JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR

Faculty of Agriculture and Veterinary Science

Department of Food and Biotechnology

SYLLABUS

DURATION –3YEARS/6 SEMESTER

BACHELOR OF SCIENCE - BIOTECHNOLOGY

SYLLABUS FOR:
3 YEARS (I – VI SEMESTER)

PROGRAM DETAIL

Name of Program	-	Bachelor of Science (B.Sc.)
Program Code	-	B. Sc. BT
Mode of Program	-	Semester
Duration of Program	-	3yrs/ 6Semester
Total Credits of Program	-	159
Curriculum Type and Medium Choice	-	English

Program Outcomes

Graduates will gain and apply knowledge of Biotechnology, Science and Engineering concepts to solve problems related to field of Biotechnology. Students will have expertise of biotechnology. Graduates will be able to decide and apply appropriate tools and techniques in biotechnological manipulation.

Specific Program Outcomes

Apply the knowledge of New emerging Biotechnology world. Recognize the importance of bioethics, IPR, entrepreneurship, Communication and management skills so as to usher next generation of Indian Biotech industrialists.

SYLLABUS DETAIL

I Semester

S. No.	Credit	Name of Course
1	2	Fundamentals of Biotechnology
2	1	Fundamentals of Biotechnology lab
3	4.5	Fundamentals of Chemistry
4	1.5	Fundamentals of Chemistry lab
5	3	Basics of Biosciences
6	1	Basics of Biosciences lab
7	3	Introduction to food technology
8	3	Fundamentals of Biological Chemistry
9	1	Fundamentals of Biological Chemistry lab
10	3	Biomolecules
11	1	Biomolecules lab
Total	24	

II Semester

S. No.	Credit	Name of Course
1	3	Fundamentals of microbiology
2	1	Fundamentals of microbiology lab
3	3	Thermodynamics
4	3	Cell biology
5	1	Cell biology lab
6	3	Biophysics and instrumentation
7	1	Biophysics and instrumentationlab
8	3	Analytical Chemistry
9	1	Analytical Chemistry lab
10	3	Fundamentals of Food Science & Technology
11	1	Fundamentals of Food Science & Technology lab
12	1	Industrial Visit
Total	24	

III Semester

S. No.	Credit	Name of Course
1	3	Metabolism and Bioenergetics
2	1	Metabolism and Bioenergetics lab
3	3	Basic Enzymology
4	1	Basic Enzymology lab
5	3	Developmental biology
6	1	Developmental biolog
7	3	Embryogenesis
8	1	Embryogenesis lab
9	2	Biostatistics
10	1	Biostatistics lab
11	2	Molecular Biology
12	1	Molecular Biology lab
13	10	Industrial Training (60 Days, after II Sem, during Summer vacation)
Total	32	

IV Semester

S. No.	Credit	Name of Course
1	3	Environmental Biotechnology
2	1	Environmental Biotechnology lab
3	3	Recombinant DNA technology
4	1	Recombinant DNA technology
5	2	Medical Biotechnology
6	1	Medical Biotechnology lab
7	3	Food Biotechnology
8	3	Introduction to Bioinformatics
9	1	Introduction to Bioinformatics lab
10	2	Principles of Immunology
11	1	Principles of Immunology lab
12	4	Minor Project
13	1	Industrial Visit
Total	26	

V Semester

S. No.	Credit	Name of Course
1	3	Enzyme technology
2	1	Enzyme technology lab
3	3	Plant biotechnology
4	1	Plant biotechnology
5	3	Bio-entrepreneurship
6	2	Genetics
7	1	Genetics lab
8	2	Animal Biotechnology
9	1	Animal Biotechnology lab
10	3	Fermentation Technology
11	10	Industrial Training **(**60 Days, after IV Sem, during Summer vacation**)**
Total	30	

VI Semester

S. No.	Credit	Name of Course
1	3	Molecular Therapeutics
2	1	Molecular Therapeuticslab
3	2	Behavioral Science
4	3	Biosafety, ethics and IPR
5	3	Research Methodology
6	3	Downstream processing
7	1	Downstream processinglab
8	3	Agriculture Biotechnology
9	2	Microbial Technology
10	1	Microbial Technologylab
11	2	Applied Recombinant DNA technology
12	1	Applied Recombinant DNA technology l**ab**
Total	25	

B. Sc. BT 1ST YEAR
I SEMESTER

Fundamentals of Biotechnology

Credits- 3

Objective : After completion of this course, student will learn about basics and historical perspective of Biotechnology; introductory knowledge of advance technologies of biotechnology along with patenting and ethical issues. So that, students can apply knowledge to solve biological problems.

UNIT-I Fundamentals of RDT Definitions and Historical perspective of Biotechnology, Commercial Potential of biotechnology, Scope and Importance of Biotechnology. Introduction to Recombinant DNA technology. Tools of Recombinant DNA technology. Introduction of Recombinant DNA into host cell, Making of Recombinant DNA. Introduction and screening techniques for Identification of Recombinants. Polymerase chain reaction.

(0.5 Credit)

Practicals(0.4 credit)

Sr. no.	Name of practical	Nature
1	To isolate genomic DNA from E.coli. (i) Grow colonies of E.coli. (ii) Make suspension of E.coli. (iii) Isolate DNA from E.coli.	practical
2	To prepare Agarose gel for gel electrophoresis (i) Preparation of agarose solution (ii) Gel casting	Practical
3	Introduction of new DNA into E.coli. by the technique of transformation. (i) Make suspension of E.coli. (ii) Making competent cells	Practical
4	To demonstrate PCR.	Practice

UNIT-II Basics of Animal and Plant cell culture Introduction to Microbial Culture Techniques. Different Microbial Culture Techniques. Measurement and Kinetics of Microbial Growth. Scale up of Microbial Process. Isolation of Microbial Products. Strain Isolation and Improvement. Applications of Microbial Culture Technology. Bioethics in Microbial Technology. Introduction to Plant tissue culture. Cell and Tissue CultureTechniques. Applications of Cell and Tissue Culture. Introduction to animal cell culture. Animal Cell Culture Techniques. Scale-up of Animal Culture Process. Applications of Animal Cell Culture.

(1 Credit)

Practicals (0.6 credit)

Sr. no.	Name of practical	Nature
1	To isolate pure strain of E.coli. by the technique of streaking plate method. (i) Serial dilution of soil sample (ii) Media preparation (iii) Streaking plate	Practical
2	To clean glassware and accessories used in plant tissue culture.	Practical
3	To prepare MS media. (i) Preparation of stock solutions (ii) Media preparation and autoclaving	Practical
4	To initiate callus culture from explants. (i) Collection and cleaning of explants (ii) Inoculation of explants into media.	Practical
5	To learn aseptic techniques of animal tissue culture.	Practical
6	To prepare BSS solutions. (i) Weighing of reagents (ii) Mixing and autoclaving	Practical

UNIT-III Introduction to patenting Introduction to Patenting. Criterion for patents. Reading a patent. National and International Patent Laws. Ethical issues in agriculture and health care. Biotechnology in India and global trends. Product safety and Marketing.

(0.5 Credit)

Recommended text book:

- Biotechnology- U. Satyanarayan

Reference Books :

1. Gene cloning and DNA analysis- T.A. Brown
2. Culture of animal cells- R. Ian Freshney
3. Introduction to plant biotechnology- H.S. Chawla
4. Microbiology- Pelczar
5. Biochemistry- J.L. Jain

Fundamentals of Chemistry **Credits- 6**

Objective : To develop the understanding of basic chemistry and its types. To make students understand about the practical aspects of things. Students will able to identify various matters and equipment used in labs, perform some basic experiments.

UNIT I Overview of Physical Chemistry Solutions: Concept of homogeneous and heterogeneous solution, Introduction of the terms, Ionization, acidity, basicity, equivalent weight and gram equivalent weight with suitable example. Preparation of solution, Normality, Molarity, and Molality as applied in relation to a solution. Simple numerical problems related to volumetric analysis. Brief concept of gravimetric analysis.

(1.5 Credit)

Practicals **(Credit: 0.5)**

Sr. no.	Name of practical	Nature
1	Preparation of original solution.	Practical
2	Correct group detection	Practical
3	Cu with change in concentration of electrolytes ($CuSO_4$)	Practical
4	Zn with $ZnSO_4$	Practical
5	using starch solution as indicator (clock reaction).	Practical

UNIT II Overview of Inorganic chemistry Occurrence and principles of extraction of aluminium, copper, zinc and Iron. position of hydrogen in periodic table, isotopes, preparation, properties and uses of hydrogen; hydrides-ionic, covalent and interstitial; physical and chemical properties of water, heavy water. Hydrogen peroxide- preparation, properties and structure; hydrogen as a fuel.Uses of hydrogen peroxide. (1.5 Credit)

Practical **(Credit: 0.5)**

Sr. no.	Name of practical	Nature
1	Systematic detection of ion.	Practical
2	Any two confirmatory tests of cation.	Practical
3	Physical nature.	Practical
4	Flame test.	Practical
5	Charcoal cavity test.	Practical

UNIT IIIOverview Organic Chemistry Stereochemistry of Organic Compounds: Concept of isomerism. Type of isomerism.Optical Isomerism - Elements of symmetry, molecular chirality, enantiomers, stereogeniccentre, optical activity, properties of enantiomers , chiral and acheral molecules and erythrodiastereomers, *, D & L and R & S systems of nomenclature.Geometric Isomerism: Determination of configuration of geometric isomers. E & Z system of nomenclature. Conformational isomerism: Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Application of Stereochemistry in biochemistry.

(1.5 Credit)

Practical **(Credit: 0.5)**

Sr. no.	Name of practical	Nature
1	Recrystallization.	Practical
2	Melting points and Boiling point and the identification of an unknown and known compound nepthlene,Benzene	Practical
3	Molecular modelling.	Practical
4	L.S modelling.	Practical
5	Distillation, steam distillation.	Practical

Recommended text Books:

1. P.W. Atkins, Physical Chemistry (7th Edition), Oxford University Press, 2006.
2. R.T. Morrison and R.N. Boyd, Organic Chemistry, Prentice Hall of India Pvt. Ltd., 5th Ed, 1990

Reference Books:

1. I. A. Levine, Physical Chemistry, McGrawHill, 2009
2. D.A. McQuarrie and J.D. Simon, Physical Chemistry – a Molecular Approach, Viva Books Pvt. Ltd., 1998.
3. G. Solomons and C. Fryhle, Organic Chemistry, John Wiley & Sons (Asia) Pte Ltd.
4. J.D. Lee, Concise Inorganic Chemistry, (5th Edition), ELBS, 1996.
5. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, Oxford University Press, 2006.

Basics of Biosciences **Credits-4**

Objective : Student will learn concept wise knowledge about diversity in biological systems. This course will describe student about classification, morphology and physiology of Plant and Animal Kingdom. This course helps to buildup concept wise knowledge to understand advanced courses of Food and Biotechnology.

UNIT-I Introduction to biology Diversity in biological systems, Cell biology and cell structure, difference between Prokaryotes & Eukaryotes systems, Five-kingdom classification and General characters, Brief account on Ecology, Morphology, Nutrition, osmosis, Locomotion and Reproduction, useful and harmful effects of Bacteria, Viruses, Algae, Fungi and Protozoans.

(1 Credit)

Practical(0.4 credit)

Sr. no.	Name of practical	Nature
1	To perform gram staining.	Practical
2	To study different types of Algae by making their slides.	Practical
3	To study different types of Fungi by making their slides.	Practical
4	To study slides of Protozoans.	Practical
5	Study of osmosis by potato osmoscope.	Practical

UNIT-II Classification and physiology of plants Classification of Plant Kingdom. Concepts of Growth, Meristems, Plant growth regulators, Bacterial & Plant photosynthesis; oxygenic and anoxygenic photosynthesis; chlorophyll as trapper of solar energy, photosynthetic reaction centres, Hill reaction, PS I & PS II, Photophosphorylation - cyclic & non-cyclic; Dark reaction & CO2 fixation.
(1 Credit)
Practical(0.4 credit)

Sr. no.	Name of practical	Nature
1	To isolate chloroplast from plants.	Practical
2	Separation of plant pigments through paper chromatography.	Practical
3	Demonstration of O_2 evolution during photosynthesis.	Practical
4	Study of distribution of stomata in the upper and lower surface of leaves.	Practical

UNIT-III Classification and physiology of animals Classification of Animal Kingdom, Functions, morphology, growth and Reproduction, economic importance. Phylogeny of Invertebrate & Vertebrate Phyla, Concepts of Species & Ecosystem. Introduction of cell cycle, cell division, Electrolytes, Body fluids.

(1 Credit)
Practical(0.2 credit)

Sr. no.	Name of practical	Nature
1	To study mitosis in onion root tip.	Practical
2	To study meiosis in grasshopper testis	Practical
3	To test the presence of urea in urine.	Practical
4	To detect the presence of sugar in urine/blood sample	Practical
5	To detect the presence of albumin in urine.	Practical

Recommended Text Books:

1. NCERT Textbook for Class 11 Biology
2. NCERT Textbook for Class 12 Biology

Reference Books:

1. Cell and Molecular biology – P.K. Gupta
2. Plant Physiology- H.S. Srivastav
3. Animal Physiology- A.K. Berry

Introduction to Food Technology

Credits-3

Objective : Students will understand about origin of life, unicellular organisms' development, biomolecule structure, molecular interaction and electrophilic reaction. Students will also learn about structure of carbohydrates, classification of carbohydrates, lipid's structure, lipids classification and role of lipids in biological composition.

