

UNIVERSITY OF MADRAS
B.Sc. DEGREE COURSE IN BIOTECHNOLOGY
SYLLABUS WITH EFFECT FROM 2020-2021

BBT-DSC01

CORE-I: CELL AND MOLECULAR BIOLOGY

Instr.Hrs.: 6
Credits : 4

Year : I
Semester: I

Learning Outcomes:

Students can understand; The structural design of Prokaryotic and Eukaryotic cells. The synthesis, structure, importance and the inter-relationships between the DNA, RNA and Proteins. The major molecular processes which governs all the cellular activities and their regulations.

UNIT 1:

Introduction to the cells: Discovery and diversity of cells - Cell theory - Structure of prokaryotic (bacteria) and eukaryotic cells (plant and animal cells).

UNIT II:

Biomolecules and Cell organelles: Biomacromolecules and Biomicromolecules (Primary functions in the cell). Structure and Functions of Cell Organelles: Cell wall - Cell membrane (Fluid Mosaic Model) - Cytoplasm - Nucleus - Endoplasmic reticulum (RER & SER) - Ribosomes - Golgi bodies - Plastids - Vacuoles - Lysosomes - Mitochondria - Microbodies - Flagella - Cilia - Centrosome and Centrioles - Cytoskeleton.

UNIT III:

Introduction to Nucleic acids: Discovery of Nucleic acids - Primary and Secondary structure of DNA - DNA Replication - Models of DNA Replication - Circular and Linear forms of DNA - A, B & Z Types of DNA - DNA Damages - DNA Repair Mechanisms - Mutations - Functions of DNA. RNA Types, Structure and Function.

UNIT IV:

Central Dogma of the cell: Structure of chromosomes and genes - Gene expression - Genetic code - Transcription in Prokaryotes and Eukaryotes - RNA Processing - Translation - Similarities and differences in prokaryotic and eukaryotic translation - Post Translational Modifications - Protein Sorting - Protein degradation

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UNIT V:

Cell cycle, cell division, cell differentiation & cellular communications: Cell cycle - Cell cycle check points - Cell division - Mitosis & Meiosis - Cellular differentiation - Cell junctions - Cell Adhesion - Extra Cellular Matrix - Cell to cell communications - Signal transduction - G - Protein Coupled Receptors Signal transduction pathways

References:

1. LodishHarwey, 6th Edition (2016), Molecular Cell Biology, W. H. Freeman Publications.
2. Bruce Alberts, 6th Edition (2014). Molecular Biology of the cell, W. W. Norton & Company.
3. Karp's Cell and Molecular Biology: Concepts and Experiments. 8th Edition (2015). Wiley Publications.
4. James D. Watson, 7th Edition (2014), Molecular Biology of the Gene, Pearson Publications.
5. Geoffrey M. Cooper, 7th Edition (2015). The Cell: A Molecular Approach, Sinauer Associates, Qxford University Press.
6. James D. Watson (2001), The Double Helix: A personal account of the Discovery of the Structure of DNA, Touchstone Publishers.
7. T. Devasena (2012), Cell Biology, Oxford University Press.
8. Gupta, Renu&Makhija, Seema&Toteja, Ravi. (2018). Cell Biology : Practical Manual.

Web Resources:

1. <http://www.cellbiol.com/education.php>
2. <https://global.oup.com/uk/orc/biosciences/cellbiology/wang/student/weblinks/ch16/>
3. <http://cellbio.com/>
4. <https://www.nestgrp.com/molbiol.shtml>
5. <https://ghr.nlm.nih.gov/primer/basics/dna>
6. <https://dnalc.cshl.edu/websites/>
7. <http://sciencenetlinks.com/lessons/cell-dna/>
8. <https://www.sciencedirect.com/topics/medicine-and-dentistry/protein-synthesis>
9. <https://www.cellsignal.com/contents/science/cst-pathways/science-pathways>
10. <https://nptel.ac.in/courses/102/106/102106025/>

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BBT-DSA01

ALLIED-I: FUNDAMENTALS OF MICROBIOLOGY

Instr.Hrs.: 6
Credits : 3

Year : I
Semester: I

Learning outcome

- Understand the basics of microbiology, types of microbes, classification and characterization, various applied aspects of microbes in biotechnology field and the role of microbes in human health

UNIT I :

History of Microbiology, Classification of bacteria, fungi, virus, protozoa and algae – classical and molecular approaches. Future of microbiology – Role of microbes in biotechnology.

UNIT II :

Structure of bacteria - Bacterial growth and measurement of growth, Media – types and preparation-plating methods - staining methods (grams, capsule, spore, LCB mount)- methods of preservation and storage of microbes. Culture of fungi, virus and algae.

UNIT III :

Sterilization methods - physical and chemical methods- Mode of action – Antibiotic in clinical use - Resistance to antibacterial agents - MRSA, ESBL.

UNIT IV :

Bioinsecticides - *Bacillus thuringiensis*, Baculoviruses- Biofertilizers -*Azospirillum* and blue green algae - single cell protein – prebiotics and probiotics - Dairy products (Cheese and Yoghurt).

UNIT V :

Microbial Disease- host -pathogen interaction, clinical features, lab diagnosis and treatment of Airborne disease (Pneumonia, Chicken pox), food borne disease (Typhoid, Aspergillosis), Water borne disease (Cholera, Amebiasis), Sexually transmitted disease (AIDS, Trichomoniasis), Vector borne disease (Dengue, Malaria).

Reference Book

- Prescott, Harley, Klein, Microbiology, 10th Edition, McGraw – Hill, 2016.
- Ananthanarayanan, Paniker, Kapil, Textbook book of Microbiology, 9th edition, Orient BlackSwan, 2013.
- Madigan, Martinko, Bender, Buckley, Stahl, Brock Biology of Microorganisms, 14th edition, 2017.
- Gillespie, Bamford, Medical Microbiology and Infection at a Glance, 4th edition, 2012.

Useful links

- Horst W. Doelle (2004). Microbial Metabolism and Biotechnology. Proceedings of an E-seminar organized by the International organization for Biotechnology and Bioengineering (IOBB)
- www. Biotech.kth.se Electronic Journal of biotechnology
- <http://www.ejb.org/content>.

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BBT-DSC03

CORE-III: GENETICS

Instr.Hrs.: 6
Credits : 4

Year : I
Semester: II

Learning outcome:

Upon successful completion the students will gain the knowledge on the concepts of heredity, Genes, Mendelian genetics, Blood grouping, genetic map preparation and help them to understand about human and population genetics, the role of genes in evolution.

