DEPARTMENT OF ZOOLOGY AND BIOTECHNOLOGY

HNB GARHWAL UNIVERSITY

SRINAGAR GARHWAL

COURSE CONTENT AND SYLLABUS

OF

B. Sc. BIOTECHNOLOGY (Add on Course with C,B,Z)

AS PER CBCS SYSTEM (Based on UGC pattern)

WEF: 2015-16

Core Courses: Biotechnology

1. Biochemistry & Metabolism (1^{st} semester)
2. General Biotechnology (2^{nd} semester)
3. General Microbiology (3^{rd} semester)
4. Immunology (4^{th} semester)

Discipline Specific Electives: Biotechnology (Any two)

–One each in 5^{th} and 6^{th} semester

1. Bioinformatics
2. Animal Biotechnology
3. Plant Biotechnology
4. Environmental Biotechnology
5. Medical microbiology

Ability Enhancement Compulsory Courses

1. English/MIL Communication (1^{st} semester)
2. Environmental Science (2^{nd} semester)

Skill Enhancement Courses (Any four) - Biotechnology

(One each in 3^{rd} , 4^{th} , 5^{th} and 6^{th} semester

1. I.P.R. Entrepreneurship, Bioethics and bio-safety
2. Molecular Diagnostics
3. Enzymology
4. Bioprocess Technology
5. Basics of Forensic science
6. Cell and Tissue culture

SYLLABUS OF 1ST SEMESTER (Biotechnology)

Core Course: Biotechnology I (1st semester) Biochemistry & Metabolism

(Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

UNIT I:

Introduction to Biochemistry: A historical prospective. Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

Carbohydrates:Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

UNIT II

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol. Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.

UNIT III

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD+, NADP+,FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions.

UNIT IV

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

PRACTICALS

1.To study activity of any enzyme under optimum conditions.
2.To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3.Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4.Estimation of blood glucose by glucose oxidase method.
5.Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein.
(ii) To study relation between absorbance and % transmission.
6.Preparation of buffers.
7.Separation of Amino acids by paper chromatography.
8.Qualitative tests for Carbohydrates, lipids and proteins

SYLLABUS OF 2nd SEMESTER (Biotechnology)

Core Course: Biotechnology II

General Biotechnology (Credits: Theory-4, Practical 2)

THEORY **Lectures: 60**

UNIT I:

Definition and scopes; Fundamentals of Genetic engineering (Isolation of DNA, Cutting of DNA and Sorting out of DNA pieces, PCR and Cloning). Instrumentation used in Biotechnology: Autoclave, Laminar air flow, Centrifuge, Water baths, Ovens, PCR

UNIT II:

Laboratory requirements for animal cell culture, media preparation, Serum and serum free media, culture vessels. Primary culture and Cell lines Adhesion, proliferation and differentiation of cultures cells.

UNIT III:

General idea of the production of transgenic animals. Production of transgenic plants: marker genes and various gene transfer methods. Applications of transgenic animals and plants

UNIT IV

Biotechnological innovations in the area of medical, agriculture, industrial and forensic sciences.

Practicals:

Working mechanism of Instruments: Autoclave, Laminar air flow, Centrifuge, Water baths, Ovens, PCR

Isolation of DNA, Gel electrophoresis.

Comments on Biotechnological innovations, transgenic animals and plants, cloning, PCR etc.

Media preparation.

SYLLABUS OF 3rd SEMESTER (Biotechnology)

Core Course: Biotechnology III

General Microbiology

(Credits: Theory-4, Practicals-2)

THEORY **Lectures: 60**

UNIT I

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation

UNIT III

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT IV

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Pr eservation of various types of foods. Fermented Foods.

PRACTICALS

1.Isolation of bacteria & their biochemical characterization.
2.Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3.Preparation of media & sterilization methods,Methods of Isolation of bacteria from different sources.
4.Determination of bacterial cell size by micrometry.
5.Enumeration of microorganism - total & viable count.

SYLLABUS OF 4th SEMESTER (Zoology)

Core Course: Biotechnology I V

Immunology

(Credits: Theory-4, Practicals-2)

THEORY **Lectures: 60**

UNIT I

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, Tlymphocytes
& immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT II

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes,
allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT III

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT IV

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

PRACTICALS

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

Discipline Specific Elective Biotechnology
(Any one in Vth and VIth semester)

Bioinformatics (DSEBt-01)
(Credits: Theory-4, Practicals-2)

THEORY **Lectures: 60**

UNIT I
History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II
Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web.
Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT III
Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT IV
Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission.
Genome Annotation: Pattern and repeat finding, Gene identification tools.

PRACTICALS
1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

Discipline Specific Elective Biotechnology
(Any one in Vth and VIth semester)

Animal Biotechnology (DSEBt-02)
(Credits: Theory-4, Practicals-2)

THEORY

Lectures: 60

UNIT I
Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

UNIT II
Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT III
Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV
Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

PRACTICALS
1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization

2. Sources of contamination and decontamination measures.

3. Preparation of Hanks Balanced salt solution

4. Preparation of Minimal Essential Growth medium

5. Isolation of lymphocytes for culturing

6. DNA isolation from animal tissue

7. Quantification of isolated DNA.

8. Resolving DNA on Agarose Gel.

Discipline Specific Elective Biotechnology
(Any one in Vth and VIth semester)

Plant Biotechnology (DSEBt-03)
(Credits: Theory-4, Practicals-2)

THEORY **Lectures: 60**

UNIT I
Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT- II
In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT - III
Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclautre, methods, applications basis and disadvantages.