Unit- I Introduction to food composition Introduction , Food composition & Food group, Introduction Introduction to food science and technology, Food composition Food composition – Carbohydrates, protein, fat, vitamins and minerals water, Food groups Composition and nutritive value of Cereals, Pulses, Legumes, Oil seeds, Fruits, Vegetables, Meat, Fish, Poultry and Milk.
(1 Credit)

Unit –II Introduction to food preservation Food preservation -High temperature, low temperature and chemical preservations. Concept of nutrition, Digestion and absorption of nutrients, balanced diet, malnutrition, Packaging-Functions of packaging, types of food packaging materials.
(1 Credit)

Unit III Introduction to role of microbes in food technology Microbiology- Microorganisms important in foods, food contamination, food spoilage, food born diseases, Engineering -Unit operation, principles of heat exchangers, Pasteurizer, refrigerator, freezer and drier.
(1 Credit)

References:

- Food Science N N. Potter & J Hotchkiss
- Food Processing and Preservation G Subbalakshmi
- Food Packaging Technology Handbook NIIR
- A practical Guide for Implementation of ISO HACCP Sohrab

Fundamentals of Biological Chemistry **Credits-4**

Objective : Students will understand about origin of life, unicellular organisms' development, biomolecule structure, molecular interaction and electrophilic reaction. Students will also learn about structure of carbohydrates, classification of carbohydrates, lipid's structure, lipids classification and role of lipids in biological composition.

UNIT-I Origin of life : Origin of amino acids, nucleotides, Urey Miller's expt., unicellular organism, multicellular organisms. Concept of biomolecules, polymerisation, formation of polymers i.e. proteins, nucleic acids, Molecular interactions, biological functions. Chiral interactions, pH, pK, buffers. Reaction mechanism. Nucleophile, electrophile, Acid base reaction, nucleophilic addition, nucleophilic substitution, electrophilic addition, electrophilic substitution reaction.
(1 Credit)

UNIT-II Carbohydrates:Intoduction, biological importance. Definition, Classification, {glyceraldehydes, Simple Aldose, Simple Ketose, D-glucose, Conformation of D glucose], Monosaccharides other than glucose, glyocosidic, bond, disaccharides, polysaccharides [starch, glycogen, peptidoglycan, proteoglycan matrix.
(1 Credit)

Practical (1 credits)

Sr. no.	Name of practical	Nature
1	Test for Carbohydrates	Practical
2	Test for proteins	Practical
3	Test for Lipids	Practical

UNIT-III Lipids: Introduction, Classes, Fatty acids [Physical prop. Chemical prop, Sap value, acid value, iodine number, rancidity. Glycerolipid, Sphingolipid, Lipid derived from isoprene, Behavior of lipid in water, Bile acids, bile salts, plasma lipoproteins, Vesicles, membrane transport.
(1 Credit)

Recommended Text books:

1. Outlines of Biochemistry: Conn and Stumpf
2. Principles of Biochemistry: Jeffory Zubey

Suggested Readings:

- Biochemistry: Strye

Bio-molecules **Credits-4**

Objective : Student will learn general account of the chemical nature of living cells including Carbohydrates, Lipids, Protein and Vitamins. These are basic concept wise knowledge from this course will make student able to learn advance knowledge related to Food and Biotechnology.

Unit-I Carbohydrates General account of the chemical nature of living cells. Carbohydrates: Classification (Monosachharides, Di- sachharides and Polysachharides), configurations and conformations, sugar derivatives, structural and storage polysaccharides.

(1 Credit)

Practical(0.3credit)

Sr. no.	Name of practical	Nature
1	To perform Molish test for the qualitative estimation of carbohydrate. (i) Preparation of Molish reagent (ii) Estimation and observation of carbohydrate	Practical
2	To perform Benedict test for the qualitative estimation of carbohydrate. (i) Preparation of Benedict's reagent (ii) Estimation and observation of carbohydrate	Practical
3	To perform Fehling's test for the qualitative estimation of reducing sugar's (i) Preparation of Fehling's reagent (ii) Estimation and observation of carbohydrate	Practical
4	To perform Barfoed's test for the qualitative estimation of reducing sugar's (i) Preparation of Barfoed's reagent (ii) Estimation and observation of carbohydrate	Practical
5	To perform Inversion of Sucrose: (i) Preparation of reagents for inversion (ii) Estimation of converted sugar by Fehling's reagent.	Practical

Unit-II Proteins Amino acids: General properties, peptide bond, essential and non-essential amino acids. Classification, different levels of protein structure, forces stabilizing protein structure, protein folding, protein modification.

(1 Credit)

Practical(0.3 Credit)

Sr. no.	Name of practical	Nature
1	To perform Ninhydrin test for the qualitative estimation of amino acids. a) Preparation of Ninhydrin reagent b) Estimation and observation of amino acids.	Practical
2	To perform Xanthoproteic test for the qualitative estimation of amino acids. a) Preparation of Xanthoproteic reagent b) Estimation and observation of amino acids.	Practical
3	To perform Millon's testfor the qualitative estimation of amino acids (Tyrosine, Phenylalanine & Glycine). a) Preparation of Millon's reagent b) Estimation and observation of amino acids.	Practical
4	To perform Lead-Sulfide test for the qualitative estimation of Cysteine and Cystine. a) Preparation of Lead sulfite reagent b) Estimation and observation of amino acids.	Practical
5	To perform Sakaguchi testfor the qualitative estimation of Arginine. a) Preparation of Sakaguchi reagent b) Estimation and observation of amino acids.	Practical

Unit- III Lipids and Vitamins Lipids: Classification, properties of lipid aggregates and biological significance.Vitamins: Water and fat soluble vitamins and their deficiency diseases .

(1 Credit)

Practicals (0.4 credit)

Sr. no.	Name of practical	Nature
1	To Estimate the Saponification value of oils. a) Preparation of reagents. b) Determination of Saponification number.	Practical
2	To Estimate the acid value of oils. a) Preparation of reagents. b) Determination of acid value by titration	Practical
3	Determination of Total Lipid Concentration a) The preparation of a sample for solvent extraction b) Extraction of lipids and its determination.	Practical

Recommended Text Books:

1. Fundamentals of Biochemistry - J.L. Jain , S. Chand publication
2. Fundamentals of Biochemistry - Dr A C Deb

Reference Books:

- Biochemistry- U. Satyanarayana, U. Chakrapani , BOOKS AND ALLIED (P) LTD. (2008)

II Semester

Fundamentals of Microbiology

Objective : Student will learn about the basics of microbes; physiology of microbes and their role in agriculture, public health, medicine and industry. With the help of this course, student will able to think and apply microbes with new innovative ideas for betterment in Food and Biotechnology.

Unit- I Introduction-aims and scope Introduction-aims and scope, Role of microbes in agriculture, public health, medicine and industry, Organization of prokaryotic and eukaryotic cells: Structure and function of cell organelles and surface structure and cellular reserve materials; Distinguishing features of various groups of microorganisms: actinomycetes, bacteria, molds, yeasts and algae and their broad classification. (1 Credit)

Practicals (0.4 credit)

Sr. no.	Name of practical	Nature
1	Purify the given bacterial sample by serial dilution method (i) To prepare culture media for microorganisms (ii) Growth study of Microorganisms	practical
2	Perform Gram's staining in given bacterial sample (i) Preparation of staining solutions (ii) Microscopic observation and identification	Practical
3	Identify the fungal flora of soil and their microscopic view (i) To prepare culture media for microorganisms (ii) Microscopic examination and identification	Practical Practical practical
4	Preparation of culture media for algae (i) Media preparation and standard stock preparation (ii) Autoclaving and finalization of media for inoculation	Practical Practical practical
5	Perform antagonistic activity of micro organisms n (i) Culture media preparation, inoculation of 2 different organisms (ii) Observation of result	Practical Practical practical

Unit-II Characteristics of micro-organisms Characteristics of selected groups of microorganisms including microorganisms of extreme environment, Microbial nutrition and growth-principles of nutrition, growth measurement techniques, effect of environmental and culture parameters on growth, assimilation of nitrogen and sulphur, Isolation and preservation of cultures. (1 Credit)

Practicals (0.4 credit)

Sr. no.	Name of practical	Nature
1	Isolate the microorganism of extreme environmental condition (i) To prepare culture media for microorganisms (ii) Streaking	practical

2	Study the bacterial growth curve with complete phases (i) Preparation of culture media for microorganisms (ii) Microscopic observation and identification of density of MO	Practical
3	Isolate nitrogen fixating bacteria and their identification (i) To prepare culture media for microorganisms (ii) Staining, Microscopic examination and identification	Practical
4	Effect of environmental conditions on bacterial growth (i) Media preparation and standard stock preparation (ii) Effect of unusual condition on MO	Practical
5	Perform the preservation process for bacterial culture (i) Culture media preparation, inoculation (ii) Observation of result after complete duration	Practical

Unit-III Energy transduction in microbial systems Energy transduction in microbial systems: fermentation, aerobic and anaerobic respiration. Phototrophic microorganisms, Phosphoketolase, Entner-Doudoroff and glyoxalate pathways, Control of microbial growth effect of heat, disinfectants and therapeutic agents, Microbial pathogenicity, Bioassays.

(1 Credit)

Practicals (0.2 credit)

Sr. no.	Name of practical	Nature
1	Study the batch and fed batch culture condition on bacterial growth (i) To prepare culture media for microorganisms (ii) Observation of different density and growth of MO	practical
2	Isolate the bacterial pigments form cyanobacteria (i) Preparation of culture media for microorganisms (ii) Microscopic observation and identification and isolation of Chl pigment	Practical
3	Chromatographic evaluation of bacterial pigments (i) To prepare culture media for microorganisms (ii) Chromatographic identification of pigment	Practical
4	To determine the ability of Microorganisms to degrade and ferment carbohydrates with the production of acid or acid and gas (i) Media preparation and standard stock preparation (ii) Microbial production	Practical
5	To detect the antibiotic sensitivity on the given culture sample (Antibiotic Sensitivity Test) (i) Culture media preparation, inoculation (ii) Observation of result after complete antimicrobial activity	Practical

Recommended Text Books:

1. Microbiology – L. M. Prescott
2. A Textbook Of Basic And Applied Microbiology - Aneja K.R.

Recommended Reference Books:

1. Pelczar Microbiology
2. Practical microbiology by Satish Gupte
3. Basic practical microbiology a manual – Cuteri

Thermodynamics **Credits-3**

Objective : Student will learn about the basic concepts of thermodynamics, stored and transit forms of energy, thermodynamic system, thermodynamic processes. Students will also be able to understand about laws of thermodynamics, Rankine, air standard cycles and heat transfer mechanisms.

UNIT – I Basic concept of Thermodynamics Basic Concepts: Introduction and scope of Thermodynamics, Thermostatics, Thermodynamic properties, Cycle integral for property and non-property variable, Stored and transit forms of energy, Thermodynamic systems and control volume, Isolated system, Universe, Steady flow system, their characteristics and examples, Types of work, Thermodynamic Processes.

(1 Credit)

UNIT – II Laws of Thermodynamics Laws of Thermodynamics: Zeroth Law, First Law of Thermodynamics, Second Law of Thermodynamics, Carnot Theorem, Steam Engine,Concept of entropy,T-S Diagram ,availability and irreversibilities. Pure Substances: Behaviour of pure substances.

(1 Credit)

UNIT – III Heat transfer Rankine vs. Carnot, modified Rankine cycle. Air Standard Cycles: Assumptions, Analysis of Otto, Diesel, Dual and Joule cycles, Calculation of cycle work and state values. Introduction to Heat Transfer, Refrigeration and Air-Conditioning.

(1 Credit)

Recommended text Books:

1. Heat thermodynamics and statistical physics by Brij lal, N.Subrahmanyam, S.Chand publication New Delhi.

Reference Books:

1. Timoshenko S P and Young D H, "Engineering Mechanics", McGraw Hill (International) 4/e, New Delhi (1984).
2. Beer, Ferdinand: Johnston, Jr., E. Russell, "Vector Mechanics for Engineers: Statics (in SI Units)", 3rd Edition Tata McGraw Hill, 2000.
3. R C Hibbeler, "Engineering Mechanics: Statics (in SI Units)", Pearson Education, India, 2000.

Cell Biology **Credits-4**

Objective : Students will understand the structures and basic components of prokaryotic and eukaryotic cells, including membranes, and organelles. This course give knowledge to understand cell division process, significance of mitosis and meiosis process. Students will apply their knowledge of cell biology to in cell function, cell signaling pathways, cell differentiation and cell biology techniques.

Unit-I Ultra-structure of Plant and animal cell Cell – Shapes, morphology, Cell theory, Cells , Structure-function relationship including organelles and their Biogenesis (e.g., Endoplasmic reticulum, Mitochondria, Chloroplast, Golgi body, nucleus, lysosomes, vacuoles), Membrane structure , Membrane transport, Cytoskeleton, Extracellular matrix , Cell junctions.