UNIT I

Concepts and Scope of Genetics.Gene, Chromosome structure and organization in Prokaryotes and Eukaryotes.Identification of the DNA as the genetic material- Griffith experiments, Avery, McLeod, Mccarty and Hershey Chase experiment.

UNIT II

Mendel and his Experiments, Monohybrid and Dihybrid inheritance,Test cross. Genetic interaction. Multiple alleles- Blood group antigens, eye colour in Drosophila, Coat colour in Rabbit.

UNIT III

Linkage, Crossing over and Genetic Mapping of Chromosomes., Three point test cross. Conjugation, Interrupted mating technique Transformation and Transduction and their mapping.

UNIT IV

Variation in Chromosome Number and Structure.Mendelian Inheritance in Man (Autosomal Dominant, Autosomal Recessive Sex linked Inheritance,) Gender defective Phenotypes, Pedigree Analysis, Eugenics.

UNIT V

Lamarckism and Darwin's Natural Selection. Gene frequency and genotype frequency.Mutation, Genetic drift, Inbreeding, Speciation.Hardy Weinberg law and the factors affecting hardy Weinberg equilibrium.

BOOKS FOR STUDY

- Lewis, R.2001. Human Genetics- Concepts and application. 4th edition. McGraw Hill.
- Griffiths, Miller, J.H., An Introduction to Genetic Analysis W.H.Freeman. New York.
- Winter,P.C.,Hickey, G.J. and Fletcher, H.L.2000. Instant notes in Genetics. Viva books, Ltd.
- Gardener E.J. Simmons M.J. Slustad D. P. 2006. Principles of Genetics.
- Good enough U. 1985. Genetics. Hold Saunders international.
- Verma PS and Agarwal VK. 2010 Genetics. S. Chand & company PVT. Ltd

Web resources:

- <http://www.ocw.mit.edu>
- <http://enjoy.m.wikipedia.org>
- <Https://www.acpsd.net>

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BBT-DSA02

ALLIED-II: CHEMISTRY
(Allied Chemistry for Biotechnology Students)

Instr.Hrs.: 6
Credits : 3

Year : I
Semester: II

Learning Outcome

1. To explain the basics of electrochemistry
2. To understand the basic concepts of Organic Chemistry
3. To understand the industrial application of fuels, fertilizers and polymers
4. To understand the fundamentals of coordination chemistry and its applications
5. To know the fundamentals of nuclear chemistry

UNIT I: ELECTROCHEMISTRY

(12Hours)

Electrolytic conductance in metals and in electrolytic solution – specific conductance and equivalent conductance – Arrhenius theory of electrolytic dissociation and its limitations - weak and strong electrolytes according to Arrhenius theory – oswald's dilution law – applications and limitations – Conductometric titrations – strong acid vs strong baseonly.

UNIT II: FUNDAMENTALS OF ORGANIC CHEMISTRY

(10 Hours)

Classification of organic compounds - Hybridization in methane, ethane, ethylene, acetylene, benzene -Classification of reagents - electrophiles, nucleophiles and free radicals - Classification of reactions - addition, substitution, elimination, condensation and polymerisation.

UNIT III: INDUSTRIAL CHEMISTRY

(15 Hours)

Fuels- Classification-gaseous fuels like water gas, producer gas, liquefied petroleum gas, gobar gas, compressed natural gas - Fertilizers- Classification - urea, ammonium sulphate, superphosphate, Triple super phosphate, potassium nitrate- manufacture and uses - Silicones - Preparation, properties and applications . Hardness of water: temporary and permanent hardness.

UNIT IV: COORDINATION CHEMISTRY

(10 Hours)

Definition of terms-classification of ligands-Nomenclature-chelation-EDTA and its applications-Werner's Theory-Effective Atomic Number-Pauling's Theory-Postulates-Biological role of haemoglobin and chlorophyll, (Elementary idea only)

CATALYSIS

(5Hours)

Characteristics of catalytic reaction, auto catalysis, promoters, catalytic poisons – Types of catalysis – homogeneous and heterogeneous - Enzyme catalysis (no derivation, elementary idea only)

UNIT V: NUCLEAR CHEMISTRY

(8 Hours)

Fundamental particles of Nuclear Isotopes, Isobars, Isotones and Isomers -Differences between chemical reactions and nuclear reactions: Fusion and fission - Radioactive series, group displacement law - Mass defect - Applications of radio isotopes- carbon dating, rock dating and in medicine.

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BOOKS FOR REFERENCE

1. Gopalan R. and Sundaram S., Allied Chemistry, Sultan Chand & Sons Publishers, New Delhi^{2nd}ed.
2. Soni P.L. and Mohan Katyal, Text Book of Inorganic Chemistry, Sultan Chand and Company Pvt. Ltd, New Delhi, 20thed.
3. Bahl B.S. and ArunBahl, A text book of Organic Chemistry 21st ed., S. Chand and Company Pvt. Ltd.

<http://dir.yahoo.com/Science/Chemistry/>
<http://www.chemistry.mcmaster.ca/faculty/bader/aim/>

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OFFERED IN THE DEPARTMENT OF BIOCHEMISTRY
SYLLABUS WITH EFFECT FROM 2020-2021

BBC-NME02

CLINICAL NUTRITION AND DIETARY MANAGEMENT

Credit: 2

Teaching Hrs: 75

Learning outcomes

On completion of the course, the students will

- Understand the need of a Balanced diet for Healthy life
- Gain insight into Nutrition requirements during different stages of Life.
- Appreciate the importance of Dietary Management in different diseases
- Acquire knowledge on different modes of nutrition

UNIT I

(15Hrs)

Definition of Nutrition, Overview of Balanced diet, Collecting and analyzing Nutritional information – Physical examination, Anthropometric measurements.

UNIT II

(15Hrs)

Common food allergies, food intolerance – lactose intolerance, Cardiovascular diseases-atherosclerosis, and myocardial infarction, foods that increase LDL and HDL.

UNIT III

(15Hrs)

Bulimia and Anorexia Nervosa. Dietary management with reference to Constipation, Diarrhoea, Dehydration, Peptic Ulcer, Hepatitis, Gall bladder diseases and Renal failure.

UNIT IV

(15Hrs)

Dietary management with reference to Hypertension, Diabetes Mellitus, AIDS and Cancer, Surgery and Nutritional support, outline of Enteral Nutrition and Parenteral Nutrition.

