



Department of Biotechnology

Integrated 5 Years M.Sc. Biotechnology

Course Contents

&

Syllabus



Hemvati Nandan Bahuguna Garhwal University
(A Central University)

Srinagar, Garhwal, 246 174, Uttarakhand



Integrated 5 Years M. Sc. Biotechnology

Code	Course Contents		MM
Semester I (July to November)			
IBTC 01	I	Biodiversity I	100
IBTC 02	II	Biodiversity II	100
IBTC 03	III	Elementary Biochemistry	100
IBTC 04	IV	Elementary Chemistry I	100
IBTC 05	V	Lab Course based on paper I & II	100
IBTC 06	VI	Lab Course based on paper III & IV	100
Total			600
Semester II (December to April)			
IBTC 07	VII	Biodiversity III	100
IBTC 08	VIII	Biodiversity IV	100
IBTC 09	IX	Elementary Cell Biology & Immunology	100
IBTC 10	X	Elementary Chemistry II	100
IBTC 11	XI	Lab Course based on paper VII & VIII	100
IBTC 12	XII	Lab Course based on paper IX & X	100
Total			600
Semester III (July to November)			
IBTC 13	XIII	Evolution & Introduction to Developmental Biology	100
IBTC 14	XIV	Fundamentals of Computers	100
IBTC 15	XV	Introductory Biotechnology	100
IBTC 16	XVI	Chemistry I	100
IBTC 17	XVII	Lab Course based on paper XIII & XIV	100
IBTC 18	XVIII	Lab Course based on paper XV & XVI	100
Total			600
Semester IV (December to April)			
IBTC 19	XIX	Growth & Reproduction	100
IBTC 20	XX	Hormonal System	100
IBTC 21	XXI	Fundamental Microbiology, Environmental Biotech & Fermentation Technology	100
IBTC 22	XXII	Chemistry II	100
IBTC 23	XXIII	Lab Course based on paper XIX & XX	100
IBTC 24	XXIV	Lab Course based on paper XXI & XXII	100
Total			600
Semester V (July to November)			
IBTC 25	XXV	Environmental Science	100
IBTC 26	XXVI	Differentiation & Morphogenesis	100
IBTC 27	XXVII	Animal Physiology	100
IBTC 28	XXVIII	Industrial Biotechnology & Bioprospecting	100
IBTC 29	XXIX	Lab Course based on paper XXV & XXVI	100
IBTC 30	XXX	Lab Course based on paper XXVII & XXVIII	100
Total			600
Semester VI (December to April)			
IBTC 31	XXXI	Economic Biology & Animal Behavior	100
IBTC 32	XXXII	Plant Physiology	100
IBTC 33	XXXIII	Elementary Biomaths & Biostatistics	100
IBTC 34	XXXIV	Fundamentals of Genetics & Molecular Biology	100
IBTC 35	XXXV	Lab Course based on paper XXXI & XXXII	100
IBTC 36	XXXVI	Lab Course based on paper XXXIII & XXXIV	100
Total			600



Semester VII (July to November)			
IBTC 37	XXXVII	Biochemistry	100
IBTC 38	XXXVIII	Cell Biology & Membrane Biophysics	100
IBTC 39	XXXIX	Molecular Biology & Genetics	100
IBTC 40	XL	Bio-Analytical Techniques	100
IBTC 41	XLI	Lab Course based on paper XXXVII & XXXVIII	100
IBTC 42	XLII	Lab Course based on paper XXXIX & XL	100
Total			600
Semester VIII (December to April)			
IBTC 43	XLIII	Immunology	100
IBTC 44	XLIV	Microbiology & Microbial Genetics	100
IBTC 45	XLV	Genetic Engineering & Applications	100
IBTC 46	XLVI	Biostatistics & Bioinformatics	100
IBTC 47	XLVII	Lab Course based on paper XLIII & XLIV	100
IBTC 48	XLVIII	Lab Course based on paper XLV & XLVI	100
IBTSS 01		Epigenetics & Cancer Biology	100
IBTSS 02		Biomedical Technology	100
Total			600
Semester IX (July to November)			
IBTC 49	XLIX	Plant Biotechnology	100
IBTC 50	L	Intellectual Property Rights, Bioethics, Bio-Entrepreneurship	100
IBTE 01a	LI (a)	Protein engineering	100
IBTE 01b	LI (b)	Immunotechnology	100
IBTE 01c	LI(c)	Nanobiotechnology	100
IBTE 02a	LII(a)	Food & Beverages Biotechnology	100
IBTE 02b	LII(b)	Animal Biotechnology	100
IBTE 02c	LII(c)	Enzymology & Enzyme Technology	100
IBTC 51	LIII	Lab Course based on paper XLIX & L	100
IBTE 03	LIV	Lab Course based on paper LI & LII	100
IBTSS 03		Research Methodology: Tools & Techniques	100
IBTSS 04		Science Communication & Scientific Writing	100
Total			600
Semester X (December to April)			
IBTC 52	LV	Environmental Biotechnology	100
IBTC 53	LVI	Fermentation & Bioprocess Technology	100
IBTE 04a	LVII(a)	Advanced Bioinformatics	100
IBTE 04b	LVII(b)	Herbal Biotechnology	100
IBTE 04c	LVII(c)	Genomics & Proteomics	100
IBTC 54	LVIII	Lab Course based on course LV & LVI	100
IBTE 05	LIX	Dissertation	100
IBTSS 05		Vaccines & Drug Development	100
IBTSS 06		Molecular Virology	100
Total			500