(1 Credit)

Practicals (0.5 credit)

Sr. no.	Name of practical	Nature
1	Study of Microscopy**: -** Simple, Compound, & Phase Contrast Microscope (i) Learn about simple microscope (ii) Learn about compound microscope (iii) Learn about phase contrast microscope	Practical
2	Study of cell organelles by using Models, Charts and Slides**.** (i) Study of models (ii) Study of charts (iii) Study of slides	Practical
3	To demonstrate osmosis by using potato osmoscope**.** (i) Setting up of potato osmoscope (ii) Demonstration of osmosis	Practical

Unit-II Brief Idea about cell cycle Cell cycle: different phases of cell cycle (G_1, S- phase, G_2 and M-phase). Regulation of cell cycle: role of cyclins and CDKs, Check points. Mitosis: phases of mitosis (prophase, metaphase, anaphase, telophase and cytokinesis). Significance of mitosis. Meiosis: phases of meiosis and gametogenesis.

(1 Credit)

Practicals (0.5 credit)

Sr. no.	Name of practical	Nature
1	Squash preparation of Onion root tip to study Mitosis**.** (i) Squash preparation (ii) Making slide (iii) Observation of mitosis	Practical
2	Preparation of polytene chromosome in chironomous larva/fruit fly**.** (i) Separation of chromosome (ii) Making slide (iii) Observation of chromosomes	Practical
3	Study of meiosis in Grasshopper testis**.** (i) Separation of testis (ii) Making slide (iii) Observation of meiosis	Practical
4	Learn about cell cycle and Gametogenesis through charts and models	Practice

Unit- III Cell signaling Cell Signaling: different pathways (G-protein mediated, cAMP mediated and tyrosine kinase mediated), secondary messengers. Cell differentiation, program cell death, techniques in Cell biology (microscopy, chromatography, centrifugation and spectroscopy).

(1 Credit)

Recommended Books:

1. Cell and molecular biology by P.K. Gupta
2. Cell biology by C. B. Panwar, Rastogi publication.

Reference books:

1. Molecular Biology of the Cell- Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff.
2. The Cell: A Molecular Approach, Sixth Edition by Geoffrey M. Cooper and Robert E. Hausman

Biophysics and Instrumentation

Objective : Student will learn about the basic principle of microscopy, types of microscopic techniques, and application of microscopy. Students will be able to understand the basic concepts of centrifugation, types of centrifugation, basic principle of spectroscopy, different spectroscopic instruments and application of spectroscopic techniques.

Unit-I Microscopy Principles and applications of light, phase contrast, fluorescence and electron Microscopy: Bright-field, dark-field and phase contrast microscopy, fluorescence microscopy, confocal microscopy and electron microscopy.

(1 Credit)

Practicals (0.4 credits)

Sr. no.	Name of practical	Nature
1	To learn structure, function, principle of Light microscope.	Practical
2	To learn structure, function, principle of Phase contrast microscope.	Practical
3	To learn structure, function, principle of confocal microscope.	Practical
4.	To learn structure, function, principle of Electron Microscope	Practical

Unit-II Centrifugation Centrifugation: Principles and application, sedimentation coefficient. Types of centrifugation :Ultra centrifugation, Differential Pelleting centrifugationand Rate-Zonal Density-Gradient Centrifugation.

(1 Credit)

Practicals (0.4 credits)

Sr. no.	Name of practical	Nature
1	To learn structure, function and principle of Ultra centrifuge.	Practical
2	To learn structure, function, principle of differential centrifuge.	Practical
3	To learn structure, function, principle of density gradient centrifuge.	Practical
4.	To learn about sedimentation co-efficient.	Practice

Unit-III Spectroscopy Basic principles of UV-Visible spectrophotometry and colorimetry.Principles and applications of UV-Visible spectroscopy, Atomic absorption spectroscopy, Fluorescence spectroscopy, Infraredspectroscopy.

(1 Credit)

Practicals(0.2 credits)

Sr. no.	Name of practical	Nature
1	To learn structure, function and principle of UV-visible spectrophotometer.	Practical
2	To learn structure, function, principle of colorimeter.	Practical
3.	To learn structure, function, principle of Fluorescence Microscope.	Practical

Recommended text book:

1. Biotechniques Theory and Practice**:** Prof. *S.V.S. Rana***.**

Suggested Readings:

- Principles and Techniques of Biochemistry and Molecular Biology- Keith M**.** Wilson, John M**.** Walker

Analytical Chemistry **Credits-4**

Objective : Students will understand the basic techniques used in analytical chemistry. This course will give student a brief knowledge about separation methods, solvent extraction methods, chromatographic techniques, separation techniques for inorganic and organic compounds. Students will apply their knowledge in spectroscopic techniques, laws of spectroscopic techniques, basic instrumentation of spectroscopic analysis, thermal diagnosis and differential scanning colorimetry.

Unit- I Separation methods Solvent extraction (liquid-liquid extraction): General principles, relationship between percentage of extraction and distribution coefficient and distribution ratio, multiple extraction, extraction of metal organic complexes and ion association complexes.Chromatographic techniques: Classification, basic principles, theory of chromatography- Ion exchange chromatography - ion exchange process, synthesis and structure of ion-exchange resin and separation of lanthanides. Paper and thin-layer chromatography- stationary and mobile phases, various techniques of development – visualization and evaluation of chromatograms, separation of inorganic and organic compounds.

(1 Credit)

Practicals (0.5 credit)

Sr. no.	Name of practical	Nature
1	To perform Ion exchange methods- (i) To the preparation of solution. (ii) To separation and estimation of mg (II) and Zn (II).	Practical
2	To perform of Solvent extraction- (i) To prepare solution. (ii) To separation and estimation of Mg (II) and Fe.	Practical
3	To the study Green leaves with the help of Thin layer chromatography-. (i) To preparation and Identification of organic compound.(Benzene) (ii) Determination of $R_f$value .	Practical
4	To the study of Organic compound with the help of Column chromatography. (i) Separation of fluoresin and methylene blue. (ii) Separation of a mixture of dying using cyclo hexane and ethyl acetate(8.5:1.5).	Practical
5	To the study of Paper chromatography-Ascending and circular. (i) Separation of a mixture of Phenylalanine and glycine. (ii) Observation of result.	Practical

Unit- II Spectral methods UV absorption spectroscopy: Beer-Lambert law, molar extinction coefficient, analysis of UV spectra, types of electronic transitions, effect of conjugation, concept of chromophores and oxochromes, bathochromic, hypsochromic, hyperchromic and hypochromic shifts, UV spectra of conjugated enes and enones. (1 Credit)

Practicals (0.5 credit)

Sr. no.	Name of practical	Nature
1	Spectral methods – (i) To Determine of Beer -Lambert law. (ii) Calculation of law by U.V	Practical
2	Spectroscopy methods- (i)To prepare the solution. (ii) Simultaneous determination of Co (II) and Cr (III) in a mixture of both by spectro - photometric method.	Practical
3	Thermal Methods- (i) To the study of Determine the content of iron in vitamin tablets by colorimetric method. (ii) Calculation by colorimetric methods.	Practical
4	To the study of fluoresin and methylene blue with the help of Column chromatography- (i) Identification of organic compound. (ii) Separation of a mixture of dying using cyclo hexane and ethyl acetate(8.5:1.5).	Practical
5.	To Analysis Solvent extraction methods- (i)To the Preparation of solution. (ii) Separation and estimation of Mg (II) and Fe metal.	Practical

Unit-III Thermal methods Theory, instrumentation and applications of Thermogravimetric method of analysis (TGA), (b) Differential thermal methods of analysis (DTA), (c) Differential scanning colorimetry (DSA).

(1 Credit)

Recommended text book:

1. Qualitative analysis ,G.R.Chatwal,

Reference books:

1. Vogel's Qualitative analysis ,Svehla,Orient Longman.
2. Inorganic synthesis Mc GrawHell

Fundamentals of Food Science & Technology

Credits-4

Objective : Students would be able to understand Scope of food processing in India and different areas of food processing. They would be able to understand the processing of different food products like meat and meat products, Fruit and vegetable, milk and milk products and marine products.

UNIT – I Food Processing & Packaging and Food Industries Scope of food processing in India; Introduction to food processing, food preservation, food packaging, food drying and dehydration. Important food industries in India; role of Food Science & Technology in national economy.
(1 Credit)

Practical(0.4Credit)

S. No.	Name of practical	Nature
1	Study of Various Processed foods available in the market	Practical
2	Study of Different Methods of Food Preservation	Practical
3	Study of Different types of Drying Techniques	Practical
4	Study of Different types of Packaging Materials	Practical
5	Study of Different Food Industries in India	Practical

UNIT – II Processing of food products Fruit and vegetable processing, processing of meat and meat products, processing of milk and milk products, processing of marine products.
(1 Credit)

Practical(0.4 Credit)

S. No.	Name of practical	Nature
1	Processing of Fruits	Practical
2	Processing of Vegetables	Practical
3	Processing of Milk & Milk Products	Practical
4	Processing of Meat Products	Practical
5	Processing of Marine Products	Practical

UNIT – III Unit operations and Food Engineering Unit operations in food industry**.** Rheology of food**.** Basic principles of food engineering**.** Introduction to various food processing equipments**.**

(1 Credit)
Practical (0.2 Credits)

S. No.	Name of practical	Nature
1	Study of Various Food Processing Equipments	Practical
2	Study of Unit operations in Food Industry	Practical
3	Study of Food Rheology	Practical

Recommended Books:

1. Norman N. Potter, Joseph H. Hotchkiss. Food Science, Springer, 1998
2. Vickie A. Vaclavik, Elizabeth W. Christian, Essentials of Food Science, Springer, 2008
3. B. Srilakshmi, Food Science, New Age International, 2007

III SEMESTER

Metabolism and Bioenergetics **Credits-4**

Objective : This course will give student a brief knowledge about molecular basis of life, structure and classification of proteins, classification of lipids, classification of carbohydrates. Students will learn about nucleic acid structure, enzyme classification, kinetics of enzymes, metabolism of carbohydrate, lipid and amino acid metabolisms and photosynthesis reaction.

UNIT – I Bioenergetics and Carbohydrate metabolism Molecular basis of life, proteins, classification, structure, function, dynamics, specificity and techniques; Protein configuration, conformation, conformational analysis, Ramachandran's map and energy calculations; Helix to coil transition of proteins. Carbohydrates and lipids,classification, structure and function, membrane fluidity. Structural proteins, actin, myosin and muscle contraction.
(1 Credit)

Practicals(0.4 credits)

Sr. no.	Name of practical	Nature
1.	To understand the principle and operation of Spectrophotometer	Practical
2.	Determination of reducing sugars by Nelson- Somogyi's method 1. Preparation of reagents 2. To perform the assay 3. Observation and Calculations	practical
3.	Determination of starch in plant Tissue 1. Preparation of reagents 2. To perform the assay 3. Observation and Calculations	Practical
4.	Determination of Glycogen in Liver 1. Preparation of reagents 2. To perform the assay 3. Observation and calculations	Practical

UNIT – II Lipid Metabolism Nucleic acids, nomenclature, properties and techniques, backbone torsional angle and sugar conformation. Enzymes, introduction, classification, kinetics and Catalysis. Metabolism, basic concepts and design.

(1 Credit)

Practical(0.4 credit)

Sr. no.	Name of practical	Nature
1	Extraction and estimation of total lipid content in the given sample of oilseed 1. Preparation of reagents and extraction of total lipids 2. Estimation of total lipids	Practical
2	Separation and identification of various lipids by Column Chromatography 1. Preparation of reagents 2. Separation of Lipids 3. Identification of lipids	Practical
3	Separation of various Components in different lipid fractions by thin layer chromatography 1. Preparation of reagents 2. Separation of various components	Practical

4	Estimation of Cholesterol content by Liebermann- Burchard method 1. Preparation of reagents 2. To perform the assay 3. Observation and Calculations	Practical

UNIT – III Protein and Nucleic acid metabolism Carbohydrates and lipids,classification, structure and function. Metabolism of carbohydrates, glycolysis, citric acid cycle and oxidative phosphorylation, lipid, amino acid and nucleotide metabolism..Integration of metabolism, coordinated control and regulation. Photosynthesis, chloroplast, dark and light reactions.
(1 Credit)

Practical(0.2 credit)

Sr. no.	Name of practical	Nature
1.	Estimation of protein by Lowry's method 1. Preparation of reagents 2. To Perform the assay 3. Observation and Calculations	Practical
2.	Determination of Protein by Bradford method 1. Preparation of reagents 2. To perform the assay and calculation for the concentration of protein	Practical

Recommended text Books:

1. A.L. Lehninger, D.L. Nelson, M.M. Cox, " Principles of Boichemistry", 3rd Edn., Worth Publishers.

Reference Books:

1. Biochemistry by Voet and Voet
2. Biochemistry by U. Staynarayan
3. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY.
4. G. Zubay, "Biochemistry", 4th Edn., McGrawhill Publishers.