RECOMMENDED BOOKS

1. Garrow, JS , James WPT and Ralph A (2000) . Human nutrition and Dietetics (10th ed) Churchill Livingston.
2. PiareyLal Mehta, NeenaVerma, P I Mehta (1999) Human Rights Under the Indian Constitution. Deep & Deep Publications Pvt. Ltd.
3. Handbook of Food and Nutrition –Dr. M. Swaminathan, BappcoPublisher,2014.
4. Nutrition Science- B.Srilakshmi,7th edition, New age International Publisher, 2017.
5. William's Basic Nutrition and Diet Therapy – Staci Nix McIntosh,First South Asian Edition, Elsevier Publisher, 2016.
6. Nutrition essentials and diet therapy-Packenpaugh,11th edition, Saunders Publishers, 2009.

Reference Books:

Davidson's Principles and Practice of Medicine – Sir Stanley Davidson, 21st edition, Elsevier Publishers, 2010

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BBT-DSA03

ALLIED-III: ESSENTIALS OF BIOCHEMISTRY

Instr.Hrs.: 5
Credits : 3

Year : II
Semester: III

Learning Outcome:

- To understand the structure, properties and functions of Biomolecules, major metabolic pathways, role of vitamins and hormones in humans, understand the importance of enzymes and porphyrins and the basics of Biological oxidation.

UNIT I: CARBOHYDRATES AND BIOLOGICAL OXIDATION

Definition and classification of carbohydrates, linear and ring forms (Haworth's formula) for monosaccharides (glucose, fructose, mannose) and disaccharides (maltose, lactose, sucrose). Physical properties-mutarotation, chemical properties, ten reactions of glucose and four reactions of fructose (oxidation, reduction, osazone formation, Seliwanoff's reaction), Disaccharide-maltose, lactose, sucrose-structure, occurrence, physical and chemical properties. Polysaccharides-starch, glycogen, cellulose, structure and properties. Glycolysis, TCA cycle, energy yield, HMP pathway, Electron Transport Chain, Oxidative phosphorylation and its mechanism

UNIT II: AMINOACIDS AND PROTEINS

Aminoacids - Classifications - Essential and Non-essential aminoacids, Non-protein aminoacids, Amphoteric nature, Isoelectric point. Proteins – Classification based on shape, solubility and composition, Biological functions of Proteins, Physical Properties – Ampholytes, Isoionic point, Salting in and Salting out, Denaturation, Peptide bond, Deamination, Transamination, Decarboxylation and Urea Cycle

UNIT III : LIPIDS

Fat - function, classification, simple lipids, fatty acids (saturated and unsaturated) compound lipids, derived lipids, properties-saponification, rancidity, reduction, oxidation, halogenation. Functions of Phospholipids. Cholesterol structure - biological importance, chemical properties. Bile salts-function. Lipoproteins: Structure, properties and Biochemical functions. Ketone bodies: structure and functions. Metabolism: Fatty acid oxidation – β oxidation. Biosynthesis of saturated and unsaturated fatty acids.

UNIT IV: NUCLEIC ACIDS, VITAMINS AND HORMONES

Purine and pyrimidine bases, nucleosides, nucleotides, polymucleotides, DNA structure, various types, properties-absorbance, effect of temperature. Different types of RNA, structure and functions. Vitamins - Definition, classification, Fat soluble vitamins-A,D,E and K.-Occurrence,

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deficiency diseases, biochemical roles, daily requirements. Water soluble vitamins-B1, B2,B3,B6,B9, B12 and vitamin C - occurrence, deficiency diseases, biochemical roles, daily requirements. Hormones – Definition, Classification based on Chemical nature and Mechanism of Action. Eicosanoids- Definition, types and functions.

UNIT V: ENZYMES AND PORPHYRINS

Enzyme definition, units, various classifications, nomenclature, specificity, isoenzymes, factors affecting enzyme activity-substrate, pH, temperature. Classification of porphyrins, their structure and properties; structure of metalloporphyrins- haeme and chlorophyll.

Reference Books

1. J.L. Jain, 2016, Fundamentals of Biochemistry, S. Chand publication, 7th edition.
2. A.C. Deb, 2016, Fundamentals of Biochemistry, New central book agencies, 7th edition.
3. Satyanarayana U, 2016, Biochemistry, MJ publishers 3rd edition (2006).
4. Nelson, David L and Cox, M.M, 2000. Lehninger's Principles of Biochemistry, Macmillan / Worth, NY.
5. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, Harper's Biochemistry, Prentice Hall International. Inc., 24th edition,
6. Geoffrey L. Zubay, William W. Parson, Dennis E. Vance, 1995, Principles of Biochemistry, W.C. Brown Publishers, 1995, 3rd edition.
7. LubertStryer, 1995, Biochemistry, W.H. Freeman & Co, 4th edition.
8. Donald Voet, Judith G.Voet and Charlotte W Pratt, John, 1999, Fundamentals of Biochemistry - Website Links
<https://www.britannica.com/science/biochemistry>
<https://www.sciencedirect.com/topics/agricultural-and-biological-sciences>
<https://biochemistry.org/education/careers/becoming-a-bioscientist/>
9. S.Sadasivam and A. Manickam, 1992, Biochemical Methods, New Age International Publishers, New Delhi, Second Edition
10. J.Jayaraman, 1981, Laboratory Manual in Biochemistry, New Age International publishers, New Delhi

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BBT-DSC07

CORE-VII: PLANT BIOTECHNOLOGY

Instr.Hrs.: 5
Credits : 4

Year : II
Semester: IV

Learning outcome: Upon completion of the course, the student would be able
To gain the knowledge about the plant tissue culture and transgenic plants, nitrogen fixation mechanism and significance of viral vectors, knowledge for the development of organic products

UNIT I

Plant Genome: Organization, structure of representative plant genes and gene families in plants – chloroplast genome organization and mitochondrial genome.

UNIT II

Hormones Auxins, cytokinins and gibberellins molecular basis of action phytochrome role in photomorphogenesis – Regulation of gene expression – abscisic acid – and stress – induced promoter switches in the control of gene expression – Ethylene and fruit ripening.

UNIT III

Plant tissue culture - Media composition (MS media) - Micropropagation techniques - direct and indirect organogenesis - somaclonal variation - somatic embryogenesis - haploid and triploid - Protoplast isolation and culture - hybrid and cybrid production, Synthetic seed production. Secondary metabolite production.

UNIT IV

Agrobacterium and crown gall tumors – Mechanism of T-DNA transfer to plants, Ti Plasmid vectors and its utility – Plant viral vectors. Symbiotic nitrogen fixation in Rhizobia. Applications of Plant Genetic Engineering: Genetic engineering & crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors.