Max. Marks (MM) for each paper: 100 (two Sessional Tests of 20 each+ 60 End Term Test)

Sessional Tests (Mid Term Test, Assignment, Tutorials, Classroom Seminar & Laboratory Work; Journal Club, Internship; Industrial/ Institutional Visits, winter/summer training based report writing & presentation)

M. Sc. Biotechnology (Integrated 5 Years) Program will have the following components, viz.

- Core Course (C)
- Electives Course (E)
- Self-study Course (SS)



Paper I: IBTC 01 Biodiversity I

No. of Credits = 3

UNIT- I

Definition of taxonomy and relationship with systematics 0.75
 Zoological nomenclature: Binomial, Trinomial
 Methodology in taxonomy: Morphological, Embryological, Cytogenetical, Molecular. Components of classification: Linnaean hierarchy. Species concepts
 Introduction to Non-Chordata – General characters.
 Protozoa: Salient features and outline classification up to classes.
 Study of *Euglena*, *Paramecium* and *Monocystis* with reference to locomotion, nutrition & reproduction. Parasitic protozoa.

UNIT- II

Origin of Metazoa. 0.5
 Porifera: Salient features and outline classification up to classes.
 Study of *Sycon* with reference to structure, reproduction.
 Cnidaria: Salient features and outline classification up to classes.
 Study of *Obelia* with reference to structure and reproduction.
 Corals and coral reefs.

UNIT- III

Platyhelminthes: Salient features and outline classification up to classes. 0.75
 Study of *Fasciola* with reference to structure, reproduction, life-cycle and parasitic adaptations.
 Nematelminthes: Salient features and outline classification up to classes.
 Study of *Ascaris* with reference to structure, reproduction and life-cycle and parasitic adaptations.

UNIT - IV

Annelida: Salient features and outline classification up to classes. 0.5
 Types and significance of coelom. Metamerism and its significance.
 Study of *Nereis* with reference to structure and reproduction. Parasitic adaptations of *Hirudinaria*.
 Arthropoda: Salient features and outline classification up to classes & economic importance.

UNIT- V

Mollusca: Salient features and outline classification up to classes. 0.5
 Study of *Unio* with reference to structure and reproduction.
 Introduction to Pearl Industry.
 Echinodermata: Salient features and outline classification up to classes.
 Study of *Asterias* with reference to structure, mode of feeding and reproduction.

Books Recommended:

1. Mayr: Principles of Systematic Zoology. McGraw-Hill, 1977
2. Barnes : Invertebrate Zoology (4th ed.), Holt-Saunders, 1980.
3. Barrington : Invertebrate Structure and function, Nelson, 1987.
4. Iyer: A Manual of Zoology, Part I. Visawanathan, 1973.
5. Hickman, Roberts & Hickman: Integrated principles of Zoology (7th ed) Times-Mirror, Mosby, 1984.
6. Kotpal, Agrawal & Khetrapal: Modern Text-book of Zoology, Invertebrates. Rastogi, 1976.



Paper II: IBTC 02 Biodiversity II

No. of Credits = 3

UNIT I

General introduction to classification of plant kingdom. 0.75
 Classification of algae, basic outlines (Fritsch's and Smith's classification).
 Ecology of Algae: A brief idea of fresh water, marine and terrestrial algae, epiphytic, parasitic and symbiotic algae.
 Economic importance of Algae as food and fodder in agriculture, industry and in public health.

UNIT II

Blue green algae: A general account (Nostoc and Spirulina). 0.5
 Chlorophyceae: Salient features (*Chlamydomonas*, and *Vaucheria*)
 Phaeophyceae: Salient features (*Sargassum* and *Ectocarpus*).
 Rhodophyceae: Salient features and general account (*Polysiphonia*).

UNIT III

General introduction and salient features of fungi. 0.75
 Outlines of classification of *Alexopoulos* and salient features of the important groups.
 Habit, habitat, structure and mode of reproduction of *Phytophthora*, *Sacharomyces*, *Penicillium*, *Puccinia* and *Alternaria*.

UNIT IV

Lichens: General structure, types and occurrence. 0.5
 Nutrition and reproduction in lichens with special reference to *Parmella*.
 Economic importance of Lichens.

UNIT V

Plant Pathology: Definition and general symptoms of plant diseases. 0.5
 General principles of infection and resistance.
 General methods of chemical and biological control of the plant diseases.

**Paper III: IBTC 03 Elementary Biochemistry**

No. of Credits = 3

UNIT I

Introduction to Bio molecules, Molecular Interactions as a basis for buffers
biological function, importance of noncovalent bonds in biological system
Water: structure, properties and water as solvent
pH and buffers 0.5

UNIT II

Carbohydrates: Definition, classification, structure and importance of
monosaccharide and oligosaccharides. 0.75
Polysaccharides: Homopolysaccharides and Heteropolysaccharides,
Storage and Structural Polysaccharides

UNIT III

Lipids: Structure, classification and properties of oils & fats, 0.75
Types of fatty acids, cholesterol structure and properties.
Vitamins: Water and fat soluble vitamins, structure, functions and deficiency symptoms.

UNIT IV

Proteins: Structure, classification and Properties of Amino Acids., Peptides, Peptide bond 0.5
Protein Structure: Primary, Secondary, Tertiary and quaternary structure,
Determination of Primary structure.

UNIT V

Protein types: Globular and Fibrous. Protein Functions 0.5
Introduction to Enzymes and their classification.