References/Correlation with Ancient Indian Literature:

- Asvalayana Grhya Sutra II 7https://www.australiancouncilofhinduclergy.com/uploads/5/5/4/9/5549439/asvalayana-eng.pdf
- Atharveda http://www.sacred-texts.com/hin/av.htm
- Yajurvedahttp://vedicheritage.gov.in/science/

Basic Enzymology **Credits-4**

Objective : This course will give student a brief knowledge about basic characters of enzymes, activation energy, enzyme classification and purification of enzyme. Students will learn about kinetics of enzyme, enzyme substrate complex, enzyme inhibition, reversible inhibition, non reversible mechanism of enzyme action and modification of enzymes.

UNIT I Introduction & Classification of enzymes Introduction– Characterstics of Enzymes, Concept of Activation energy, free energy, Difference between enzyme and biocatalyst, IUB enzyme classification (specific examples), enzyme specificity, methods for isolation, purification and characterization of enzymes
(1 Credit)

Practicals (0.5credit)

Sr. no.	Name of practical	Nature
1	To examine the effect of pH on activity of alkaline phosphatase 1. Preparation of Reagents 2. To perform the assay 3. Observation and calculations	Practical
2	To determine the temperature optima for alkaline phosphatase 1. Preparation of Reagents 2. To perform the assay 3. Observation and calculations	Practical
3	Time course of enzymatic reaction 1. Reagent preparation 2. To perform the assay and observe for the results	Practical
4	Specificity of enzyme action. 1. Preparation of Reagents 2. To perform the assay and observation	Practical

UNIT II Enzyme kinetics Kinetics of enzyme action –Concept of ES complex, active site, specificity, derivation of Michaelis-Menten equation for uni- substrate reactions. Different plots for the determination of Km & Vmax and their physiological significances. Importance of Kcat/Km. Kinetics of zero & first order reactions. Classification of multi-substrate reactions with examples of each class. Derivation of the rate of expression for Ping Pong, random & ordered Bi-Bi mechanisms. Use of initial velocity, inhibition and exchange studies to differentiate between multi-substrate reaction mechanisms.
(1 Credit)

Practicals (0.5credit)

Sr. no.	Name of practical	Nature
1.	To understand the principle and operation of Spectrophotometer	Practical
2.	Influence of substrate concentration on the rate of enzymatic reaction. 1. Preparation of Reagents 2. To perform the assay 3. Observation and calculations	Practical
3.	Inhibition of enzyme activity Determination of K_i values 1. Preparation of Reagents 2. To perform the assay 3. Observation and calculations	Practical
4.	Determination of β-amylase activity in germinating barley seeds 1. Preparation of Reagents 2. To perform the assay 3. Observations and calculations	Practical

UNIT III Enzyme Inhibition and Mechanism of Enzyme action Reversible and irreversible inhibition. Competitive, non-competitive, uncompetitive, mixed type inhibitiors and their kinetics, determination of Ki and numerical based on these. Suicide inhibitor. Mechanism of Enzyme Action – Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain and distortion theory. Chemical modification of active site groups. Site directed mutagenesis of enzymes. Mechanism of action of chymotrypsin, lysozyme, glyceraldehyde 3-phosphate dehydrogenase, aldolase, carboxypeptidase, triose phosphate isomerase and alcohol dehydrogenase.
(1 Credit)

Recommended Text Books :

1. N.S. Kulkarni -General Enzymology

Reference Books

1. Travor and Palmer - Enzymology
2. A.L. Lehninger, D.L. Nelson, M.M. Cox, " Principles of Boichemistry", 3rd Edn., Worth Publishers.

References/Correlation with Ancient Indian Literature:

- Ras Ratna Samuchchay https://www.exoticindiaart.com/book/details/rasa-ratna-samucchaya-NZI038/
- Rasayan Shastrahttps://www.pgurus.com/chemistry-ancient-india/

Developmental biology **Credits-4**

Objective : This course will give student a brief knowledge about developmental biology, gametogenesis in animals, Phases of Oogenesis and Structure of Ovary. Students will also learn about Gametogenesis in plants, Fertilization, Pollen germination, Types of fertilization, Mechanism of fertilization, Activation of ovum, types and physiology of cleavage.

Unit I Gametogenesis in animals Gametogenesis in animals: Historical review and types of embryology, Structure of Testis, Phases of spermatogenesis and structure of sperm. Phases of Oogenesis and Structure of Ovary, Formation of egg, Vitellogenesis.
(1 Credit)

Practicals (0.4 credits)

Sr. no.	Name of practical	Nature
1	Study of T.S of ovary & Testis	practical
2	Different type of placentation	Practical

Unit II Gametogenesis in plants Gametogenesis in plants: Plant Morphology/Embryology, Pre-fertilization changes, Microsporogenesis and Microgametogenesis, Fertilisation, Pollen germination.

(1 Credit)
Practicals (0.3 credits)

Sr. no.	Name of practical	Nature
1	Study of different types of stomata	Practical
2	Study of cambial ring	Practical

Unit III Fertilization Fertilization: Types of fertilization, Mechanism of fertilization, Activation of ovum, essence of activation: changes in the organization of the egg cytoplasm. Parthenogensis, Cleavage, Planes, types and physiology of cleavage.
(1 Credit)

Practicals (0.3 credits)

Sr. no.	Name of practical	Nature
1	Study of T.S. of early cleavage & Late Cleavage	Practical
2	Study of window making process in unfertilized egg	Practical

Recommended Text books:

1. Development biology by Asha Sharma, Ramesh book

Suggested Readings:

1. Principles of Animal Developmental Biology :Goyal S.C. : Himalaya Publishing Co., Mumbai.
2. Fundamentals of Comparative Embryology. Huettner, A.F. Millan, New York.
3. Chordate Embryology : Berma. P.S. Agrawal. V.K. and Tyagi, B.S. S Chand and Co. New Delhi.

References/Correlation with Ancient Indian Literature:

- Sharma PV, editor. Caraka Samhita of Agnivesha (Text with English Translation) Sutra Sthana. Ch. XX, Ver. 1-25. I. Varanasi: Chaukhambha Orientalia; 1981. pp. 137–43. [Google Scholar]https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5688840/
- Sharma PV, editor. Susruta Samhita of sushruta. First edition. Sutrasthana, Ch. I, Ver. 1-41. I. https://rarebooksocietyofindia.org/book_archive/Sushruta%20Samhita%201.pdf
- Varanasi: Chaukhambha Visvabharati; 1999. pp. 3–28.file:///C:/Users/jvwu/Downloads/182-Article%20Text-545-1-10-20151215.pdf
- Rudras Adhityashttps://sreenivasaraos.com/2012/09/29/the-rudras-eleven/

Embryogenesis **Credits-4**

Objective : Students will understand the basic concepts of embryology, embryology in flowering plant, Structure of Ovary and anther, Formation of egg, Development of male and female gametophyte. Students will also learn about Blastulation, Development of Blastula, types of blastula, Development of Gastrulation, characteristics of Gastrulation and Significance of Gastrulation.

Unit I Embryogenesis of Angiosperms Historical review and types of embryology in flowering plant, Parts of a typical Angiospermic plant, Phases of embryonic development, seed structure, Structure of Ovary, Formation of egg, Structure of anther, Development of male gametophyte, Development of female gametophyte (Embryosac).

(1 Credit)

Practicals **(0.3 credits)**

Sr. no.	Name of practical	Nature
1	Study of T.S of anther	Practical
2	Study of various types of ovules and draw the diagrams	Practical
3	Study the germination of pollen grains *in situ* and observe the path of pollen tube	Practical

Unit II Blastulation Introduction of Blastulation, Development of Blastula, Morulation, formation and structure of blastula, types of blastula, Significance of blastulation.

(1 Credit)

Practicals **(0.3 credits)**

Sr. no.	Name of practical	Nature
1	Study of male germ cells	practical
2	Study of female germ cells	Practical
3	Blastulation stage of amphibian	Practical

Unit III: Gastrulation Introduction of Gastrulation, Development of Gastrulation, Morphogenetic movements, epiboly, emboly, invagination, involution, polyinvagination, delamination, characteristics of Gastrulation. Significance of Gastrulation.

(1 Credit)

Practicals **(0.4 credits)**

Sr. no.	Name of practical	Nature
1	Study of T.S. of early cleavage	practical
2	Study of T.S. of late cleavage	Practical
3	Study of early Gastrulation	Practical
4	Study of window making process in unfertilized egg	Practical

Recommended Text books:

1. Bhojwani and Bhatnagar (2000): The embryology of angiosperm.
2. Developmental biology by Asha Sharma (RBD Publication New Delhi)
3. Mahesgwari P. (1950): an introduction of embryology of angiosperm

Suggested Readings

1. Recent advance in embryology of angiosperm: Maheshwari P. (1963).
2. Fundamentals of Comparative Embryology. Huettner, A.F. Millan, New York.

Biostatistics **Credits- 3**

Objective : Students will learn about basic of biostatistics, classification of data, tabulatin of data, correlation coefficient, regression, measures of dispersion and measures of central tendancy. This course will give students knowledge about vital statistics, life tables, sampling techniques, hypothesis testing, large sample test, small sample test and analysis of variance.

UNIT-I Classification and Tabulation of Data Classification and tabulation of data ,Frequency distribution Histogram , Frequency polygon and frequency curve ,Cumulative frequency curves, Measures of central tendency:arithmetic mean geometric mean harmonic mean median, mode;Measures of dispersion:range, quartile deviation, mean deviation, variance and standard deviation; Correlation:karl Pearson's correlation coefficient, Spearman's rank correlation coefficient, Spearman's rank correlation coefficient, Regression: Lines of regression and regression coefficient.

(1 Credit)

Practicals: **(0.5 credits)**

Sr. no.	Name of practical	Nature
1.	To find out Mean	Practical
2.	To find out Median	Practical
3.	To find out Mode	Practical
4.	To draw Bar Graph	Practical
5.	To draw Pie diagram	Practical

UNIT-II (Vital Statistics) Vital statistics: Concept, importance, Vital index,Birth rates:CBR,GFR,SFR,TFR,Death rates:CDR,SDR,STDR,Life tables:introduction,Description and uses, Sampling: concept of population and sample, Sampling distribution and standard error of sample mean and sample proportion, Hypothesis testing, type I& II errors, Level of significance, Critical region, acceptance region, p-values of the statistics, confidence limits.

(0.5 Credit)

Practicals: **(0.5 credits)**

Sr. no.	Name of practical	Nature
1.	To draw Histogram	Practical
2.	To draw line graph	Practical

3.	To find out correlation	Practical
4.	To find out rank correlation	Practical
5.	To draw Histogram	Practical

UNIT-III ANOVA and sampling Large sample tests (normal test): Test for one sample proportion and two sample proportion test, Small sample tests : t-test (test for one and two sample means): F-test, Chi square test (goodness of fit test, test of independence, homogeneity of samples), Analysis of variance (ANOVA);One way and two way analysis of variance, Application of these tests to analyze the biological data (0.5 Credit)

Recommended Text Books:

1. Elements of Biostatistics; S. Prasad; Rastogi Publications, Merrut
2. Elements of Mathematical Statistics; S.C.Gupta and V.K. Kapur; Sulatan chand & Sons, New Delhi

Reference books:

1. Statical methods in Biology; T.I. Norman; Bailey,3rd edition
2. Fundamentals of Mathematics; S.C. Gupta and V.k. kapur; Sultan Chand& sons , New Delhi

References/Correlation with Ancient Indian Literature:

1. Sankhyā: The Indian Journal of Statistics Published by: Indian Statistical Institutehttps://www.springer.com/statistics/journal/13171
2. The Sulba Sutras http://www-history.mcs.st-and.ac.uk/Projects/Pearce/Chapters/Ch4_2.html
3. "History of Hindu Mathematics, Asia Publishing House, Bombay, 1962"https://link.springer.com/article/10.1007/BF02836134

Molecular Biology **Credits-3**

Objective : This course will give student a brief knowledge about molecular biology, nucleic acid structure, prokaryotic and eukaryotic replication, control of replication and nucleosomes. Students will learn about transcription in prokaryotes and eukaryotes, promoters for transcription, RNA processing, translation, mechanism, genetic code, mutation and DNA repair mechanisms.

Unit-I Synthesis of DNA and its mechanism Nucleic acids, DNA structure, central dogma; Replication: eukaryotic and prokaryotic replication, mechanism and control, replication of double stranded and single stranded circular DNA, the end-replication problem and telomerase; Nucleosomes: eukaryotic and prokaryotic genome packing, heterochromatin, euchromatin.

(1 Credit)

Practicals (0.4 credit)

Sr. no.	Name of practical	Nature
1	To isolate genomic DNA from E.coli. (i) Grow colonies of E.coli. (ii) Make suspension of E.coli. (iii) Isolate DNA from E.coli.	practical
2	To prepare Agarose gel for gel electrophoresis (i) Preparation of agarose solution (ii) Gel casting	Practical
3	To separate and visualize genomic DNA of E.coli. (i) Loading of DNA into agarose gel (ii) Visualization of DNA	Practical

Unit-II Mechanism of Transcription Transcription: mechanism of RNA transcription in prokaryotes and eukaryotes; model systems of transcriptional control: lac operon, lambda phage; promoters, enhancers, repressors; RNA processing: processing of heterogeneous nuclear RNA: splicing, capping, polyadenylation; Translation: universal genetic code, degeneracy of codons.
(0.5 Credit)

Practicals(0.3 credit)

Sr. no.	Name of practical	Nature
1	To isolate genomic DNA from blood. (i) Reagent preparation. (ii) Blood collection. (iii) Isolation of DNA.	practical
2	To isolate DNA from plant sample. (i) Grinding of plant sample (ii) Isolation of DNA	Practical
3	To determine the concentration of DNA.	Practical

Unit-III Mechanism of Translation Mechanisms of initiation, elongation and termination of translation, wobble hypothesis, genetic code in mitochondria; Mutations: nonsense, missense, frameshift and point mutations; intragenic and intergenic suppression; DNA repair: photoreactivation, excision, mismatch and SOS repair; Recombination: mechanism of homologous recombination in prokaryotes, site specific recombination, insertion sequences, transposons.