UNIT V

Seed storage proteins. Transgenic plants, Regeneration of gene expression . Applications – plant vaccine and plant development, genetically modified food - future perspectives & ecological impact of transgenic plants.

BOOKS FOR STUDY:

- Kojima, Lee, H. and Kun, Y. 2001. Photosynthetic microorganisms in Environmental Biotechnology. Springer – Verlag.
- Sudhir, M. 2000. Applied Biotechnology and plant Genetics. Dominant publishers and distributors.

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- Trivedi, P.C.2000. Applied Biotechnology: Recent Advances. PANIMA Publishing corporation.
- Reynolds, P.H.S. (ed). 1999. Inducible gene expression in plants. CABI Publishing, U.K. pp 1-247.
- Chrispeels, M. J. and sadava, D.F. 1994. Plants, genes and agriculture. Jhones and Bartlett.
- Ignacimuthu. 1996. Applied Plant Biotechnology. Tata McGraw – Hill.
- Lycett, G.W. and Grierson, D. (ed). 1990. Genetic Engineering of crop plants.
- Grierson and Covey, S.N.1988. Plant Molecular biology. Blackie.
- Trigiano, R.N. and Gray, D.J. 1996. Plant tissue culture concepts and laboratory exercise. CRC Press. BocaRatin, New York.
- Street, H.E. 1977. Plant tissue culture. Blackwell Scientific Publications, oxford, London.
- Narayanaswamy S. 1994. Plant cell and tissue culture. Tata McGraw Hill Publishing Company limited, New Delhi.
- Chawla, H.S., "Introduction to Plant Biotechnology", 3rd Edition, Science Publishers, 2009.
- Gamborg OL, Philips GC, Plant Tissue & Organ Culture fundamental Methods, arosa Publications. 1995.
- Stewart Jr., C.N., "Plant Biotechnology and Genetics: Principles, Techniques and Applications" Wiley-Interscience, 2008.
- Heldt HW. Plant Biochemistry & Molecular Biology, Oxford University Press. 1997.

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BBT-DSA04

ALLIED-IV: BIOINSTRUMENTATION AND BIOSTATISTICS

Instr.Hrs.: 5
Credits : 3

Year : II
Semester: IV

Learning Outcome:

- The students would have depth knowledge in the analytical techniques and principles and handling of instruments

UNIT-I

Measurement of pH and calibration of pH meter, Centrifuge-Preparative and Analytical centrifuge, density gradient centrifugation. Spectroscopy: Principle, Instrumentation and applications of UV-Visible. Microscopy: Principle and applications of Compound , Bright field, phase contrast and fluorescence Microscope.

UNIT-II

Chromatography: Principle, Instrumentation and applications of Paper, TLC, Ion exchange, Gel filtration, Affinity, GLC and HPLC. Electrophoretic techniques: Agarose gel Electrophoresis, SDS-PAGE, Isoelectric focusing, Immunoelectrophoresis.

UNIT-III

Radioisotopic techniques: Principle and applications of GM counter, Solid and Liquid Scintillation, Autoradiography, Radioimmunoassay and Radiation Dosimetry.

UNIT-IV

Scope of Biostatistics, Data- collection, tabulation, classification Frequency table, graphical representation of data-bar diagram. Measures of central tendency- Mean, Median, and Mode. Measures of Dispersions- Range, Mean deviation, Std deviation, Variance.

UNIT-V

Correlation- types and methods. Regression. Probability distribution-Binomial, Negative binomial, multinomial distribution, Poisson distribution. Test of significance- t test, F test, chi square test. Spreadsheet, ANOVA-One way and Two way.

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REFERENCES:

1. Keith Wilson,John Walker,(2010).Principles and techniques of Biochemistry and Molecular Biology"(7th edition) Cambridge University Press.
2. David L.Nelson, Michael M Cox.Lehninger(2008)."Principles of Biochemistry",Fifth edition W.H.Freeman,Newyork.
3. Upadhyay and UpadhyayNath. (2009). "Biophysical Chemistry", Principles and Techniques.Himalaya Publishing House.
4. L.Veerakumari, (2006) "Bioinstrumentation" MJP publishers , Kindle Edition.
- 5 .SkoogD.A.F.James Holler and Stunkly,R.Crouch, (2007) "Instrumental Methods of Analysis" Cengage Learning.
6. L.A Geddes and L.E.Baker (2008) "Principles of Applied Biomedical Instrumentation" WileyIndia Third Edition.
7. N.Gurumani (2011) "An Introduction to Biostatistics" MJP Publishers
8. Zar,(J.H.2010)."Biostatistical Analysis" Fifth Edition, Pearson Education Pvt Ltd, Indian Branch,NewDelhi.
9. VerbalRastogi,(2011)."Fundamentals of Biostatistics", Ane books Pvt Ltd Publishers,Chennai.
10. P.N.Arora and P.K. Malhan.(2013)"Biostatistics"Himalaya publishing House..
11. S.Sadasivam and A.Manickam,2005. "Biochemical Methods" New Age International (P) Ltd Publishers.
2. David T.Plummer, 2004. "An Introduction to practical Biochemistry" McGraw Hill Education Third Edition.
3. Keith Wilson and John Walker, 2005, "Practical Biochemistry Principles and techniques", Sixth Edition, Cambridge University Press.

Web Links

- <https://curlie.org//Science/Physics/Optics/Spectroscopy/>
- <https://www.iaea.org/topics/nuclear-science/isotopes/radioisotopes>
- <https://www.pharmatutor.org>
- <https://www.biologydiscussions.com>
- <https://youtu.be/lgrXb8kcZTE>
- https://youtu.be/1QW_sWL_sf0
- <https://webassign.net>
- <https://www.columbia.edu>
- <https://youtu.be/ndmKGskCyhg>
- <https://kHQM4BbRD40>

UNIVERSITY OF MADRAS
UG - NON MAJOR ELECTIVE COURSE
OFFERED IN THE DEPARTMENT OF COMMERCE
SYLLABUS WITH EFFECT FROM 2009-2010

BGE-NM003

BASICS OF HEALTH CARE MANAGEMENT

Objectives:

To help the students to know about Health care Management.

To train the students to acquire Family and Communal health.

Outcomes:

To train the students to overcome the Health problems.