Paper IV: IBTC 04 Elementary Chemistry I

No. of Credits = 3

UNIT I

Atomic Structure: Concept of orbitals, Aufbau principle, periodic trends in atomic properties, atomic spectra. 0.75
 Atoms. Isotopes, electrons.
 Molecules: Potential Energy diagram, diatomic molecules, valence bond theory hybridization, VSEPR theory, linear combination of atomic orbitals, homo and hetero-nuclear molecules magnetic properties, polyatomic molecules.

UNIT II

Periodic table –groups and periods, s and p block elements, transition metals, d orbitals splitting in octahedral, tetrahedral and square planar environment – spectral and magnetic properties 0.5
 Gaseous State: Kinetic theory of gases, and derivation of kinetic gas equation.
 Deduction of gas laws such as Boyle's law, Charles' law, Graham's law of diffusion.
 Avogadro's principle, velocity of gas molecules, kinetic energy of translation motion.
 Dalton's law of partial pressure.

UNIT III

Colligative properties: Lowering of vapour pressure of solvent, elevation of boiling point, freezing point lowering of solutions, Osmosis and osmotic pressure, Relation of osmotic and vapour pressure, Van't Hoff equation for osmotic pressure, Electrolytes, Arrhenius theory for dissociation of electrolytes, Debye Huckel theory of inter-ionic attractions. 0.5

UNIT IV

Phase Rule: Gibbs phase rule, one component/ two component systems, determination of solid liquid equilibria, determination of nature of solid phases, classification of two-component solid – liquid equilibria, simple eutectic diagram. 0.5

UNIT V

Chemical bonds: Ionic bonds, covalent bonds. 0.75
 Water molecule: Properties & biologically important behaviour (water acts like a magnet, water dings to polar molecules, water stores heat, water is a powerful solvent, water organizes nonpolar molecules water ionizes). Buffers
 Solution: (1) Unseparated (2) Saturated expression for the concentration of solutions
 (i) percent by weight (ii) mole fraction (iii) parts per millions (ppm)
 (iv) grams per liter (v) Molarity (vi) Formality (vii) Normality (viii) Ideal solution

Book Recommended

1. Physical Chemistry – A molecular approach by McQuarree and Simon
2. Physical Chemistry by G M Barrow
3. Concise Inorganic Chemistry by J D Lee
4. Inorganic Chemistry by Shriver and Atkin



Paper VII: IBTC 07 Biodiversity III

No. of Credits = 3

UNIT I

Outline classification of chordates.	0.75
Hemichordata: Classification; General organization with special reference to <i>Balanoglossus</i> ; and affinities.	
Urochordata: Classification; General organization with special reference <i>Herdmania</i> ; and affinities.	
Cephalochordata: Classification; General organization with special reference <i>Branchiostoma (=Amphioxus)</i> ; and affinities.	

UNIT II

Cyclostomata: Classification; External features of <i>Petromyzon</i> and <i>Myxine</i> ; Comparison between Lampreys and Hagfishes.	0.75
Pisces: Teleosts- General classification, Types of Fish Scales, Aquatic and aerial respiratory organs, Air bladder in fishes. Aquatic adaptations (including Hill streams). Fish fauna of Uttarakhand.	

UNIT III

Amphibia: Origin & evolution. Parental care, Neoteny.	0.5
Gymnophiona: General Characteristics.	
Reptilia: Origin & Classification, General Organization. Terrestrial adaptations. Venom and anti-venom. Reptiles of Uttarakhand.	

UNIT IV

Aves: Origin, general characters, classification and evolution.	0.5
Adaptation for aerial mode of life. Feathers in Birds, Ratitae, Migration, Birds of Uttarakhand.	

UNIT V

Mammalia: Origin, General organization & Classification. Prototheria, Metatheria & Eutheria. Adaptations: aerial, aquatic, burrowing and fossorial forms. Mammals of Uttarakhand.	0.5
---	-----



Paper VIII: IBTC 08 Biodiversity IV

No. of Credits = 3

UNIT I

Salient features of bryophytes, preredophytes and gymnosperms. 0.50
 Classification of each group proposed by
 Structure and life-history of *Riccia*, *Funaria*, *Selaginella* and *cycas*.

UNIT II

Morphology: General organization of an angiospermic plant body. 0.50
 Modifications of stem, root and leaf. Flower: its definition, function of each
 flower part, inflorescences and its types. Fruit, type of fruits.

UNIT III

Anatomy: Meristems: Characteristics & functions. Internal structure of stem, 0.75
 leaf and root of monocot, dicot and gymnospermic plants.
 Complex tissue: Structure and function.
 Annual rings and secondary growth.

UNIT IV

Embryology: Microsporogenesis and megasporogenesis 0.75
 Endosperm and embryo development Fruit function and parthenocarpy.
 Seed germination and seed dormancy.

UNIT V

Plant Diversity: Basic concept, diversity of Garhwal Himalaya. 0.50
 Causes of loss of biodiversity.
 Biodiversity conservation action plan, including introduction
 account of Biosphere Reserves. National park and Sanctuaries.



Paper IX: IBTC 09 Elementary Cell Biology & Immunology

No. of Credits = 3

UNIT I

Diversity of Cell size and shape. 0.5
Structure of prokaryotic and eukaryotic cell, bacteria, eukaryotic microbes, plant and animal cells.

Microscopic techniques for study of cells.
Brief introduction to cellular energy transactions: Laws of thermodynamics, Free energy, Oxidation-reduction, ATP.