(0.5 Credit)

Practicals(0.3 credit)

Sr. no.	Name of practical	Nature
1	To isolate genomic DNA from cheek cells. (i) Reagent preparation. (ii) Separation and lysis of cells. (iii) Precipitation of DNA.	Practical
2	To isolate RNA from bacteria. (i) Grow colonies of E.coli. (ii) Make suspension of E.coli. (iii) Isolate RNA from E.coli.	Practical
3	To determine the concentration of RNA.	Practical

Recommended text book

1. Lehninger's principles of biochemistry.

Reference book

1. Genes by Benjamin Lewin
2. Molecular biology of the cell by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter.

References/Correlation with Ancient Indian Literature:

1. Rig-Veda 1-163Rig-Veda 1-163http://xn--j2b3a4c.com/rigveda/1/163/1
2. The Rigveda, A Historical Analysis, by Shrikant G. Talageri, Aditya Prakashan, New Delhi. Hindi translation of Rigveda by Ramgovind Tripathhttp://voiceofdharma.org/books/rig/

IV SEMESTER

Environmental Biotechnology

Credits-4

Objective : Students will learn about basic concept of environment, environmental pollution, pollution, control, pollution monitoring, air pollution and water pollution. This course will give students knowledge about waste water treatment, solid waste, sludge waste disposal, bioremediation, biostimulation, bioaugmentation, hazardous waste management and biological detoxification.

UNIT-I Pollution Environment –Basic concepts**.** Environmental Pollution**-** sources and nature**.** Pollution monitoring and biotechnological methods for management of pollution**.** Air pollution and Control**.** Water pollution and sewage**.**

(1 Credit)

Practicals*(0.4credit)*

Sr. no.	Name of practical	Nature
1	Isolation and Characterization of Bacteria from Crude Petroleum Oil**.** (i) Collection of sample (ii) Media preparation (iii) Spreading/streaking (iv) Incubation and identification	Practical
2	Isolation and Characterization of Bacteria from Contaminated Soil**.** (i) Collection of sample (ii) Media preparation (iii) Spreading/streaking (iv) Incubation and identification	Practical

UNIT-II Management of Pollution Waste water treatment :Preliminary treatment , primary treatment , secondary treatment *(* Aerobic attached growth treatment process & Anaerobic attached Growth treatment *)* and Tertiary treatment. Sludge and Solid wastes- Sources, characteristics and treatment of sludge. Disposal of sludge.

(1 Credit)

Practicals(0.4credit)

Sr. no.	Name of practical	Nature
1	To determine DO of water sample**.** (i) Reagent preparation and sample collection. (ii) Mixing of reagents in water. (iii) Titration.	practical
2	To determine hardness of water (i) Sample collection (ii) Analytic procedure (iii) Titration	Practical
3	To determine the BOD in water sample**.** (i) Sample collection (ii) Mixing and titration	Practical

UNIT-III Bioremediation Bioremediation*:* Introduction, constraints and priorities of Bioremediation, Biostimulation of Naturally occurring microbial activities, Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation.Hazardous Waste Management- Xenobiotic compounds, recalcitrance. hazardous wastes -biodegradation of Xenobiotics .Biological detoxification - market for hazardous waste management. (1 Credit)

Practicals(0.2credit)

Sr. no.	Name of practical	Nature
1	To determine the BOD in water sample**.** (i) Sample collection (ii) Mixing and titration	Practical
2	Detection of streptomycin producing bacteria**.** (i) Sample collection (ii) Media preparation (iii) Streaking/spreading (iv) Incubation and observation	Practical
3	To perform water potability of water sample**.** (v) Sample collection and media preparation (vi) Incubation and observation	Practical

Recommended text book*:*

1. Biotechnology- U.Satyanarayan

Reference book:

- Environmental biotechnology by S.N. Jogdand.

References/Correlation with Ancient Indian Literature:

1. N.J. Lockyer, The dawn of Astronomy, Massachusetts, Institute ofTechnology, p. 432.http://bhupendravidya.blogspot.com/2013/12/the-concept-of-environmental.html
2. Raja Ram Mohan Roy, Vedic Physics, Scientific Origin of Hinduism,Golden Egg Publishing, Toronto, 1999, p.6.https://www.scribd.com/doc/79678937/Vedic-Physics
3. Yudhishthira Mimansaka, Vaidika Siddhanta Mimansa, Sonipata, 1976,p. 40.http://ignca.bestbookbuddies.com/cgi-bin/koha/opac-search.pl?q=ccl=su%3A%7BHinduism%7D&sort_by=relevance_dsc&expand=se

Recombinant DNA Technology **Credits-4**

Objective : This course will give student a brief knowledge about recombinant DNA technology, basic steps of gene cloning, restriction enzymes, tools of RDT and vectors for gene cloning. Students will learn about methods of gene transfer, preparation of molecular probes, blotting methods, preparation of genomic library and DNA sequencing.

UNIT-I Tools of RDT Basic steps in gene cloning, Enzymes: Restriction endonuclease enzymes, DNA ligase, etc. Cloning Vectors**:**Plasmids, Lambda phage, Phagemids, Cosmids, Artificial chromosomes (BACs, YACs), Shuttle vectors, and virus based vectors.

(1 Credit)

Practicals (0.4 credit)

Sr. no.	Name of practical	Nature
1	To isolate plasmid DNA from*E.coli.* (i) To grow colonies of E.coli. (ii) To make suspension of E.coli. (iii) Isolation of Plasmid DNA	practical
2	To quantify plasmid DNA in given sample**.**	Practical
3	Digestion of lambda DNA by EcoRI and HindIII**.** (i) Mixing reagents (ii) Incubation and observation	Practical

UNIT-II Techniques of RDT Methods of gene transfer**:**Micro-injection, microprojectile, Electroporation, Agrobacterium mediated gene transfer. Preparation and application of molecular probes**:**DNA probes, RNA probes, radioactive labeling, Non radioactive labeling, use of molecular probes, DNA fingerprinting, Southern blotting, Northern blotting, Western blotting, In-situ hybridization, Colony and plaque hybridization.

(1 Credit)

Practicals (0.4 credit)

Sr. no.	Name of practical	Nature
1	Introduction of new DNA into E**.**coli**.** by the technique of transformation**.** (i) Make suspension of E.coli. (ii) Making competent cells	Practical
2	To perform electroporation for introduction of DNA into plant cell	Practical
3	To perform Southern blotting**.** (i) Separation of DNA fragments (ii) Blotting of DNA fragments (iii) Autoradiography	Practical

UNIT-III Application of RDT Gene libraries- CDNA library, Genomic DNA libraries, Amplification of gene libraries,Techniques of DNA sequencing. Polymerase Chain reaction **(**PCR**):**Basic principles, modifications, applications.

(1 Credit)

Practicals (0.2 credit)

Sr. no.	Name of practical	Nature
1	Amplification of interferon gene from human genome**.** (i) Isolation of genomic DNA from cheek cells (ii) Amplification of genome by PCR (iii) Observation of result	Practical
2	To perform nothern blotting**.** (iv) Separation of RNA fragments (v) Blotting of RNA fragments (vi) Autoradiography	Practical
3	To perform western blotting**.** (vii) Separation of proteins (viii) Blotting of proteins (ix) Autoradiography	Practical

Recommended text books

1. Genetic engineering by Smitha Rastogi and Neelam Pathak.

Reference books

- Gene cloning and DNA analysis by T. A. Brown

References/Correlation with Ancient Indian Literature:

- Ganguli, K.M. (1883-1896) "Adi Parva" in The Mahabharata of Krishna-Dwaipayana Vyasa (12 Volumes).
- Calcuttahttps://archive.org/stream/TheMahabharataOfKrishna-dwaipayanaVyasa/MahabharataOfVyasa-EnglishTranslationByKMGanguli_djvu.txt

Medical Biotechnology **Credits-3**

Objective : Students will learn about basic concept of medical biotechnology, role of biotechnology in healthcare, tissue engineering and stem cell therapy. This course will give students knowledge about sign, symptoms, diagnosis, treatment and prevention of communicable and non-communicable diseases, disease diagnosis techniques, microbial culture techniques and monoclonal antibody production.

Unit IBiomedical engineering Biomedical engineering: Introduction and applications of medical Biotechnology, Biotechnology in health care, Regenerative medicines- Tissue engineering, Characteristics of cells involved in Tissue engineering, Types and characteristics of various biomaterials used in Tissue engineering, Applications of Tissue engineering, Stem Cells-Types and characteristics, history and scope of stem cell therapy.

(1 Credit)

Practicals (0.4 credit)

S. no.	Name of practical	Nature
1	Determine the lethal effect of temperature on micro-organisms (i) To prepare culture media for microorganisms (ii) Evaluation of temp effect on growth of Microorganisms	practical
2	Blood collection from given animal (i) Manage necessary initial requirement and surgical needs (ii) Animal handling and blood collection	Practical
3	Serum separation from given animal (i) Animal handling cleaning with disinfectant (ii) Blood collection and serum isolation	Practical
4	Effect of batch and fed batch culture condition (i) Media preparation and standard stock preparation (ii) Observation of culture after complete incubation	Practical
5	Study of Microbial production (i) Culture media preparation, inoculation, seed flask (ii) Observation of result	Practical

Unit IICommunicable &Non- Communicable diseases Communicable & non- Communicable diseases: Sign, Symptoms, Diagnosis, Treatment and Prevention of Tuberculosis, AIDS, Typhoid, Pneumonia, Dysentery. Atherosclerosis/ Hyperlipidaemia , Coronary Heart Diseases, Hypertension and Diabetes.

(0.5 Credit)

Practicals(0.4 credit)

Sr. no.	Name of practical	Nature
1	Demonstration of Bacterial Flora of the skin (i) To prepare culture media for microorganisms (ii) Evaluation of growth of microorganism	practical
2	Microbial flora of mouth/oral (i) Culture media for microorganisms (ii) Observation of plates and result	Practical
3	Determination of Blood stream Infection (Bacteremia) (i) Blood collection and smear preparation (ii) Microscopy of smeared slide	Practical
4	Testing of Antimicrobial activity (i) Media preparation and standard drug disc preparation (ii) Activity observation of culture after complete incubation	Practical
5	To perform the gram staining of given bacterial culture (i) Culture media preparation, inoculation (ii) Smear preparation and observation of result	Practical

Unit IIIDisease diagnosis techniques Disease diagnosis techniques: Advancement of diagnosis, Hybridoma techniques and monoclonal antibody production and applications of monoclonal antibodies in diseases diagnosis, Diagnostic Immuno Assay, Widal Test- diagnosis of Typhoid, Culture Techniques, Antibiotic sensitivity.

(0.5 Credit)

Practicals(0.2 credit)

Sr. no.	Name of practical	Nature
1	Enzyme Linked Immuno Sorbent Assay (i) Initial requirement (ii) Evaluation of out come on the basis of principle	practical
2	Polymerase Chain reaction (i) Mastermix preparation (ii) Observation via electrophoresis and staining by Etbr	Practical
3	Widal test (i) Blood collection (ii) Separation of serum and observation	Practical
4	Hemoglobin estimation (i) Collection of sample (ii) Activity observation	Practical
5	RBC count (i) Sample collection (ii) Microscopic examination and observation	Practical

Recommended text books:

1. Pratibha Nallari, V. Venugopal Rao; Medical Biotechnology, oxford University press, 2010.
2. Text Book of Social and Preventive medicine by Park and Park-Bhanot edition MP
3. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002
4. Short Text book of Medical Microbiology by Satish Gupta

Reference text books:

1. James W. Goding , Monoclonal antibodies; Principles and Practice , 3rd Edition , Academic Press 1996
2. George Patrinos and Wilhelm Ansorage, Molecular Diagnostics, 1st Edition , Academic Press, 2005

References/Correlation with Ancient Indian Literature:

- Sharma PV, editor. Caraka Samhita of Agnivesha (Text with English Translation) Sutra Sthana. Ch. XX, Ver. 1-25. I. Varanasi: Chaukhambha Orientalia; 1981. pp. 137–43. [Google Scholar]https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5688840/
- Sharma PV, editor. Susruta Samhita of sushruta. First edition. Sutrasthana, Ch. I, Ver. 1-41. I. Varanasi: Chaukhambha Visvabharati; 1999. pp. 3–28.file:///C:/Users/jvwu/Downloads/182-Article%20Text-545-1-10-20151215.pdf
- Rudras Adhityashttps://sreenivasaraos.com/2012/09/29/the-rudras-eleven/

Food Biotechnology **Credits-3**

Objective : Students will be able to understand the basic concepts of food biotechnology, role of microorganisms in food, types of microorganisms in food, starter culture for various food and health benefits of fermented food. This course will give students knowledge about control of microorganisms in food, microbial toxins in food, protein engineering in food, biogums, traditional fermented food, transducers in food and types of biosensors in food.