UNIT I: PERSONAL (SELF) HEALTH CARE

Personal Hygiene - Personal Diet patterns - Self health maintenance by yoga and other spiritual practice - Drills

UNIT II: FAMILY HEALTH CARE

Family Hygiene - group health care by vaccination - propagation and prevention - Sanitation and diet patterns

UNIT III: COMMUNAL HEALTH CARE

Mass - Hygiene (Social Hygiene) - Environmental Hygiene - Communal health care systems - Hospitals - Statistical bodies - Government and Non government organizations (NGO) for propagation of nutritious diet patterns - maintained by voluntary health organizations and government schemes.

UNIT IV: HEALTH AWARENESS

Health awareness programme organized by governmental and non governmental agencies. Communal health programme.

UNIT V: HEALTH DISASTER MANAGEMENT

First Aid - Disaster management techniques like epidemic,epidemic control, management and eradication.

BOOK REFERENCE:

1. Social and preventive Medicine, K. Park, Brinser publishers

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BBT-DSC09

CORE-IX: ANIMAL AND MEDICAL BIOTECHNOLOGY

Instr.Hrs.: 6
Credits : 4

Year : III
Semester: V

Learning Outcome:

- To gain knowledge in the concepts of animal and medical biotechnology would be developed.
- To demonstrate an understanding of setting up an animal tissue culture laboratory would be obtained.
- Ability to recall the transmissions, pathogenicity, symptoms of microorganisms.
- To describe various molecular techniques in disease diagnosis and reproduction technologies
- To differentiate various vaccine producing methodologies

UNIT I

Historical aspects - Basics of developmental biology - Animal Biotechnology – setting up animal cell line laboratory and SOP - Principles of sterile techniques and cell propagation - media and types of cell culture - Scaling up of animal cell cultures.

UNIT II

Manipulation of reproductive process: Artificial insemination – freezing of semen – Embryo technology – *in vitro* maturation and fertilization – Pregnancy diagnosis – Assisted reproductive technology – cloning strategies – Preservation and characterization of animal cells- transgenic animals

UNIT III

Medical Biotechnology – Zoonotic diseases: Bacterial, Viral, Fungal and Protozoan disease - diagnosis using modern techniques – DNA/RNA probes- application of Probes for diagnosis of existing and emerging disease in animal and human disease.

UNIT IV

Vaccines – Production of recombinant vaccines – bacterial, viral or parasitic infections – DNA Vaccines. Synthetic peptide, anti-idiotype, deletion, mutant and vaccinia vectored vaccine – Prophylaxis.

UNIT V

Genetic engineering of Microorganisms and molecules – Protein production by genetically engineered mammalian cell lines, Stem cells and their applications-; Cell culture as a source of valuable products.

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BOOKS FOR STUDY

1. R. Ian Freshney, Culture of Animal cells – A Manual of Basic Technique Fourth Edition, WILEY LISS & Publications.
2. Glick, B.R. and Pasternack. 2002. Molecular Biotechnology: Principle and applications of recombinant DNA.
3. Ramasamy.P. 2002.Trends in Biotechnology, University of Madras of Publications, Pearl Press
4. Dr.C.K.Leach, Invitro cultivation of Animal cells Butterworth and Heinemann Ltd.1994.
5. Gopalakrishnan . Hand book of Animal Husbandry
6. Kreuzer, H. and Massey, A. 2001. Recombinant DNA and Biotechnology: A guide for teachers, 2nd edition. ASM Press Washington.
7. Traven. 2001. Biotechnology. Tata McGraw – Hill.
8. Walker,J.M. and Gingold, E.B. 1999.Molecular biology and Biotechnology, 3rd edition.Panima Publishing Corporation.
9. Jenkins, N. (ed). 1999 Animal cell Biotechnology: Methods and protocols. Humana press, New Jersey.Pp 1-302.
10. Ignacimuthu. 1996. Basic Biotechnology. Tata McGraw-Hill.
11. Puhler, A.V.C.H. 1993. Genetic engineering of Animals. VCH Publishers, Weinheim, FRG.
12. Watson, J.D., Gilman, M., Witkowski, J. and Zoller, M. 1992.Recombinant DNA (2ndded) Scientific American Books, NY.
13. Murray, E.T. 1991. Gene transfer and expression protocols – Methods in Molecular biology Vol.7. Humana Press.
14. Watson, J.D., Hopkins, N.H., Roberts, J.W. Steitz, J.A. and Weiner, A.M. 1987.Molecular biology of gene Benjamin/ Cummings 4th Ed. Vol 1&2.

USEFUL LINKS

1. <https://www.sanfoundry.com/best-reference-books-animal-cell-tissue-im...>
2. https://micro.magnet.fsu.edu/cells/animal_cell

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SYLLABUS WITH EFFECT FROM 2020-2021

BBT-DSC11

CORE-XI: IMMUNOLOGY

Instr.Hrs.: 5
Credits : 4

Year : III
Semester: V

Learning outcome:

The students will gain the knowledge about the immune response and reactions, cells involved in immunity, vaccines and tissue rejection.

UNIT I:

Introduction – Historical development in Immunology. Cells involved in immune response. Primary and Secondary lymphoid organs – Thymus, Bone marrow, Lymph nodes and Spleen. Hematopoiesis – development of B and T lymphocytes. Types of immunity – Innate and acquired.

UNIT II:

Antigen: Characteristics and types. Antibody – Structure, Types, Properties and their Biological function. polyclonal - monoclonal antibody production and its biomedical applications.

UNIT III:

Antigen – Antibody interactions, Immunodiffusion and Immuno electrophoresis. Principle and application of ELISA and RIA and Flourescent antibody technique. Purification of antibodies.

UNIT IV:

The complement system and activation and regulation. Types – Classical, alternative and Lectin pathway. Biological function of C³ proteins. Cytokines- Structure and Function. Vaccines – Types , Production and application.

UNIT V:

Hypersensitivity Reactions and Types. Major Histocompatibility Complex – MHC genes, MHC in immune responsiveness, Structure and function of Class I and Class II MHC molecules. HLA tissue typing.

REFERENCE BOOKS:

1. Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby, 2006. Kuby Immunology, 6th edition, W. H . Freeman and Company.
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011. Roitt's Essential Immunology, 12 edition, Wiley- Blackwell. USA.
3. Kannan, I., 2010. Immunology. MTP Publishers, Chennai.
4. Abbas, A.K., A.H.L., Lichtman and S. Pillai, 2010. Cellular and Molecular Immunology, 6th Edition. Saunders Elsevier Publications, Philadelphia.
5. NandiniShetty, 1996, Immunology : introductory textbook – I. New Age International, New Delhi.