UNIT II

Cellular organelles: Endoplasmic reticulum, Nucleus, Golgi complex, Peroxisomes, Lysosomes, Mitochondria, Cytoskeleton, chloroplast 0.75

Membranes: Lipid foundation, Architecture, Passage of water, Selective transport of molecules, Inter cellular connection, Ionic basis of membrane excitability.

UNIT III

Cell-division cycle. 0.5
Mitosis, Meiosis.
Biology of cancer: Definition, salient features and causes of cancer, Types of cancer.

UNIT IV

Introduction to Immune System 0.75
Innate and Acquired Immunity
Hematopoiesis, Cells of the Immune System.

UNIT V

Antigens 0.5
immunogenicity Versus Antigenicity
Antibodies
AIDS: General Accounts/ overview on AIDS



Paper X: IBTC 10 Elementary Chemistry II

No. of Credits = 3

UNIT I

Kinetics: order and molecularity of a reaction, differential and integrated rate equations, rate equations for reversible, parallel and consecutive reactions, steady state approximation, rate determining. 0.75
 Step and reaction mechanisms from SSA, temperature dependence of reaction rates, collision theory basics of absolute reaction rate theory, Eyring equation, thermodynamic aspects, reactions in solutions.

UNIT II

Adsorption, chemisorption, adsorption isotherms 0.5

UNIT III

Classification of organic compounds: nomenclature structural and constitutional isomers, functional group chemistry (alcohols, aldehydes) 0.5

UNIT IV

Chemistry of ketones, esters, amines and amides 0.5

UNIT V

Electrochemistry – electrochemical cells, half cell reactions, reduction potentials, the electrochemical series, thermodynamic functions from cell potential measurements liquid junction potentials, Debye Huckel Theory, over voltage. 0.75

Book Recommended

1. Physical Chemistry by PW Atkins
2. Physical Chemistry by Venullapalli
3. Physical Chemistry for life sciences and biosciences by R Chang
4. Organic Chemistry by R T Morrison and R N Boyd (2006)
5. Organic Chemistry by P Y Bruice (2006)



Paper XIII: IBTC 13 Evolution & Introduction to Developmental Biology

No. of Credits = 3

UNIT I

Historical development of the concept of evolution. 0.5
 Theories of organic evolution: Lamarckism (Neo-Lamarckism); Darwinism (Neo-Darwinism); Modern synthetic theory.
 Evidence in favour of evolution: Comparative anatomy, Comparative Embryology, Paleontology, Biochemistry & Genetics.

UNIT II

Paleontology: Fossils & fossilization. Dating of fossils. Significance of fossil record. 0.5
 Geological distribution of animals, period of evolution and extinction of major groups
 Evolution of Horse.

UNIT III

Basic concepts in developmental biology. 0.75
 Modern concept of embryology on the basis of molecular analysis.
 Gametogenesis: Events in spermatogenesis. Morphology of mature mammalian spermatozoon. Events in Oogenesis.
 Fertilization: Steps in fertilization; Mechanism of fertilization; Molecular events.
 Elementary idea of parthenogenesis.

UNIT IV

Types of eggs and cleavage. Role of yolk during cleavage. 0.5
 Products of cleavage (Morula and Blastula).
 Comparison of gastrulation in sea urchin, frog, chick and mammal up to the formation of three germ layers. Fate of germ layers.
 Extra Embryonic Foetal Membrane (Chick).

UNIT V

Elementary concept of primary organizer; Induction; nature and its mechanism of 0.75
 Action. Totipotency. Teratogenesis. Different developmental stages in insect (*Drosophila*); Metamorphosis in Frog. Development of chick embryo up to 72 hours.
 Organogenesis of vertebrate eye. Neurogenesis & Notogenesis

Books Recommended:

1. Grant: Biology of Development System. Holt, Reinehart & Wilson, 1978.
2. Gilbert, Developmental Biology. 3rd ed. Sinauer, 1991.
3. Berril: Developmental Biology, McGraw-Hill. Indian ed. 1974.
4. *Instant Notes* Developmental Biology R. M. Twyman 2003.
5. Modern Text Book of Zoology Vertebrates. R. L. Kotpal 2009.



Paper XIV: IBTC 14 Fundamentals of Computers

No. of Credits = 3

UNIT I

Introduction: What is computer? A simple model of computer, Characteristics of the computer, Problem solving using computer, Input/output units. 0.5

UNIT II

Computer Memory: Memory organization, primary/secondary memory, magnetic hard disk, floppy disk drives, CD ROM, Magnetic Tape Drives, Cache memory, CPU & its components 0.5

UNIT III

Binary Arithmetic: Addition, subtraction, Multiplication, Division. Two's complement representation of numbers, Floating point form. Computer languages: Assembly language, high level languages 0.75

UNIT IV

Operating Systems: definition need and types of operating system. Batch operating system, Multiprogramming operating system, Time sharing operating systems 0.5
Computer generation & classifications

UNIT V

Windows: How windows differ from DOS? 0.75
Features of Windows. Installing & removing programs.
Windows Explorer-moving files, copying, click & drag method, accessories, program manager, file manager, control panel
MS Office- Word, Excel, PowerPoint



Paper XV: IBTC 15 Introductory Biotechnology

No. of Credits = 3

UNIT I

What is Biotechnology? Historical inputs. Biotechnology as a 'tool' not a 'product' 0.75
 Interdisciplinary nature. Foundation of Biotechnology: Importance of basic Biology disciplines eg. Human, Animal and Plant Physiology, Genetics, Cell and Molecular Biology, Microbiology, Biochemistry, Immunology and Chemical engineering.