UNIT I Introduction to Food Biotechnology Historical Background: History of Microorganisms in food, Historical Developments. Role and significance of microorganisms in foods. Parameters of Foods that affect microbial growth. Starter cultures, cheeses, beer, SCP, probiotics and health benefits of fermented milk and foods products.

(1 Credit)

UNIT II Micro-organisms control Control of Micro-Organisms – Bacteriocins of Lactic acid bacteria, applications of bacteriocins in food systems. Aflatoxins – production, control and reduction using molecular strategies, antagonistic microbes. Protein Engineering In Food Technology – Methods, objectives, limitations and applications of protein engineering (e.g. Glucose isomerase, Lactobacillus â-galactosidase and peptide antibiotic nisin).

(1 Credit)

UNIT III Biotechnology & Food Ingredients Biotechnology And Food Ingredients – Biogums, fats, oils, fatty acids and oilseed crops, fat substitutes, citric, fumaric and malic acids, Bioflavors and bicolors, Traditional fermented foods, Soya based oriental fermented foods. Transducers And Biosensors In Food - Principle, types and applications in food processing.

(1 Credit)

Recommended Text Books:

1. Lee, B.H. (1996). Fundamentals of Food Biotechnology, VCH Publishers.
2. Tombs, M.P. (1991). Biotechnology in Food Industry, Open University Press, Milton Keynes

Suggested Readings:

1) Biotechnology- Food fermentation, Volume 1&2 Educational publishers and Distributors.
2) Schwartzberg, A & Rao (1990). Biotechnology & Food Process Engineering, Marcel Dekker, INC,New York.

References/Correlation with Ancient Indian Literature:

- (Rigveda – 10-19-7)http://www.gatewayforindia.com/vedas/rigveda/rigveda10.shtml
- Rigveda (10-179-3)http://www.gatewayforindia.com/vedas/rigveda/rigveda10.shtml

Introduction to Bioinformatics **Credits-4**

Objective : Students will learn about basic concept of bioinformatics, nucleotide database, DNA sequences, sequence alignment and phylogenetics. Students will also understand about sequence alignment, ORFinder, structure prediction, secondary structure prediction, molecular pattern recognition and hidden Markov model.

UNIT I Biological Databases Introduction; Databases - sequence, structure, non-redundant; Sequence alignment - pairwise and multiple; phylogenetics.

(1 Credit)

Practicals (0.5 Credit)

Sr. no.	Name of practical	Nature
1	To study about the different biological databases in variable formats	Practical
2	To study about the different biological databases in variable formats	Practical
3	To study about the different biological databases in variable formats	Practical

UNIT II Sequence Alignment ORFinder; Structure prediction methods – high-accuracy, template based, free modeling (new folds).

(1 Credit)

Practicals **(0.5 Credit)**

Sr. no.	Name of practical	Nature
1	To study about the sequence similarity in different molecules through BLAST	Practical
2	To study about the sequence similarity in different molecules through BLAST	Practical
3	To study about the sequence similarity in different molecules through FASTA	Practical

UNIT III Molecular prediction Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models.

(1 Credit)

Text Books:

1) The Essientials of Bioinformatics, Xin Jiong 2008**.**
2) Bioinformatics. Keith, J. Humana Press.

Suggested Readings:

1. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
2. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.

References/Correlation with Ancient Indian Literature:

- The Sulba Sutra http://www-history.mcs.st-and.ac.uk/Projects/Pearce/Chapters/Ch4_2.html
- History of Hindu Mathematics, Asia Publishing House, Bombay, 1962"https://link.springer.com/article/10.1007/BF02836134

Principles of Immunology **Credits-3**

Objective : Students will be able to understand the basic concepts of immunology including introduction of immunology, molecular patterns of pathogen, types of immunity, components and processes of innate and acquired immunity, antigen and antibody interaction, antibody structure, MHC molecules, B Cell and T Cell activation, cytokines and vaccines.

UNIT-I Cells and Organs of Immune system Natural immunity, defensins, pathogen associated recognition motifs, Toll receptors, complement system, applications of complement proteins in rapid clearance of pathogens, acquired immunity: immune cells, antigens haptens, B and T cell.

(1 Credit)

Practicals (0.4 credit)

Sr. no.	Name of practical	Nature
1	To separate serum from blood (i) Withdrawal of blood (ii) Incubation (iii) Centrifugation	Practical
2	To identify different leukocytes by making blood smear**.** (i) Pricking of figure tip (ii) Making slide (iii) Observation	Practical

3	To determine the blood group (iv) Pricking of figure tip (v) Mixing with anti-serum (vi) Observation	Practical
4	To learn about antigen- antibody interaction	Practice

UNIT-II Adaptive and Innate Immunity Antibodies: structure and function, monoclonal antibodies, single chain antibodies, domain antibodies, antigen antibody reactions, genetics of immunoglobulins and antibody diversity, Major Histocompatibility Complex, structure and functions of class I and class II MHC molecules, antigen presentation by MHC and non MHC molecules.
(0.5 Credit)

Practicals(0.3 credit)

Sr. no.	Name of Practical	Nature
1	To perform RID (i) Solution making (ii) Incubation and observation	Practical
2	To perform Ouchterlony double diffusion. (i) Solutions making (ii) Preparation of Agarose layer (iii) Loading and incubation	Practical
3	To demonstrate antimicrobial activity of skin (i) To prepare media (ii) Making suspension of two strains of bacteria. (iii) Incubation and observation	Practical

UNIT-III Organ transplant Cytokines, in vivo regulation of immune responses, B and T cell activations, hypersensitivity, mucosal immunity, introduction to transplantation immunology tolerance, tumor immunology and vaccines.

(0.5 Credit)

Practicals(0.3 credit)

Sr. no.	Name of practical	Nature
1	To perform dot ELISA (i) Solution making (ii) Incubation and observation	Practical
2	To learn about the technique of RIA	Practical
3	To perform sandwich ELISA (i) Solution making (ii) Loading and incubation (iii) Observation and plotting graph	Practical

Recommended text books

1. Immunology: concepts and mechanics by Asha Sharma and Rajendra Kaushik. Oxford book company.

Reference book

- Kuby immunology by Richard A. Goldsby, Thomas J. Kindt and Barbara A. Osborne.

References/Correlation with Ancient Indian Literature:

- Suśruta 600 BC, SS. Sū chaps. 4, 15, 21 edited by Singhal et.al. Choukhamba Surbharati 2nd edition Varanasi/ Delhi, India, 2002"https://pdfs.semanticscholar.org/68ec/5838cad4c40baf2563699c8e1d2514249fea.pdf
- "Suśruta 600BC, SS Ci Chap. 27-30 edited by Singhal et al Choukhamba Surbharati 2nd edition Varanasi/Delhi, India 2002"https://ayushdhara.in/review/pdf/ayush_5218193.pdf
- "Sarangdhara 1300AD, Sarandhara samhita Choukhamba publications Varanasi/Delhi, India"http://www.carakasamhitaonline.com/mediawiki-1.32.1/index.php?title=Rasayana

V SEMESTER

Enzyme Technology **Credits-4**

Objective : Students will be able to understand the basic concepts of Enzyme technology including introduction of enzyme and enzyme kinetics, enzyme inhibition and regulation, Enzyme immobilization techniques and their applications, free and immobilized enzymes, extraction and application of commercially important enzymes in medicine and industrial purposes.

UNIT I Introduction to Enzyme kinetics Kinetics of single substrate enzyme catalyzed reactions, Michaelis-Menten equation, turnover number, Enzyme inhibition kinetics- competitive, non-competitive, and uncompetitive, allosteric enzyme inhibitiors and their kinetics and determination of Ki. General mechanisms of enzyme regulation.

(1 Credit)

UNIT II Concept of Immobilization and its applications Types of reactors used for enzyme catalysis for free and immobilized enzymes, Immobilized enzymes: Physical and chemicalmethods of immobilization, immobilization supports, kinetics of immobilized enzymes. effects of inhibitors, temperature and pH on immobilized enzyme catalysis and deactivation, Therapeutic, Diagnostic and Industrial applications of Immobilized enzymes.

(1 Credit)

Practicals(0.5 credit)

Sr. No.	Name of practical	Nature
1	Enzyme Immobilization (i) Preparation of Reagents (ii) Practice (iii) To perform the assay (iv) Observation and calculations	practical
2	To study physical and chemical method of Immobilization (i) Preparation of Reagents (ii) To perform the assay (iii) Observation and calculations	practical
3	Preparation of urease entrapped in alginate beads and determination of percent entrapment (i) Preparation of Reagents (ii)To perform the assay (iii)Observation and calculations	practical

UNIT III Application of Enzyme and Enzyme Biosensors Extraction of commercially important enzymes from natural sources; Commercial applications of enzymes in food, pharmaceutical and other industries; enzymes for diagnostic applications. Industrial production of enzymes. Use of enzymes in analysis types of sensing-gadgetry and methods. Case studies on application – chiral conversion, esterification etc.Applications of enzymes in analysis; Design of enzyme electrodes and case studies on their application as biosensors in industry, healthcare and environment, Immunoenzyme techniques, Concept of Isozymes, Ribozymes and Multienzyme substrate complex.

(1 Credit)

Practicals (0.5 credit)

Sr. no.	Name of practical	Nature
1	Determination of β-amylase activity in germinating barley seeds (i) Preparation of Reagents (ii) Practice (iii) To perform the assay (iv) Observations and calculations	Practical

2	Degradation of organic carbon compounds by enzymatic reactions (i)Reagent preparation (ii)Practice (iii)To perform the assay and observe for the results	Practical
3	To detect degraded enzymatic product by TLC (i)Reagent preparation (ii)Practice (iii)To perform the assay and observe for the results	Practical

Recommended Text Books :

1. N.S. Kulkarni -General Enzymology

Suggested Reference Books:

1. Travor and Palmer - Enzymology
2. A.L. Lehninger, D.L. Nelson, M.M. Cox, " Principles of Boichemistry", 3rd Edn., Worth Publishers.

References/Correlation with Ancient Indian Literature:

1. Asvalayana Grhya Sutra II 7 https://insa.nic.in/writereaddata/UpLoadedFiles/IJHS/Vol24_1_5_Supplement.pdf
2. Atharva Veda. X. 3http://www.sacred-texts.com/hin/sbe42/index.htm
3. Yajurvedahttp://www.sacred-texts.com/hin/yv/index.htm

Plant Biotechnology **Credits-4**

Objective : Students will be able to understand the basic concepts of plant biotech with introduction of plant tissue culture, various types of tissue culture media in plants and techniques of plant tissue culture for preparation oof disease free plants, production of secondary metabolites, construction of mapping, physical methods of gene transfer for the production of transgenic plants and Application of plant tissue culture.

UnitI Introduction to Plant tissue culture Historical perspectives, laboratory organization and tissue culture media. Cell, tissue and organ culture, cryopreservation, protoplast culture and applications. Plant regeneration and hardening, micropropagation of disease free plants.

(1 Credit)

Practical(0.4 credit)

Sr. no.	Name of practical	Nature
1.	To clean glassware and accessories used in plant tissue culture.	Practical
2.	Preparation of different types of tissue culture medium. (i) Preparartion of stock solutions and Growth hormones. (ii) MS media preparation and autoclave (iii) Inoculation explain in media	Practical
3.	In Vitro Multiplication of medicinal plant. (i) Preparation of media and autoclave. (ii) Inoculation of explants	Practical

Unit-II Techniques of tissue culture Somaclonal variation, production of haploid plants, biotransformation, production of secondary metabolites. Molecular markers and construction of maps, molecular breeding and DNA fingerprinting and IPRs and biosafety guidelines.

(1 Credit)

Practical(0.4 credit)

Sr. no.	Name of practical	Nature
1	Optimization of medium and explants for callus induction. (i) Preparation of media and autoclave. (ii) Inoculation of explants	Practical
2	To regenerate callus into disease free plant. (i) Preparation of media and autoclave.	Practical

	(ii) Inoculation of explants	
3.	Root initiation of invitro multiplicated shoots (i) Preparation of rooting media and autoclave (ii) Inoculation of explant	Practical
4	To maintain media for cell suspension culture so those to obtain disease free plants from single cells. (i) Preparation of liquid media for single cell culture. (ii) Inoculation and its incubation	Practical

Unit-III Applications of Tissue culture Physical methods of transfer of genes to plant, vectorless and vector mediated transformation, transgenic plants and their commercialization, development of insect resistance, herbicide, salt and draught resistance plants.