USEFUL WEBSITES:

- * www.Immunologylink.com
- * www.Library.csusm.edu/course_guides/biology

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BBT-DSC10

CORE-X: BIOINFORMATICS

Instr.Hrs.: 6

Credits : 4

Year : III

Semester: V

Learning Outcome:

- The students will be able to extract information from large databases and to use this information in computer modeling, the ability to develop new algorithms and analysis methods

UNIT I

Introduction of Bioinformatics: Overview and Definition, Application of Bioinformatics, Sequences format used in Bioinformatics- Biological Database: Introduction, Classification of biological databases, Primary database- Nucleic acids- NCBI-DDBJ-EMBL, Protein- PDB-SWISSPORT. Secondary database- PROSITE ,PFAM, Structure and classification-SCOP-CATH, Metabolic pathway database.

UNIT II

Sequences Analysis: Sequences similarity, Identify & homology- Definition of homologues, Orthologues, Paralogues, Scoring matrices, Pairwise Sequences alignment, Dot Matrix, BLAST, FASTA- Needleman Wunsch – Smith and waterman Algorithm.

UNIT III

Phylogenetic Analysis (DEMO-Optional): Multiple Sequences alignment – Different method of multiple sequences alignment- Evolutionary analysis, clustering methods Phylogenetic trees-rooted and unrooted tree- Methods to generate phylogenetic tree- Tools for multiple sequences alignment and phylogenetic analysis (PHYLIP)

UNIT IV

Drug Discovery: History of Drug Discovery, Steps in Drug design - Chemical libraries – Role of molecular docking in drug design.

UNIT V

Protein prediction: Study of internet resources in Bioinformatics -Tools for primary (Compute PT/Mw, Protparam), secondary (PROSITE), Tertiary (Swiss Model), Structure prediction of proteins, Homology modeling of proteins. Visualization tools (RASMOL), Gene prediction tools (Genscan, Grail).

REFERENCE BOOKS:

1. Rastogi, S.C, Mendiratta, N,Rastogi, P., 2004. Bioinformatics methods and application. Prentice-Hall of India private limited, New Delhi.
2. David Mount., Bioinformatics: sequence and genome analysis, second edition., Taylor & Francis, UK; 2009.
3. D.R.Westhead. Instant Notes in Bioinformatics,second edition,Taylor & Francis,UK, 2009.
4. Gautam B. Singh., Fundamentals of Bioinformatics and Computational Biology, Oakland University Rochester, Michigan USA.
5. Arthur M.Lesk.,Introduction to bioinformatics., Oxford University Press.

USEFUL WEBSITE:

- WWW.expasy.org

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BBT-DSE1B

ELECTIVE-I(B): NANOBIOTECHNOLOGY

Instr.Hrs.: 5

Credits : 5

Year : III

Semester: V

Learning outcomes:

This makes the students to understand the advancing research and fostering innovations in the synthesis and characterization of nano particles and Types of nanomaterial and their applications.

UNIT I: History of Nanobiotechnology

Glimpse of Nanotechnology based material in ancient India: Wootz steel (iron carbide) and the Delhi iron pillar (anticorrosive nanomaterial), Bhasma (nanomaterial as medicine). Contributions of Indian Research Institutes in the field of nanobiotechnology.

UNIT II: Synthesis and characterization of nanoparticle

Metals: Silver nanoparticle synthesis and its analyses by UV-spectroscopy and FTIR. Self Assembly nanomaterial: Cell membrane and its analyses by SEM

UNIT III: Types of Nanobiomaterials.

Nano-thin films: Chitosan thin film, Nanodevices (nanorobots), Nanotubes: Microtubules assembly and its importance, Nanoshells- Dendrimers: Liposomes, Nanofibers: Collagen, Fibronectin& elastin, nanofluidics: Extracellular matrix assembly and its importance.

UNIT IV: Application of Nanotechnology the field of agriculture and medicine

Agriculture: Crop production- Nanofertilizers technology, Biomaterial to improve shelf life of vegetables. Medicine: Collagen thin films in wound healing mechanism, Nanoscale devices – DNA microarray for disease diagnosis, Antibodies as drug delivery system.

UNIT V: Applications of Bionanoparticles

Nanobiosensors (Firefly-luciferase) and its applications, Introduction to Biomimetics (Gecko foot effect, Lotus leaf effect: Paint and fabrics, Box fish based Car).

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REFERENCE BOOKS:

- Vasanthapattabbi and N. Gautham (2009), Biophysics, Narosa Publishing House, New Delhi.
- Narayanan .P (2010), Essentials of Biophysics, New Age International (P) Ltd. Publishers, New Delhi.
- D.Voet&J.G.Voet (2010), Biochemistry, John Wiley & Sons, New York.
- Biochemistry by LubertStryer, 4th Ed., WH.Freeman, 1995.
- David S. Goodsell, "Bionanotechnology", John Wiley & Sons Inc., publications, 2004.
- Niemeyer, C.M. Mirkin C.A., "Nanobiotechnology concepts, Applications and Perspectives", 2004.
- Shammugam S, "Nanotechnology", MJP publishers, 2010.
- http://vwm.org.in/study_material/ENG%20-%20Indian%20Contributions%20to%20Science. HYPERLINK "http://vwm.org.in/study_material/ENG%20-%20Indian%20Contributions%2520to%2520%20Science.%20pdf"
- https://www.jabonline.in/admin/php/uploads/16_pdf.pdf

USEFUL URL:

- <https://www.youtube.com/watch?v=gSpHINVmgoE>
- <https://www.youtube.com/watch?v=ITtGIUGXFk>
- <https://www.youtube.com/watch?v=4cGR0rskyLM>
- <https://www.youtube.com/watch?v=0lZRA5hgft0>
- https://www.youtube.com/watch?v=_SI_QjyL3ml
- <https://www.youtube.com/watch?v=OwkKwS3dBt0>
- <https://www.youtube.com/watch?v=Zd78VgngR3c>
- <https://www.youtube.com/watch?v=tsc8zYFlod0>

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SYLLABUS WITH EFFECT FROM 2020-2021

BRT-DSC13

CORE-XIII: INDUSTRIAL BIOTECHNOLOGY

Instr.Hrs.: 6
Credits : 4

Year : III
Semester: VI

COURSE OUTCOMES

This programme will help the students to explore the beneficial potentials of microbes in the fermentation industry, production of primary and secondary metabolites using microbes, its recovery and purification of biomolecules and methods using biotechnological principles.