UNIT II

Introduction to Genetic Engineering. Tools and techniques. 0.5
 Enzymes, Restriction endonuclease.
 Ligases, Alkaline phosphatase, Reverse transcriptase, DNA polymerase,
 Vectors-plasmids, phages, cosmids. Biotechnology hazards and safety.
 Social, moral and ethical issues

UNIT III

Biotechnology in health care. Therapeutic products (Hormones, regulatory proteins, 0.75
 antibiotics). Prenatal diagnosis of genetic diseases. Vaccines, Immunodiagnostics (RIA, ELISA, IRMA) and DNA probe for disease identification. Gene therapy. Human Genome and Biomedicine.

UNIT IV

Introduction to Environmental Biotechnology. Bioprocessing Techniques. Enzyme 0.5
 Biotechnology. Single cell proteins. Food and Beverage Biotechnology. Biotechnology in animal agriculture. Biotechnology in plant agriculture.

UNIT V

Genetics and Biotechnology: Introduction, Genetic manipulation at organism level: in 0.5
 nature and artificial species improvement of plants and animals. Genetic manipulation at cellular and molecular level. Industrial genetics. Cell fusion techniques



Paper XVI: IBTC 16 Chemistry I

No. of Credits = 3

UNIT I

Acids and Bases 0.5
Arrhenius, Bronsted and Lowry, Lux flood and Lewis concepts of Acids and Bases. Conjugate Acid-Base pairs, classes of Bronsted acids and bases. Relative strength of acids and bases. Buffers, pH acid base indicators & its theories.

UNIT II

Nomenclature of alkanes, Isomerism, sources, methods of formation, physical and chemical properties. 0.75
Mechanism of free radical halogenation of alkanes.

Alkenes nomenclature, methods of formation, saytzev Rule, Hoffman elimination, chemical reactions, mechanism involved in hydrogenation, electrophilic and free radical additions Markovnikov rule, Hydroboration and polymerization reactions.

UNIT III

Dienes and alkynes: Nomenclature, methods of formation, structure and Bonding, chemical reactions, Acidity of alkynes, Nomenclature and classification of dienes, structure of alkenes and Butadiene, 1.2 and 1.4 additions, Diels-Alder reaction. 0.5

UNIT IV

Thermodynamics – First & Second laws of Thermodynamics 0.5
Comparative study, diagonal relationship, Salient feature of Hydrides, comparative study of group 13 – 17 elements, compounds like hydrides, Oxides, oxyacids and halides. Hydrides of Boron, interhalogen compounds and Polyhalides.

UNIT V

Organic Chemistry: Stereochemistry and Reaction Mechanisms. 0.75
Stereochemistry of organic compounds.
Conformational, constitutional isomers, stereoisomers, isomers with one chirality centre, more than one chirality centre, separation of stereoisomers.

Reaction mechanisms in organic chemistry – substitution and elimination reactions
SN1, SN2, SNi, E1, E2, E1cb reaction.

Book Recommended

1. Stereochemistry of organic compounds by EL Eliel and SH Wilen (2005)
2. Organic Chemistry by R T Morrison and RN Boyd (2006)
3. Organic Chemistry by J Clayden, N Greaves, S Warren, P Warren, P Wothers, first edition
4. Advanced Organic Chemistry, Wiley Publication
5. Organic Chemistry, Solomon
6. Spectrometric Identification of Organic compounds: Silverstein
7. Introduction to Spectroscopy: Pavia and Lampman



Paper XIX: IBTC 19 Growth & Reproduction

No. of Credits = 3

UNIT I

Growth: Types of growth. Hypertrophy and hyperplasia. 0.5
 Cell division and cell cycle.
 In vivo and In vitro growth. Tissue and cell culture.
 Measurements of growth in cell, tissue and whole body.

UNIT II

Plant growth & Reproduction: Meristems and cambium, senescence and programmed 0.5
 cell death.
 Regulation of growth in unicellular and multicellular organisms.
 Reproduction: Reproductive patterns in plant life cycles, unicellular algae, mosses,
 liver worts, Ferns, Gymnosperms and angiosperms.

UNIT III

Comparative account of gametes and reproductive organs in plants and animals. 0.75
 Asexual and sexual modes of reproduction.
 Gametogenesis in animals. Viviparity, Pregnancy and lactation.
 Hormonal regulation of reproduction in animals.

UNIT IV

Fertilization: Movements of gametes, Chemotaxy and Chemokinesis. 0.75
 Fertilization in plants.
 Biochemistry of fertilization in animals.

UNIT V

Reproductive strategies in animals: Fish, amphibia, reptiles, birds & mammals. 0.5
 Pattern: Abiotic and biotic factors in regulation.

Books Recommended:

1. Ingrouille, M.: Diversity and Evolution of Land Plant, Chapman and Hall, London, 1992
2. Johnson, H.M. and Everitt B.J. Essential Reproduction, Blackwell Science
3. Barnes R.S.K.: The Invertebrate, Blackwell Science, 1993



Paper XX: IBTC 20 Hormonal System

No. of Credits = 3

UNIT I

Basic idea of endocrine, paracrine & autocrine secretions. 0.75
 The endocrine system: Introduction, Endocrine system as a regulatory device.
 Types of hormones: Tyrosine derivative hormones, protein & peptide hormones, steroid hormones.
 Salient features of hormone action: amplification, specificity, diversity of actions, hormonal interactions, feedback.

UNIT II

Endocrine glands & their secretions- Pituitary, Thyroid, Parathyroid, Adrenal, 0.5
 Pancreas, Gastro-intestinal hormones & Leptin.
 Basic structure of Hypothalamo- Hypophysial system. Neuroendocrine control.