(1 Credit)

Practical(0.2 credit)

Sr. no.	Name of practical	Nature
1	To acclimatize the cultured plants in growth room so that they may able to grow in field/green house (i) Sterilization of soil (ii) Preparation of soil for plant transfer (iii) Transfer of tissue cultured plant in green house for acclimatization.	Practical
2	To produce haploid plant- Anther culture (i) Preparation of Nistch media (ii) Extraction of anther and microspore (iii) Inoculation of anther in media	Practical

Recommended text books:

1. Introduction to plant biotechnology- H.S. Chawla

Reference Books:

1. Plant biotechnology- M.K. Razdan

References/Correlation with Ancient Indian Literature:

(i) Atharva Vedas http://www.sacred-texts.com/hin/sbe42/index.htm
(ii) AitareyaBrihmana.https://insa.nic.in/writereaddata/UpLoadedFiles/IJHS/Vol24_1_5_Supplemendf

Bio- Entrepreneurship **Credits-3**

Objective : Students will be able to understand the role of state government in promoting entrepreneurship, various incentives, grants. Export Oriented Units, Creating Entrepreneurial Venture and Business Planning Process. Students will also learn about Environmental Analysis, Business Idea, Problems and Prospects, importance of Positioning a company, Case studies of Successful Entrepreneurial Ventures in Biotechnology, Capital Funding marketing and group discussion on negotiaton.

Unit- I Introduction & role of Entrepreneurs in Biotechnology Role of State Government in promoting Entrepreneurship. Introduction to various incentives Introduction to subsidies and grants. Export Oriented Units, Fiscal and Tax concessions available. Fundamentals of marketing and selling of Biotechnology. Creating and marketing the image of the biotechnology company. Effective advertising and marketing. Creating Entrepreneurial Venture .Group discussion on new entrepreneur Venture, Business Planning Process.
(1 Credit)

UNIT II Environment Analysis & Negotiation Environmental Analysis - Search and Scanning, Identifying problems and opportunities. Defining Business Idea. Basic Government Procedures to be

complied. Women Entrepreneurs, Reasons for Low / No Women Entrepreneurs. Role, Problems and Prospects. The Art of Negotiation Workable marketing and the strength of distribution.
(1 Credit)

UNIT III Different Ventures & Case Studies Power and importance of Positioning of a company name and product. Case studies of Successful Entrepreneurial Ventures in Biotechnology. Failed Entrepreneurial Ventures. Turnaround Ventures. Project Management Technical, Financial, Marketing, Personnel and Management Feasibility .Capital Fundingmarketing and lessons to be learned.Steps involved in commercialization of a biotechnological productCase Study.Group Discussion on negotiation.

(1 Credit)

Recommended text Books:

1. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies 1st Edition, Craig Shimasaki, Academic Press

Reference books:

- Handbook of Bioentrepreneurship ,Patzelt, Holger, Brenner, Thomas (Eds.),Springer-Verlag New York

References/Correlation with Ancient Indian Literature:

- The Sulba Sutras

Genetics **Credits-3**

Objective : This course will give student a brief knowledge about genetics, chromosomes, cell divisin, Mendelian principles and principle of independent assortment. Students will also learn about qualitative and quantitative traits, Penetrance & Expressivity Nature, gene interaction, Linkage and Crossing over, Control of Development and genetic material Organisation.

Unit I Mendelism What is Genetics? Heredity & Continuity of Life, History of Genetics-Landmarks, Chromosomes, Cell division-Mitosis and Meiosis Presence of DNA in Chromosomes Reproductive Cycle Mendelian Principles- Law of Segregation of Genes and Chromosomes Principle of Independent Assortment.

(1 Credit)

Practicals (0.4 credits)

Sr. no.	Name of practical	Nature
1	Preparation of slide of polytene chromosome from Chironomous larva.	Practical
2	To study meiosis in grasshopper testis	Practical
3	Study of barr bodies.	Practical

Unit II Gene interaction Multiple factor Inheritance-Qualitative and Quantitative traits Heredity & Environmental effects Allelism and Pleiotropism Lethal genes, Penetrance & Expressivity Nature-Nurture problem in Man Sex linked Inheritance. Gene interactions - Incomplete Dominance, Co Dominance, Epistasis, supplementary genes, complementary genes and duplicate genes.
(0.5 Credit)

Practicals(0.4 credits)

Sr. no.	Name of practical	Nature
1	To study different phases of mitosis &Meiosis through slides.	Practical
2	To study different phases of Meiosis through slides.	Practical

Unit-III Linkage & crossing over Linkage and Crossing over Genetic maps of Chromosomes Chromosomal Aberrations Spontaneous Mutation, Induced Mutation. Genes in Populations Crossing, Selfing, Inbreeding and Heterosis Genetic Control of Development Cytoplasm in Heredity & Environment Elements of Genetic System Bacteriophage, Prokaryotic and Eukaryotic genetics Organisation of Genetic material.

(0.5 Credit)

Practicals(0.2 credits)

Sr. no.	Name of practical	Nature
1	To solve genetics problem	Practical

Recommended text Books:

1. Genetics by Veer Bala Rastogi.
2. Genetics by B. D. Singh. Kalyani publishers.

Reference books:

1. Principles of genetics by Gardner.
2. Genetics: A conceptual approach by Benjamin

References/Correlation with Ancient Indian Literature:

- Sharma PV, editor. Caraka Samhita of Agnivesha (Text with English Translation) Sutra Sthana. Ch. XX, Ver. 1-25. I. Varanasi: Chaukhambha Orientalia; 1981. pp. 137–43. [Google Scholar]1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5688840/
- Sharma PV, editor. Susruta Samhita of sushruta. First edition. Sutrasthana, Ch. I, Ver. 1-41. I. Varanasi: Chaukhambha Visvabharati; 1999. pp. 3–28.1. file:///C:/Users/jvwu/Downloads/182-Article%20Text-545-1-10-20151215.pdf
- Rudras Adhityashttp://www.sacred-texts.com/hin/maha/index.htm

Animal Biotechnology **Credits-4**

Objective : This course will give student a brief knowledge about animal biotechnology, animal cell culture, types of media in animal cell culture, stem cell, cytotoxicity and viability test. Students will also learn about diagnosis, therapy and variation of disease in animals, transgenic animals' microinjection method, types of transgenic animals and importance of animal biotechnology.

UNIT-I Introduction of animal biotechnology and its terminology Animal cell culture, basic principles, serum free and serum based media, scaling-up, characterization and preservation of cell lines, cytotoxicity and viability assays. Stem cells, micromanipulation of embryos, and generation of modified stem cells.

(1 Credit)

Practicals (0.5 credits)

Sr. no.	Name of practical	Nature
1.	To prepare Dulbecco's BSS	Practical
2.	To prepare Hank's BSS	Practical
3.	To determine the optimum pH of trypsin	Practical

UNIT-II Techniques of Animal cell culture Animal diseases, diagnosis, therapy, variations of diseases, modes of transmission of diseases, control and management of disease spreading. Transgenic animals, retroviruses and DNA microinjection method, transgenic mice, cattle, sheep, goat, pig, birds, knock in and knock out animals.
(1 Credit)

Practicals **(0.5 credits)**

Sr. no.	Name of practical	Nature
1.	To isolate serum from blood sample.	Practical
2.	To disaggregate tissue by the technique of warm trypsinization	Practical

UNIT-IIIApplications of animal biotechnology Importance of transgenic animals in biotechnology, valuable genes for animal biotechnology.
(1 Credit)

Recommended Text Books

1. Biotechnology- U. Satyanarayn

Reference books

- Culture of Animal Cells- R. Ian Freshney
- References/Correlation with Ancient Indian Literature:
- Ganguli, K.M. (1883-1896) "Adi Parva" in The Mahabharata of Krishna-Dwaipayana Vyasa (12 Volumes). Calcuttahttp://www.sacred-texts.com/hin/maha/index.htm

FERMENTATION TECHNOLOGY **Credits-3**

Objective : Students will be able to understand the basic concepts of fermentation technology. Students will learn about introduction of fermentation, Introduction of microbial process, alchoholic fermentation, microbial food products, production of fermented food like citric acid, gluconic acid, production of amino acids, organic acids and antibiotics from microorganisms by fermentation.

UNIT-I Introduction of Fermented Microbial Process Introduction and scope of microbial processes. Sources of industrial cultures and maintenance. Alcoholic fermentation: Production of Industrial Alcohol – Fermentation mechanism. Recent developments, brewing and malting, manufacture of wine and other distilled liquors. Microbial Foods – Food, Fodder and Bakers yeast, applications of the nonconventional raw materials (cellulosic material and hydrocarbons).
(1 Credit)

UNIT-IIProduction of fermented foods Organic acids: Production of acids, viz., citric, lactic and gluconic acid. Mechanism of each fermentation, their uses. Nutritional characteristics of food yeast, mushroom production. Vitamins- Vitamin B-2, Riboflavin, Soya-sauce & cheese production.
(1 Credit)

UNIT-III Production of Amino acids & Antibiotics Production of Amino acids (Lysine and glutamic acid) and Antibiotics (Penicillin, Streptomycin and Tetracycline) and its new Developments. Production of Organic Acids (Acetic acid and vinegar) its spoilage and prevention.
(1 Credit)

Recommended books:

1. Biotechnology: a textbook of industrial microbiology. Crueger and Crueger. 2nd ed. 2003. Panima publications.
2. Fermentation microbiology and biotechnology. Ed. El-mansi. 2nd ed. 2007. Taylor

References/Correlation with Ancient Indian Literature:

1. Brhadaranayakopanisat http://www.sacred-texts.com/hin/#other
2. Matsyapuranahttps://sanskritdocuments.org/sanskrit/purana/
3. Ramayanahttp://www.sacred-texts.com/hin/#other

Details of Training/Visit/Dissertation/Internship: Industrial Training (Jun- Aug) for Recent trend in food processing

VI SEMESTER

MOLECULAR THERAPEUTICS **Credits-4**

Objective : Students will be able to understand the basic concepts of molecular therapeutics. Students will learn about gene therapy, gene delivery, gene transfer technology, gene delivery, stem cell therapy. Students will also learn about recombinant therapy and application of recombinant technology, gene silencing technology and ethical issues in cloning.

Unit IGene therapy Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome and nanoparticles mediated gene delivery. Cellular therapy; Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells & Concept of tissue engineering.

(1 Credit)

Practical (1.0 credits)

S. No.	Name of practical	Nature
1	Restriction digestion and mapping of DNA	Practical
2	Isolation of total RNA from various sources and gel electrophoresis	Practical
3	Design of primers and PCR	Practical

Unit IIRecombinant Therapy Recombinant therapy; Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors.
(1 Credit)

Unit III Gene Silencing Gene silencing technology; Antisense therapy; si RNA; Tissue and organ transplantation; Transgenics and their uses; Cloning; Ethical issues.
(1 Credit)

Texts/References:

1. Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
2. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, Edition, Sringer, 2008.

References/Correlation with Ancient Indian Literature:

- The Rigveda, A Historical Analysis, by Shrikant G. Talageri, Aditya Prakashan, New Delhi. http://www.sacred-texts.com/hin/rigveda/index.htm
- Yajurvedahttp://www.sacred-texts.com/hin/yv/index.htm
- Asvalayana Grhya Sutra II 7https://www.hinduwebsite.com/sacredscripts/hinduism/grihya/asva.asp

Behavioral Science **Credits-2**

Objective : This course will give student a brief knowledge about introduction of animal behavior, Animal Behaviour and Environment, .Characteristics for instincts.Sign or key stimulus or Releasers, Behaviour genetics and Evolution of behavior. Students will also learn about Sociobiology, Altruis, Aggressive behavior, Strategies in animals, Feeding Strategies in animals, Communication Patterns, Types of communication, Identification of individuals and Role of animal behavior in Biodiversity conservation.

UNIT – I Introduction to animal behavior Introduction to animal behavior.Ethology and Branches of animal behavior.Significance of study of Animal Behaviour.Animal Behaviour and Environment.Concepts and Patterns- Introduction,Motivation,Fixed action Patterns or Instinctive Behaviour.Constancy or Stereotype and Resistant to phylogenetic changes.Need sign stimulus for release.Characteristics for instincts.Sign or key stimulus or Releasers.Innate releasing mechanism.Action specific Energy.Physiological Basis.Learning or Experience,Imprinting,Behaviour genetics,Evolution of behavior.

(1 Credit)

Unit-II Sociobiology Sociobiology- Definition, Units of Sociobiology, Altruism, Eusociality,Cooperation,Reciprocation,Selfish and spite,Aggressive behaviour patterns,Types and causes of Aggression- Xenophobia,Proximate and Crowding,Space and Seasonal changes,Previous experience and Social status,Food and Nest,Food sharing, Feeding Strategies in animals, Confuse the Predator, Cooperation/Reciprocation;Selfishne.
(0.5 Credit)

Unit-III Brain Behavior and communication Communication Patterns,Types of communication, Patterns of parental care,Types of Parental care,Courtship Patterns,Neurophysiological technique,Neurochemical,Studies in wild,Sampling, Identification and Naming of individuals,Identification and Naming of individuals,Neural mechanism of Learning. Role of animal behavior in Biodiversity conservation.
(0.5 Credit)

Recommended text Book:

1. Animal Behavior : Dr. Reena Mathur - Rastogi Publications.

References/Correlation with Ancient Indian Literature:

- Chandogya Upanishad VI.6.5https://sanskritdocuments.org/sanskrit/upanishhat/
- Chandogya Upanishad, Vi.6.1 & 2https://sanskritdocuments.org/sanskrit/upanishhat/
- Gita,17.7http://www.sacred-texts.com/hin/index.htm#gita

Biosafety, Bioethics and IPR **Credits-3**

Objective : This paper develops concepts a holistic and comprehensive regulatory approach to ensure biosafety would be based on the precautionary principle, covering the entire range of activities from research and development of GMOs to their commercialization, and post-release monitoring.