UNIT 1: Biotechnology & Bioprocess Engineering, steps in bioprocess development, Microbial culture, Screening and selection for fermentation processes; Preservation and improvement of industrially important microorganisms, Strain development. Media for industrial fermentations: Media ingredients, medium formulation, oxygen requirements, antifoams, medium optimization, Media sterilization, Batch Process, continuous sterilization process; sterilization of fermenter and other ancillaries, filter sterilization of air and media. Inoculum development. Types of fermentation – Aerobic & Anaerobic systems - Submerged, Semisolid, Solid and slurry fermentation processes.

UNIT 2: Design of bioreactors: Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Bioreactor configurations and types: Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Animal and plant cell bioreactors. Factors affecting broth viscosity, Mixing in Fermenters. Fermentation systems Batch culture, Continuous culture, Fed-batch culture,

UNIT 3: Downstream processing Filtration, Centrifugation, Cell disruption, Liquid-liquid extraction, Chromatography, membrane processes, Drying, Crystallization, Whole broth processing. Different types of fermented foods produced from microorganisms- Idli, Soysauce, Sauerkraut - Dairy products- Cheese and Yoghurt.

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UNIT 4: Microbial biomass, Microbial enzymes— Amylase & protease, Immobilization of enzymes: Methods, Properties, Applications, Advantages and Disadvantages of Immobilization, Biosensors and Biochips-Types and applications. Microbial Polysaccharide production: Xanthan, Dextran, Alginate, Scleroglucan, Gellan, Pullulan, Curdlan. Bioplastic-Biopol, Microbial rubber and adhesive polymers.

UNIT 5: Ore leaching (methods and examples), MEOR, Production of antibiotics – Penicillin - Alcoholic beverages: Wine, Beer –Biofertilizers- Rhizobium & Azotobacter. Biopesticides – *Bacillus thuringiensis* and microbial toxin production and their applications - Single cell protein, Biosurfactants, Vitamins- Folic acid & Vitamin B12, Organic acids. Biotechnology biosafety – Norms and measures

REFERENCES:

1. Peter F. Stansbury, Allan Whitaker, Stephen J. Hall (2013). Principles of Fermentation Technology Second Edition, Elsevier Science Ltd
2. Michael J. Wailes, Neil L. Morgan, John S. Rockey Gary Higton (2001.), Industrial Microbiology: An Introduction, Blackwell Science Ltd
3. NdukaOkafor, Modern Industrial Biotechnology & Microbiology (2017), Science Publishers, Edenbridge Ltd.
4. H.J. Peppler and D. Perlman, Microbial Technology (1979) .Vol 1&2 . Academic Press.
5. L E Casida, Industrial Microbiology (1968) Jr. John Wiley and Sons Inc.
6. Wailes, Morgan, Rockey and Higton, Industrial Microbiology: An Introduction, Blackwell Science (2001).
7. Madigan, Michael and Martinko, John, Brock biology of microorganism, 11th edition, (2005).
8. H. Scott Fogler, Elements of Chemical Reaction and Engineering, 4 th edition, by Pearson Education Inc., (2006).
9. [E. M. T. El-Mansi, C. F. A. Bryce, Arnold L. Demain, A.R. Allman, \(2011\) Fermentation Microbiology and Biotechnology, Third Edition.](#)
10. [T. Satyanarayana, Bhawdsh Narain Johri, Anil Prakash, \(2012\). Microorganisms In Sustainable Agriculture and Biotechnology](#)

WEBSITES:

www.Prenhall.com/Madigan
www.e-bug.eu/
www.microbeworld.org/
www.practicalbiology.org/

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BBT-DSC14

CORE-XIV: ENVIRONMENTAL BIOTECHNOLOGY

Instr.Hrs.: 6
Credits : 4

Year : III
Semester: VI

Learning outcome

This course is planned to provide an idea about Global environmental changes, Biotechnological methods of handling recent environmental problems like waste water treatment, solid waste management and bioenergy

UNIT I

Environmental Pollution – Sources and types - Water, Air, Thermal, Industrial and Radiation - Global environmental changes. Global warming, Green house effect, acid rain, ozone depletion, and photochemical smog. Environmental issues, management strategies and safety, Biotechnological approaches for management.

UNIT – II

Waste water treatment: Aerobic and anaerobic methods (Primary, Secondary and Tertiary) –Use of aquatic plants in waste water treatment. Solid waste management. Bioenergy and SCP from waste. Drinking water treatment.

UNIT – III

Biodiversity and Biodegradation: Biodiversity at global level, species diversity. Conservation - *in situ* and *ex situ* conservation. Loss of biodiversity and its causes. Ecological considerations, decay behaviour and degradative plasmids; hydrocarbons, oil pollution, surfactants, pesticides.

UNIT – IV

Bioremediation: Biotechnology approaches for industrial effluent (Paper, tannery and dye). Pesticide waste disposal and use of genetically engineered microbes. Biosorption and Bioaccumulation principles. Hazards of genetically engineered microbes, plants and animals to the environment and their recovery.

UNIT V

Environmental toxicology – Toxicants – Toxicity, Acute, sub acute, chronic, dose effect and LD₅₀. Dose response safe limits. Dose response relationship, detoxification of hazardous chemicals.

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Text Book

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

References:

1. Eugene P. Odum, 1972. Fundamentals of Ecology, W.E. Saunders Company, London,
2. Metcalf and Eddy, 1979. Wastewater Engineering – Treatment Disposal and Reuse Inc., Tata McGraw Hill, New Delhi,
3. Crosby and Donald G, 1998. Environmental Toxicology and Chemistry, Oxford University Press.
4. Chatterji, A.K., 2002. Introduction to Environmental Biotechnology, Prentice-Hall of India, New Delhi.
5. Anil Kumar De., 2000. Environmental Chemistry, 4th Edition. New Age International, New Delhi.
6. Murugesan, A.G., Rajakumari, C., 2005. Environmental Science and Biotechnology Theory and Techniques., MJP publishers, Chennai.

Useful links

1. <https://nptel.ac.in/courses/120/108/120108004/>
2. <https://www2.hcmuaf.edu.vn/data/quoctuan/Environmental%20Biotechnology%20-Theory%20and%20Application.%20G%20M%20Evans%20&%20C%20Furlong.pdf>

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BBT-DSE2B

ELECTIVE-II(B): MARINE BIOTECHNOLOGY

Instr.Hrs.: 5

Credits : 5

Year : III

Semester: VI

Course Learning Outcome:

The students will gain knowledge about marine pharmacology, marine resources and byproducts, aquaculture and commercial development and value creation of marine resources in Industries

UNIT I

Introduction to Marine Ecosystems: Marine Ecosystems & its functioning, Ocean currents, Physical & chemical properties of sea water, Ecological divisions of the Sea- Euphotic- Mesopelagic- Bathopelagic- Benthos-Intertidal, Estuarine- Saltmarsh- Mangrove- Coral Reef.