UNIT III

Physiological action of different hormones. Reproductive endocrinology. 0.5
 Hormone biosynthesis: Protein/peptide hormones.
 Steroid hormones.
 Thyroid hormones.

UNIT IV

Storage & secretion of hormones. Transport of hormones in the blood. 0.5
 Elementary knowledge of hormonal dysfunctions and related disorders in humans.
 Brief introduction to behavioral endocrinology.

UNIT V

Measurement of hormones: Bioassay, Immunoassay, Receptor-assay. 0.75
 Mechanism of hormone action: Signal transduction & amplification
 Hormone- receptor interactions, binding affinity, up-regulation, down regulation. Orphan receptors.
 Membrane bound receptors, second messenger, c-amp cascade.
 Intracellular receptors, nuclear receptor & gene expression



**Paper XXI: IBTC 21 Fundamental Microbiology, Environmental Biotech
& Fermentation Technology**

No. of Credits = 3

UNIT I

Introduction to the microbial world: Historical developments, use of microscopes, Importance of Electron microscopy, Brief introduction to Bacteria, fungi, protozoa, algae and viruses. 0.5

UNIT II

Microorganisms as a causative agent of infectious diseases and their control through drug and vaccines, Brief idea about their culturing, sterilization and disinfection. 0.75

UNIT III

Environmental biotechnology: Definition & Scope
Environmental pollution: Types of pollution (Air, water, solid wastes, radioactive), Methods of measurement. 0.5

UNIT IV

Microbes in relation to environmental pollution: Bacteriology of water & sewage (indicator organisms, faecal & non faecal colliforms, MPN estimation)
General concept of biodegradation (aerobic & anaerobic)
Genetically engineered microbes (GEMs) in environmental management 0.75

UNIT V

Brief idea about the role of microorganisms in ecosystem. 0.5
Introduction to fermentation. Microbial production of commercial food products and antibiotics.



Paper XXII: IBTC 22 Chemistry II

No. of Credits = 3

UNIT I

Organometallic Compounds 0.5
 Organomagnesium compounds: Grignard reagents-formation, structure and chemical reactions.
 Organozinc compounds: formation and chemical reactions.
 Heterocyclic Compounds: Molecular orbital picture and aromatic characteristics of pyrrol, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives.
 Comparison of basicity of pyridine, piperidine and pyrrole.

UNIT II

Polymers: materials, synthesis, characterization (inert polymers, biodegradable polymers, hydro gels, natural; polymers, genetically engineered polymers, Bioactive polymers) 0.5
 Bioinorganic Chemistry: Role of metal ions in biological system.
 Spectroscopy to deduce structure: NMR.

UNIT III

Haloalkanes: Alkyl and Aryl halides, effect of alkyl group on the S_NI reaction, Unimolecular elimination (E₁), Bimolecular elimination (E₂). 0.5
 Ether and epoxides: Nomenclature of ethers and methods of their formation, physical properties. Chemical reactions-cleavage and autoxidation, Ziesel's method.
 Synthesis of epoxides.
 Colloidal State: Definition of colloids, classification of colloids.

UNIT IV

Chemical kinetics, rate of reaction, factors influencing the rate of a reaction. 0.75
 Mathematical characteristics of Chemical reaction-zero order, first order, second order, pseudo order, half life and mean life. Method of half life period, concept of activation energy.
 Photochemistry: Interaction of radiation with matter, difference between thermal and photochemical of processes. Laws of photochemistry: Grothus – Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, Qualitative description of fluorescence, phosphorescence.

UNIT V

Spectroscopy of Bio-organic Compounds. 0.75
 Structure elucidation of organic molecules.
 Ultraviolet-visible spectroscopy, solvent effects, Woodward rules.
 Infra-red spectroscopy, infrared absorption bands, shapes of absorption bands and intensity of absorption bands.
 Mass spectrometry, mass spectrum, fragmentation patterns, isotopes in mass spectrometry.



Paper XXV: IBTC 25 Environmental Science

No. of Credits = 3

UNIT I

Introduction to Environmental Science: Definition, Scope and importance (the multidisciplinary nature of environmental science) 0.75
 Need for public awareness on environment, role of individual in environmental protection
 Natural Resources: Renewable and Non-renewable resources

UNIT II

Ecosystem: Concept and components of an ecosystem (pond, lake, river & forest) 0.5
 Ecosystem energetic: trophic levels, food chains, energy flow,
 Biogeochemical cycles (Nitrogen, Phosphorous, Carbon)

UNIT III

Population: Definition, density, age structure, sex ratio, mortality & natality. 0.5
 Population growth models (exponential and logistic)
 Mechanisms of population regulation.
 Niche Concept.
 Community: Structure, dominance, diversity & abundance; Ecological succession, edge communities

UNIT IV

Biodiversity: Definition, genetic, species and ecosystem diversity 0.75
 Values of Biodiversity: 5 Es (Esthetic / Aesthetic), Economic, Environmental, Ethical, Emotional.
 Biodiversity at global, national and local levels; Hot spots of biodiversity
 Conservation of biodiversity: *In-situ* and *Ex-situ* conservation
 Biogeographical classification of India.

