbial isolation.
- Students should know about the production methods for industrially important products of microbial origin such as antibiotics, vaccines, proteins, primary and secondary metabolites, as well as food and dairy products.

1) Bioprocess – Fermentor
2) Part and design, types of fermentors / bioreactors
3) Isolation and characterization of Microorganisms involved in Biodegradation (Cellulolytic)
4) Determination of cellulolytic activity
5) Isolation and characterization of microorganisms involved in biodegradation (amylolytic)
6) Determination of amylolytic activity by DNS method
7) Compost making
8) Production of wine from grapes using bakers yeast
9) Production of alcohol by S.Cerevisiae
10) Isolation of Rhizobial colonies involved in biofertilization
11) Isolation of lactic acid bacteria.
12) Milk quality testing

CORE PRACTICAL IV – LAB IN PLANT TISSUE CULTURE – UBTP64

Objectives **Hours : 5** **Credit : 4**

- The students will be able to establish and maintain aseptic techniques in controlled conditions for plant tissue culture.
- Students should able to explain the various components of plant tissue culture media, e.g. minerals, growth factors, hormones, and what governs the choice of components.
- Students will able to perform some of the more advanced techniques, e.g. embryo rescue, and protoplasting.
- To acquire knowledge in maintaining plants in tissue culture and micropropagation, including morphogenesis.

1. Sterilization procedures, media preparation, different media combination.
2. In vitro germination of seeds
3. Callus induction and differentiation
4. Embryo Culture
5. Somatic embryogenesis.
6. Isolation and fusion of protoplast
7. Artificial seed production
8. Meristem culture
9. Micropropagation

Referrence Books

Hurse P.I. and Patterson., M.K.Tissue culture, methods and applications,

2. Marchan,D.J. 1964.Handbook of Cell and Organ Culture (2nd ed).Burgess Pub.Co., Minneapolis, USA.

3. Animal cell culture course manual – cold spring warbor laboratory, Newyork.

4. Shanmugam, Laboratory Manual of Cell Biology,Macmillan, India.

5. Dixon, L.A. and R.A. Gonzales. Plant cell culture – A Practical Approach. Revan Press, New York.

6. Quak, F. 1981. Plant Tissue Culture: Methods and Applications in Agriculture. Academic Press, New York.

Option 1

ELECTIVE IV THEORY – BIOSAFETY AND IPR – UBTE64

Objectives **Hours : 3** **Credit : 3**

- Students will gain awareness about Intellectual Property Rights (IPRs) to take measure for the protecting their ideas.
- They will able to devise business strategies by taking account of IPRs.
- Students will acquire adequate knowledge in the use of genetically modified organisms and its effect on human health.
- Students will gain more insights into the regulatory affairs

UNIT - I

Biosafety: Introduction; biosafety issues in biotechnology-historical background; Introduction to Biological Safety Cabinets; Biosafety Levels.

UNIT - II

Biosafety Guidelines: Biosafety guidelines and regulations (National and International) – operation of biosafety. Guidelines and regulations of Government of India; Roles of Institutional Biosafety Committee.

UNIT - III

Definition of GMOs & LMOs; RCGM, GEAC etc. GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication.

UNIT - IV

Types of Intellectual Property: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications. Importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO).

UNIT -V

Patent Filing Procedures: National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/nondisclosure;Financial assistance for patenting.

REFERENCES:

1. Martin. M.W. and Schinzinger R. 2003. Ethics in engineering, III Edition, Tata McGraw-Hill, New Delhi.

2. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007

3. Kankanala, K . C. 2007. Genetic Patent Law & Strategy, 1st Edition. Manupatra Information Solution Pvt. Ltd.,.Noida, India.
4. Jose B. Cibelli, Robert P. Lanza, Keith H. S. Campbell, Michael D.West. 2002. Principles of Cloning, Academic Press, SanDiego, Gurdon.

Option 2

Electives I -Choice 1 General Biology – UBTE64

Objectives **Hours : 3** **Credit : 3**

- To provide a foundation in basic biological principles.
- Student should develop an understanding of the scientific method and its implications.
- To develop an understanding of some natural laws and their applications to life.
- To develop the ideas of the uniqueness and diversity of life.
- To develop an understanding of the interrelationships among living organisms.

Unit I

Basis of Classification – Bentham and Artificial, Natural Classification of plants. Morphology, Structure and reproduction in plants. Algae: General characters – *Sargassum* as an example – Economic importance of Sea weeds. Fungi: General characters – *Yeast* as an example.

Unit II

Bryophytes: General characters – *Funaria* as an example - alternation of generation. Pteridophytes: General characters – *Selaginella* as an example. Gymnosperm: General characters – *Pinus* – Economic uses of gymnosperms. Angiosperms – Monocot flower – *Allium cepa*; Dicot flower – *Tribulus terrestris*.

Unit III

Digestion: Organization, movement and secretions of gastrointestinal tract. Respiration: respiratory organs– morphology and respiratory pigments. Circulation: Blood – composition of blood - General organization of circulatory systems.

Unit IV

Excretion system – excretory organs – general organization in man – muscular system – ultra structure of voluntary muscle.

Unit V

Nervous system – CNS – Autonomic nervous system – Endocrine system in man.

Reference

1. A.C.Dutta, Botany for degree students

2. G.M.Smith, Cryptogamic Botany Volume I & II
3. W.T.Taylor and R.J.Wehe – General Biology
4. Narayanaswamy – Outlines of Botany
5. General Biology – Cambridge Press

SKILL BASED STUDIES IV-THEORY BIOFERTILIZER – UBTS64

Objectives **Hours : 2 Credit : 2**

- To know about the rural based economically viable & self income generation, Entrepreneurship & Skill Development Programme (ESDP) on Biofertilizers.
- To demonstrate the effectiveness of biofertilizer cultural practices in the farmers fieldsfor enhanced crop productivity through bioreclamation of waste/ marginal land.
- To demonstrate the know-how technology pertinent to microbiological and physico-chemical analyses of soil samples and their assessment.

UNIT - I

Introduction: History, importance and present status of different types of fertilizers and their application to crop plants. Need of ecofriendly fertilizers. Effect of chemical fertilizers on environment. Energy consuming pattern for chemical fertilizers.

UNIT – II

Algal and fungal (mycorrhizae) biofertilizers Bacterial biofertilizers Rhizobial, free living N2 fixers and phosphate solublizing bacteria, their significance and practice. Nitrogen fixing mechanisms.

UNIT- III

Manures: A general account of manures such as leaf moulds, composts form Yard Manure and a study of the following oilseed cakes: castro and neem as Biopesticide. Green Manuring Role of serbania serban for improving soil fertility.

UNIT- IV

Application of biofertilizers and manures: A combination of biofertilizer and manure application.organic farming-compost and vermi compost.

UNIT - V

Mass production of Cyanobacterial Biofertilizers -- Nostoc, Anabaena Azolla. Blue green algae. Bacterial Biofertilizers -Azotobacter, Azospirillum ,Rhizobium ,Pseudomonas

Reference:

1.N.S. Subbao Rao-soil microorganisms and plant growth.

2.N.S. Subbao Rao-Biofertilizer

3.Ronald M. Atlas& Richard bartha, Microbial Ecology,Fundamentals & application

4. Alexander1977.Introduction to soil microorganinsm and plant growth.