UNIT II

Marine Microorganism: Marine microbial habitats- Screening for Secondary metabolites from marine microbes (Bacteria, Fungi, Actinomycetes and marine microalgae). Biofouling - Biofilm- Antifouling-Anticorrosion. Probiotic bacteria and their importance in aquaculture.

UNIT III

Introduction to Marine Pharmacology: Definitions- Medicinal compounds from flora (Seaweeds, Seagrass and Mangrove) and fauna (Sponges, Sea anemone and Corals)- marine toxins- antiviral and antimicrobial agents.

UNIT IV

Aquaculture Technology: Culture aspect-Seaweed (*Kappaphycusvahlii*), Fish chromosome manipulation in aquaculture- Hybridization- Gynogenesis-Androgensis- Polyploidy, Artificial Insemination, Eye stalk ablation- Transgenesis and Cryopreservation.

UNIT V

Marine By products: Agar- Agrose – Algin- Alginate- Carragenan- Chitin- Chitosan- Heparin.

TEXT BOOKS

1. Italy, E (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub.Corp.

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2. Milton Fingerman and Rachakonda Nagabhushanam, 1996, Molecular Genetics of Marine Organisms, Science Pub Inc.
3. Y. Le Gal and H.O. Halvorson 1998, New Developments in Marine Biotechnology, Springer.

REFERENCE BOOKS

1. David H. Attaway, 2001. Marine Biotechnology, Volume 1, Pharmaceutical and Bioactive Natural Products.
2. Rita R. Colwell 1984. Biotechnology in the Marine Sciences (Advances in Marine Science & Biotechnology) Wiley Interscience.
3. Scheuer, P.J. (Ed.), 1984. Chemistry of Marine Natural Products, ,Chemical and Biological Perspectives. Vol. I III, Academic Press, New York
4. Marine Biology- Lalli C.M. and T.R. Parsons., 1997. Biological Oceanography - An Introduction, Elsevier, 314 pp
5. Marine Pollution- Clark, R. B. 2001. Marine pollution, Fifth edition. Oxford University press, New York Inc., 231pp

Weblink

- <http://cne.genomics.org.cn/>
- <http://www.bcb.iastate.edu/>
- <http://www.nwfsc.noaa.gov/protocols/bioinformatics.html>
- <http://www.ebi.ac.uk/ ExPASy.org/>
- <http://www.expasy.org/>
- <http://www.rcsb.org/pdb/>

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BBT-DSE2A

ELECTIVE-II(A): BIO-ENTREPRENEURSHIP

Instr.Hrs.: 5

Credits : 5

Year : III

Semester: VI

Learning Outcomes

The student will be able to identify the challenges of being a bio entrepreneur and describe the current status of the bio industry globally. They will also be able to generate a detailed business plan and identify various funding agencies. The technical skills in vermicomposting, Sericulture, aquaponics, mushroom cultivation and SCP Production will also be obtained.

UNIT I : Bio entrepreneurship

Basics of Bio entrepreneurship -biotechnology in a global scale; ; types of bio-industries – biopharma, bioagri and bioservices innovation – successful entrepreneur – creativity, leadership, managerial skills, team building, decision making; public and private funding agencies (MSME, DBT, BIRAC, Startup & Make in India)

UNIT II : Business Plan

Business plan preparation; business feasibility analysis by SWOT, business plan proposal for virtual startup company; statutory and legal requirements for starting a company/venture; basics in accounting practices. Market Conditions, Identifying the need of the customers

UNIT III :Vermicomposting and Sericulture

Vermicomposting –Earth worms-Ecological types-Vermiculture-Compost pit-Vermi bed-applications - Sericulture-Mulberry cultivation-silkworm rearing-Economics of silkworm production-Chawki rearing-Sericulture in India

UNIT IV : Mushroom Cultivation &Aquaponics

Phases of Mushroom Cultivation; Selection of an acceptable mushroom species/strains, Management of mushroom development, Mushroom harvesting; Mushroom diseases, Medicinal and Nutritional properties of mushroom. Aquaponics- systems-Fish and Vegetables-Nutrients and Biofilters-Advantages and Disadvantages.

UNIT V: Single Cell Protein

Single Cell Protein Production: Source: Algae, Bacteria, Yeast – Cultivation of Single Cell protein: SPIRULINA Cultivation – Production site, Microorganism, Experimental design; harvesting and Drying.

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REFERENCES

1. Adams, D. J., & Sparrow, J. C. Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Bloxham: Scion.
2. Shimasaki, C. D. (2014). Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
3. Onetti, A., & Zucchella, A. (n.d.). Business modeling for life science and biotech companies: Creating value and competitive advantage with the milestone bridge. Routledge.
4. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
5. Desai, V. The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.
6. The Earthworm book,Ismail,S.A.,other India Press,Goa
7. Worm Farming: Setup A Sustainable Vermiculture Earthworm Composting Ranch by Brian grant
8. Aquaponics for Beginners,2018Nick Bimboe
9. Aquaponics Fish: Best Fish Species ForAquaponic Gardening by Timothy trip
10. An Introduction to sericulture by G.Ganga,J.SulochanaChetty.
11. Silk: Processing, Properties and Applications Book by K. MurugeshBabu
12. Organic Mushroom Farming and Myco remediation: Simple to Advanced and Experimental Techniques for Indoor and Outdoor Cultivation by Trad cotter
13. Growing gourmet and medicinal mushrooms by Paul stamets
14. The Essential Guide to Cultivating Mushrooms: Simple and Advanced Techniques for Growing Shiitake, Oyster, Lion's Mane, and Maitake Mushrooms at Home by Stephen Russell
15. Single Cell Protein Production from Lignocellulosic Biomass by P.Bajpai
16. Neutraceuticalspirulina: Commercial cultivation using rural technology in india by Pushpa Srivastava

Useful Links

- 1) agritech.tmau.ac.in › org_farm › orgfarm_vermicompost
- 2) <https://archive.india.gov.in › citizen › agriculture>
- 3) <http://www.recirculatingfarms.org/resources/>
- 4) <https://academy.vertical-farming.net/intro-to-mushroom-growing/>