UNIT V

Organism & its environment: Adaptation, tolerance, homeostasis, phenotypic plasticity. 0.5
 Physiological and biochemical adaptation to extreme environments (desert, polar seas, hypersaline lagoons, hot spring, deep sea etc).
 Invasive species
 Global Climate change (linked to nutrient cycle)
 Island biogeography and conservation biology (linked to biodiversity)

Books Recommended:

1. William P. Canninyham: Environmental Science 3rd ed., Wm. C. Brown Publishers
2. Michael L. McKinney: Environmental Science, Jones & Bortett Publishers
3. Botkin & Keller: Environmental Science 3rd ed., John Willey & Sons, Inc.
4. J.L. Chapman & M.J. Reiss: Ecology Principles & Application, Cambridge Univ. Press



Paper XXVI: IBTC 26 Differentiation & Morphogenesis

No. of Credits = 3

UNIT I

Evolution of developmental patterns 0.5
 Evolution of developmental patterns in unicellular protists
 Multicellularity: The evolution of differentiation
 Differences in the development mechanisms of animals: pro-embryonic vs. post embryonic development

UNIT II

Cellular basis of morphogenesis 0.5
 Fate maps: Specification of cell fates during cleavage
 Induction of competence
 Paracrine factors; Juxtacrine signalling Cross-talk between pathways
 Developmental dynamics of cell specification: Autonomous specification;
 Conditional specification; Syncytial specification

UNIT III

Formation of axes 0.5
 Drosophila: Morphogen gradients and role of pattern forming genes in the establishment of anteroposterior, dorsoventral and bilateral symmetry; Maternal effect genes; Segmentation genes; Homeotic selector genes.

UNIT IV

Organogenesis 0.75
 Development of the central nervous system: Formation and differentiation of the neural tube ; Differentiation of neurons
 Derivatives of the mesoderm: Formation of somites; Myogenesis, erythropoiesis and chondrogenesis
 Derivatives of the endoderm: The pharynx; the digestive tube and its derivatives; the respiratory tube; the extra embryonic membranes

UNIT V

Unique components of plant cells in relation to development: cell wall, chloroplasts, Plasmodesmata. Apical meristems & formation of plant body 0.75
 Floral Development & homeotic genes in lower & higher vascular plants
 Model systems for the molecular analysis of plant development: Arabidopsis
 Polarity in plant development
 Embryogenesis and seed formation: Seed and bud dormancy

Books Recommended:

1. Developmental Biology by Scott F. Gilbert Sinauer Associates, Inc., SIII - 7111 editions
2. Principles of Development by Lewis Wolpert Oxford University Press, 2nd edition
3. Introduction to Embryology by B. 1. Balinsky CB.S. College Publishers.
4. Development by Goodwin, B. 1991, Hodder and Stoughton.
5. The Coiled Spring by Ethan Bier, 2000, Cold spring Harbour Press.



Paper XXVII: IBTC 27 Animal Physiology

No. of Credits = 3

UNIT I

Respiration: Types of respiration (cutaneous, branchial, tracheal and pulmonary) 0.75
 Respiratory pigments (Haemoglobin, myoglobin, haemoerythrin, haemocyanin and chlorocruorin). Transport of gases.
 Dissociation of oxyhaemoglobin, factors affecting oxyhaemoglobin dissociation curve (carbon dioxide, pH and temperature); Chloride shift.

UNIT II

Nutrition: Food constituents; Intracellular and Extracellular digestion. 0.75
 Digestion and absorption of Carbohydrates, Lipids and Proteins.
 Circulation: Composition of blood and functions of blood corpuscles;
 Haemopoiesis; Blood coagulation; Blood groups; Types of heart (tubular, pulsative, ampullar and chambered);

UNIT III

Physiology of Cardiovascular system. Origin and regulation of heart beat.. 0.5
 Excretion: Excretion of nitrogenous wastes (Ammonotelic, Uricotelic, Ureotelic and Guanotelic animals);
 Structure of nephron; Physiology of urine formation.

UNIT IV

Nervous system: Types of neurons; Myelinated and non-myelinated nerve fibres. 0.5
 Initiation and conduction of nerve impulse; Resting and action potential; Synapse and chemical transmission;
 Reflex action.

UNIT V

Muscles: Types of muscles; Ultrastructure of skeletal muscles; Muscle proteins; 0.5
 Chemistry of muscle contraction.
 Mechanism of muscle contraction; Elementary knowledge of muscle twitch, isotonic and isometric contraction, tetanus and fatigue.

**Paper XXVIII: IBTC 28 Industrial Biotechnology & Bioprospecting**

No. of Credits = 3

UNIT I

Role of microorganisms in natural system and artificial systems; 0.5
 Influence of Microbes on the Earth's Environment & Inhabitants;
 Ecological impacts of microbes; Symbiosis(Nitrogen fixation and ruminant symbiosis);
 Microbes & Nutrient cycles; Microbial communication systems;
 Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines

UNIT II

Primary and secondary metabolites; Extracellular enzymes; 0.75
 Biotechnologically important intracellular products; exopolymers;
 Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH
 Microbial processes-production, optimization, screening, strain improvement,
 Factors affecting downstream processing and recovery;
 Representative examples of ethanol, organic acids, antibiotics etc.