UNIT - IV
Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

PRACTICALS
1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.

2. Preparation of complex nutrient medium (Murashige & Skoog's medium)

3. To selection, Prune, sterilize and prepare an explant for culture.

4. Significance of growth hormones in culture medium.

5. To demonstrate various steps of Micropropagation.

Discipline Specific Elective Biotechnology
(Any one in Vth and VIth semester)

Environmental Biotechnology (DSEBt-04)
(Credits: Theory-4, Practicals-2)

THEORY **Lectures: 60**

UNIT I
Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol

UNIT II
Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

UNIT III
Treatment of municipal waste and Industrial effluents. Bio-fertilizers
Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT IV
Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

PRACTICALS
1. Calculation of Total Dissolved Solids (TDS) of water sample.

2. Calculation of BOD of water sample.

3. Calculation of COD of water sample.

4. Bacterial Examination of Water by MPN Method.

Discipline Specific Elective Biotechnology
(Any one in Vth and VIth semester)

Medical Microbiology (DSEBt-05)
(Credits: Theory-4, Practicals-2)

THEORY **Lectures: 60**

UNIT I
Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.
Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus*, *S.pyogenes*, *B.anthracis*, *C.perferinges*, *C.tetani*, *C.botulinum*, *C.diphtheriae M.tuberculosis*, *M. leprae.*

UNIT II
Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli*, *N. gonorrhoea*, *N. meningitidis*, *P. aeruginosa*, *S. typhi*, *S. dysenteriae*, *Y. pestis*, *B. abortus*, *H. influenzae*, *V. cholerae*, *M. pneumoniae*, *T. pallidum M. pneumoniae*, *Rickettsiaceae*, *Chlamydiae*.

UNIT III
Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT IV
Fungal and Protozoan infections. Dermatophytoses (*Trichophyton, Microsporun and Epidermophyton*) Subcutaneous infection (*Sporothrix*, *Cryptococcus*), systemic infection (*Histoplasma*, *Coccidoides)* and opportunistic fungal infections (*Candidiasis*, *Aspergillosis*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

PRACTICALS
1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.

2. Growth curve of a bacterium.

3. To perform antibacterial testing by Kirby-Bauer method.

4. To prepare temporary mounts of Aspergillus and Candida by apprpriate staining.

5. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

SKILL ENHANCEMENT COURSES
(One each in 3rd, 4th, 5th, and 6th semester, if opted from Biotechnology)
(Credits 2)

I.P.R., ENTREPRENEURSHIP BIOETIHCS & BIOSAFETY

(SECBt-01)
(Credits: Theory-4, Practicals-2)

THEORY **Lectures: 30**

UNIT-I

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology

UNIT II

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc..

UNIT III

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

UNIT IV

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

SKILL ENHANCEMENT COURSES

Molecular Diagnostics (SECBt-02)

(CREDITS 2)

LECTURES: 30

UNIT I

Enzyme Immunoassays:

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology.

UNIT II

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures.

UNIT III

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT IV

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

SKILL ENHANCEMENT COURSES
Enzymology (SECBt-03)
(Credits 2)

Lectures: 30

UNIT - I

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

UNIT – II

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation,
Different plots for the determination of Km and Vmax and their physiological significance.

UNIT – III

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

UNIT – IV

Enzyme Technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry.

SKILL ENHANCEMENT COURSES
BIOPROCESS TECHNOLOGY (SECBt-04)
Credits 2 **Lecture - 30**

UNIT I

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT II

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT III

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

SKILL ENHANCEMENT COURSES

BASICS OF FORENSIC SCIENCE (SECBt-5)

Credits 2 **Lecture - 30**

Unit I

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Unit II

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Unit III

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

Unit IV

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

SKILL ENHANCEMENT COURSES

CELL AND TISSUE CULTURE (SECBt-6)

Credits 2 **Lecture - 30**

UNIT-I

Historical background and terminology used in cell and tissue culture.
Laboratory organization, equipments and materials used for plant tissue culture, green house, types and composition of media, sterilization techniques.
General account of Cytodifferentitation, organogenic differentiation, seed culture, embryo culture, callus culture, organ culture, cell and protoplast culture

UNIT-II

Somatic embryogenesis and organogenesis in plants, somaclonal variations.
In vitro production of haploids: Anther culture, microspore culture, ovary culture and ovule culture.
Micropropagation, production of secondary metabolites through plant tissue culture.

UNIT-III

Laboratory requirements for animal cell culture, media preparation, Serum and serum free media, culture vessels.
Primary culture and Cell lines Adhesion, proliferation and differentiation of cultures cells.

UNIT-IV

Monolayer, suspension and immobilized culture. Large scale cultivation of animal cells, idea of bioreactors for animal cell cultivation.