UNIT I General Introduction to Biosafety Introduction to Bioethics and Biosafety: Need of bioethics, Definition of bioethics, application to bioethics. Introduction to Biosafety: Need, Definition and applications.Biosafety guidelines and regulations: Introduction, Biosafety guidelines in india, Regulation specific to biotechnology companies and research institutes, Aims of the National institute of health (NIH) guidelines.
(1 Credit)

UNIT II GLP and international Organization Good laboratory practices: Introduction, definition, test facility organization and personnel, Quality assurance program, Apparatus materials and reagents. Good manufacturing practices and its applicability. International organization and intellectual property rights: Worde trade organization(WTO), General Agreement on Tariff and Trade (GATT) and its different articles, main features of Trade- Related Aspects of Intellectual Property Rights (TRIPS).
(1 Credit)

UNIT III IPR Introduction to Patent and process involve in patenting: Introduction, History of Indian patent system and law, Patenting authorities, Essential requirements for patenting, Types of patent, Requirements of Patent , Things that are patentable, Things that are non patentable, The procedure involved in Patent Application and Granting of a Patent, Patents in India, Drug Patents in India, Various types of Patent applications in India, patent search, patent Coorperation treaty, patents and compulsory Licencing, Procedure for the grant of Compulsory Licence, Impect of IPR or patenting on Biodiversity Rich Developing Countries, Farmer's Right, Applications for plant breeder's Rights, Impact of plant Variety Protection.
(1 Credit)

Recommended Text Books:

1. Biosafety and Bioethics- M.K. Satish

References/Correlation with Ancient Indian Literature:

- Atharva Vedahttp://www.sacred-texts.com/hin/yv/index.htm
- CharakaSamhita 1. file:///C:/Users/jvwu/Downloads/182-Article%20Text-545-1-10-20151215.pdf
- Somavedahttp://www.sacred-texts.com/hin/yv/index.htm

RESEARCH METHODOLOGY **Credits-3**

Objective : Students will be able to understand the basic concepts of research methodology including meaning and objectives of research, types of research, various research criteria, research problem, research design, measurement and scaling techniques in research, various scaling techniques in research, methods of data collection in research and report writing of research.

UNIT – I Introduction & Types of research Research methodology: Introduction & meaning of research, Objectives of research, motivation in research. Types of research & research approaches. Research methods vs. methodology, Criteria for good research. Research problem: Statement of research problem, Statement of purpose and objectives of research problem, Necessity of defining the problem.
(1 Credit)

UNIT – II Research design Research design: Meaning of research design, Need for research design, Features for good design, Different research designs, Basic principles of research design.
Measurement & scaling techniques: Measurement in research- Measurement scales, sources of error in measurement, Technique of developing measurement tools, Meaning of scaling, its classification, important scaling techniques.
(1 Credit)

UNIT – III Methods of data collection Methods of data collection: collection of primary data, collection data through questionnaires& schedules, Difference between questionnaires & scheduleReport Writing.

(1 Credit)

Recommended Text Books:

1. Kothari CR (2004). Research Methodology: Methods and Techniques, New Age International.
2. Bhattacharya DK (2009). Research Methodology, Excel Books.

Reference Text:

1. Annals of Food Science & Technology
2. Journal of Nutrition
3. Journal of Food Science & Technology

References/Correlation with Ancient Indian Literature:

1. V¡jasaneyisamhitahttp://www.sacred-texts.com/hin/#other
2. Vishnu Puranahttps://sanskritdocuments.org/sanskrit/purana/
3. Shabdhakalpadrumahttp://www.sacred-texts.com/hin/#other

Down Stream Processing **Credits-4**

Objective : This course develops concepts of management and controls on the microbial processes in industrial settings. Ability the principles of physiological understanding in improvement of industrial processes.

Unit- I Cell disruption method Various downstream process steps, Fundamental principles of obtaining the product from cell cultures – intracellular vs. extra-cellular product; Cell disruption – mechanical, enzymatic, and chemical methods; Pre-treatment strategies; Solid-liquid separation – filtration and centrifugation.

(1 Credit)

Practicals (0.5 credits)

Sr. no.	Name of practical	Nature
1	To determine the ability of Microorganisms to degrade and ferment carbohydrates with the production of acid or acid and gas.	Practical

Unit-II Chromatographic separation Adsorption; Liquid-liquid extraction; Membrane separation – ultrafiltration and reverse osmosis, dialysis etc; Precipitation of proteins by different methods; Chromatograph – principles, instruments and practice. Membrane based separation; Dialysis, Electrodialysis; Micro filtration and Ultra filtration.
(1 Credit)

Practical **(0.5 credits)**

Sr. no.	Name of practical	Nature
1	To test the presence of enzyme responsible for fat hydrolysis in given bacterial culture.	Practical

Unit-IIICrystallization & drying of products Crystallization: Supersaturation , Nucleation Growth of Crystals and Precipitation.Common Methods for Crystallization and crystal mounting. Drying: Difference between drying and evaporation,Classification of dryers and its application.
(1 Credit)

Recommended Text Book:

1. Principles of Fermentation Technology: Peter F. Stanbury, S. Hall and A. Whitaker Butterworth-Heinemann

References Books:

1. Biotechnology - a handbook of industrial microbiology: W. Crueger and A. Crueger
2. Industrial Microbiology: L.E. Casida, Willey Eastern Ltd., 1989.
3. Industrial Microbiology: Prescott & Dunn, CBS Publishers, 1987.

Microbial Technology **Credits-3**

Objective : This course deals with characteristics, properties and biological significance of the biomolecules of life. In depth knowledge of the energetic and regulation of different metabolic processes in microorganisms.

Unit ITechniques in Microbial Technology: Isolation of industrially important microorganism from different sources using specific substrates; Design and Preparation of Media for Bioprocesses; Growth curve studies of bacteria/Yeasts in batch culture and calculation of maximum specific growth rate; To study the various methods of biomass measurement.
(1 Credit)

Practicals **(0.5 Credits)**

Sr. no.	Name of practical	Nature
1	Purify the given bacterial sample by serial dilution method	practical
2	Perform Gram's staining in given bacterial sample	Practical

Unit IIBasic principle and methods of sterilization: Control of micro organism by physical methods, heat, filtration, radiation, chemical methods, phenolics, alcohols, halogens, heavy metals, aldehydes and gases, evaluation of antimicrobial agent effectiveness, principal and functioning of LAF.

(0.5 Credit)

Practicals **(0.5 Credits)**

Sr. no.	Name of practical	Nature
1	Isolation of industrially important microorganisms	Practical
2	Study the bacterial growth curve with complete phases	Practical
3	Isolation of microorganisms from cheese samples	Practical

Unit IIIIndustrial production: Production of ethanol from sucrose by yeast; To study the design of fermenter and its working; Production of citric acid using sucrose and molasses; Production of extracellular enzymes ; Ethanol production using immobilized yeast culture.
(0.5 Credit)

Recommended Text Books

1. L. M. Prescott, J. P. Harley and D. A. Klein. Microbiology-, McGraw Hill
2. General Microbiology- A.N.Panikar

Suggested Readings:

1. N. J. Pelczar, S. Chand, R. Krieg. Microbiology- Tata McGraw Hill
2. Casida, Industrial microbiology-, L.E. New age international Ltd, Publishers. New Delhi:
3. Frazier, Food microbiology. W.C. Tata McGraw Hill.
4. Carr NG & Whitton BA. 1982. The Biology of Cyanobacteria. Blackwell.
5. Bergerson F J. 1980. Methods for Evaluating Biological Nitrogen Fixation. John Wiley & Sons.

References/Correlation with Ancient Indian Literature:

- Rigveda1/191/9http://www.sacred-texts.com/hin/rigveda/index.htm
- Rasa-]ala-Nidhi or Ocean of Indian chemistry and alchemy/vol.vIEd.1984/AvaniPrakashan,Ahmedabad,India;CharakSamhita http://www.carakasamhitaonline.com/mediawiki-1.28.2/index.php?title=Main_Page
- AvS'5/23/5;Medicine in the Veda Ikenneth Zyskhttp://www.new.dli.ernet.in/handle/2015/201547

References/Correlation with Ancient Indian Literature:

- Atharva Vedas http://www.sacred-texts.com/hin/yv/index.htm

Agricultural Biotechnology **Credits-3**

Objective : This course develops the concepts of understanding & manipulating the genetic make up of agricultural products to increase its productivity & efficiency. Courses based on this subject cover the study of optimum crop yield, increased nutrition & taste of produces, reducing use of chemicals in agriculture, etc.

UNIT I Brief idea of Agriculture Histrory of agricultural development in India. Current production , utilization and growth trends of agricultural commodities in India and abroad. Status of Indian Horticulture, fruits, vegetables, floriculture, post- harvest quality issues, value chain, quality seed production.
(1 Credit)

UNIT II Transgenic plants: Utility of transgenics in basic studies and in crop improvement (resistance for herbicides, viruses, insects and abiotic stresses; molecular farming for production of foreign proteins and edible vaccines; Use of antisense RNA and other technologies, biosafety issues including risks associated with transgenic crops; biosafety regulations.

(1 Credit)

UNIT III Stress Resistance Plant: Salt tolerance, freezing tolerances, chilling tolerance, and drought. Modern approaches of management of pest and diseases. Pesticides: groups, mode of action, application methods and pesticide interactions.

(1 Credit)

Recommended text book:

1. Plant biotechnology by K. G .Ramavat

References Books:

1. Swaminathan, MS (1991). Biotechnology in Agriculture – A dialogue. MacMillan India, New Delhi.
2. Gupta, PK (2004). Biotechnology and Genomics. Rastogi Publications, Meerut

References/Correlation with Ancient Indian Literature:

- Debroy, B. (2010) The Mahabharata, Volume 1. Gurgaon: Penguin Books India, pp xxiii - xxvihttp://www.sacred-texts.com/hin/maha/index.htm
- Dutt, M.N. (1895) The Mahabharata (Volume 1): Adi Parva. Calcutta: Elysium Presshttp://www.sacred-texts.com/hin/maha/index.htm
- "Book 1: Adi Parva: Jatugriha Parva". Sacred-texts.com. Retrieved 1 September 2010http://www.sacred-texts.com/hin/maha/index.htm

Applied Recombinant DNA technology **Credits-3**

Objective : Students will be able to understand the basic concepts of recombinant DNA technology including transgenic animals, methods of production of transgenic animals and animal cloning. Students will be able to understand advanced technique in recombinant technology including FISH, RAPD, RFLP, gene silencing gene transfer technology and gene therapy, DNA chips mutagenesis and gene knockout techniques.

Unit I Transgenic animals Brief idea about tools of recombinant DNA technology. Transgenic animals: methods for production (microinjection method, embryonic stem cells method and retrovirus mediated method), applications of transgenic animals. Animal cloning: methods for production and significance of clones.
(0.5 Credit)

Unit IIAdvanced techniques in recombinant DNA technology Gene augmentation, oligonucleotide synthesis, FISH, RAPD, RFLP, DNA fingerprinting and their applications for diagnosis of disease, site-directed mutagenesis, Gene silencing, Gene transfer technologies, Gene therapy; Molecular basis of genetic diseases, genetic counseling.
(1 Credit)

Practicals(1credits)

Sr. no.	Name of practical	Nature
1.	To learn about FISH	Practice
2.	To perform the technique of RAPD (i) Isolation of genomic DNA (ii) Amplification of genome (iii) Gel electrophoresis of amplified product	Practical
3.	To perform the technique of RFLP (i) Isolation of genomic DNA (ii) Restriction digestion of genome (iii) Gel electrophoresis of digested product (iv) Blotting (v) Autoradiography	Practical
4.	To learn principle and operating procedure of microprojectile.	Practice

Unit IIIAdvanced techniques in recombinant DNA technology Functional genomics: DNA chips, microarray and gene screen technology; site directed mutagenesis, gene knockout techniques, cell culture based techniques. Genetically modified organisms and their significance.
(0.5 Credit)

Recommended text books

1. Genetic engineering by Smitha Rastogi and Neelam Pathak.

Reference books

1. Gene cloning and DNA analysis by T. A. Brown

References/Correlation with Ancient Indian Literature:

- Sharma PV, editor. Caraka Samhita of Agnivesha (Text with English Translation) Sutra Sthana. Ch. XX, Ver. 1-25. I. Varanasi: Chaukhambha Orientalia; 1981. pp. 137–43. [Google Scholar] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5688840/
- Sharma PV, editor. Susruta Samhita of sushruta. First edition. Sutrasthana, Ch. I, Ver. 1-41. I. Varanasi:Chaukhambha Visvabharati; 1999. pp. 3–28.
- file:///C:/Users/jvwu/Downloads/182-Article%20Text-545-1-10-20151215.pdf
- Rudras Adhityas https://sreenivasaraos.com/2012/09/29/the-rudras-eleven/