UNIT III

Application of Microbes in food process operation & production. 0.5
 Fermented foods and beverages; food ingredients and additives prepared by fermentation
 and their purification; fermentation as a method of preparing and preserving foods;
 Microbes and their use in pickling, producing colours and flavours; alcoholic beverages
 and other products; process wastes-whey, molasses, starch substrates and other
 food wastes for bioconversion to useful products; bacteriocins from lactic acid
 bacteria-production and applications in food preservations

UNIT IV

Scale up- factors involved in scale up, sterilization. 0.5
 Scaling up of stirred tank reactors
 Scaling up of air lift reactors
 Scale down methods

UNIT V

Bioprospecting: Definition, Bioprospecting of novel genes, biomolecules and enzymes 0.75
 Bioprospecting of bioresources (plants, microbes, fungi and lichens).
 Bioprospecting by novel means: metagenomics, community genome as a reservoir of
 Important genes, approaches in metagenomics and future prospects
 Use of PCR and gene cloning in Bioprospecting

Recommended Books

1. EMT Elmansi & CFA Bryce: Fermentation Microbiology & Biotechnology, Taylor & Francis
2. OL Gambory & G.C Phillips: Plant cell, Tissue & Organ Culture
3. Taylor: Biological Science, Cambridge
4. Pelczar: Microbiology, Tata MC Graw Hill
5. Smith: Biotechnology, Cambridge
6. Glick: Molecular Biotechnology, ASM Press



Paper XXXI: IBTC 31 Economic Biology & Animal Behavior

No. of Credits = 3

UNIT I

Elementary knowledge of sericulture, apiculture & lac culture. 0.75
 Fish culture,
 Poultry keeping.
 Elementary knowledge of Animal Husbandry.
 Integrated Pest Management (IPM).

UNIT II

Origin, history, botanical features and cultivation of cereals – wheat, paddy, maize. 0.75
 Introduction to the economically important legumes.
 General account of fruit and vegetable. Fibres and timber yielding plants.
 Common medicinal plants of Garhwal Himalaya.

UNIT III

Approaches to study of animal behavior: Ecological, physiological, 0.5
 quantitative and evolutionary. Proximate and Ultimate causes of behavior.
 Patterns of behavior: Individual types, social types. Instinct verses learning. Imprinting.

UNIT IV

Introduction to internal control of behavior: Neural and hormonal control of behavior. 0.5
 Genetic basis of behavior.
 Brief introduction to communication in animals: Visual, acoustic and chemical.
 Language of bees.

UNIT V

Introduction to socio biology (animal societies) : Social structure –Family Unit, 0.5
 social grouping , social hierarchy . Costs and benefits of living in groups.
 Biological Rhythms: Circadian and circannual rhythms.
 Biological Clocks.



Paper XXXII: IBTC 32 Plant Physiology

No. of Credits = 3

UNIT I

Solutions, suspension and colloidal systems; Diffusion, osmosis and imbibition; absorption of water; transpiration and guttation 0.5

UNIT II

Ascent of sap; Absorption of mineral salts; mineral nutrition of plants; Special methods of nutrition in angiosperms. 0.5

UNIT III

Photosynthesis: Photosynthetic pigments and absorption of light energy system, Fluorescence, Phosphorescence, Quantum requirement and quantum yield, red drop and Emerson's Enhancement Effect, Two pigment systems, Quantosome Mechanism of Photosynthesis: Primary Photochemical Reaction, Dark reaction- C₃ Pathway, C₄-Pathway, Photorespiration, CAM 0.75

UNIT IV

Nitrogen cycle, biological N₂ fixation, Mechanism of BNF: Non symbiotic and Symbiotic Translocation of organic solutes 0.5

UNIT V

Plant movements; circadian rhythms in plants; photoperiodism; Vernalization; Germination and dormancy of seeds and buds 0.75



Paper XXXIII: IBTC 33 Elementary Biomaths & Biostatistics

No. of Credits = 3

UNIT I

Basic Algebra: Multiplication & Factorization. Number System, Solving simple equations 0.5
 Graphs: Plotting of Graphs, distance between two points
 Quadratic equations, the remainder & factor theorem

UNIT II

Relations & Functions: Direct proportion, inverse proportion, making new functions from old, odd & even functions, exponential & log functions 0.5
 Sequences & Series: AP, GP, HP. Arithmetic mean, Geometric mean

UNIT III

Trigonometry: Pythagoras's Theorem, Trig functions & relation between them, Sine rule, Cosine rule, Trig reciprocal functions. 0.75
 Solving Trig equations.

UNIT IV

Sampling: Methods of Sampling, Errors in Sampling 0.75
 Diagrammatic & Graphical representation of data: Line diagram, Bar diagram, pie diagram, histogram, frequency polygon, frequency curve, ogive
 Measures of Central Tendency: Mean, Median, Mode, Geometric Mean, Harmonic mean
 Measures of Dispersion: Range, Mean Deviation, Standard Deviation, Standard Error, Skewness & Kurtosis

UNIT V

Probability: Theorems, Addition rules, multiplication rules, 0.5
 Probability applications, probability distributions- Normal, Binomial & Poisson Distributions
 Correlation & Regressions



Paper XXXIV: IBTC 34 Fundamentals of Genetics & Molecular Biology

No. of Credits = 3

UNIT I

Mendel's law; Exceptions to Mendel's law. 0.75
 Chromosomal theory of Inheritance
 Sex-linked inheritance & genetic disorders;
 Linkage & Crossing over. DNA as a genetic material

UNIT II

Chromosome structure; Euchromatin; Heterochromatin; 0.5
 Polytene & lampbrush chromosomes. Chromosome banding, Karyotyping.
 Fine structure of gene and allelism.
 Interaction of genes. Sex determination and Sex Linkage

UNIT III

Cytoplasmic Inheritance, Polygenic Inheritance, Pedigrees and their applications, 0.5
 Mutation, population and evolution genetics, Eugenics.

UNIT IV

Nucleic Acid: Structure, chemical and physical properties, Organization of DNA. 0.5
 Enzymes involved in prokaryotic and eukaryotic DNA replication; Mechanism &
 Type of replication.

UNIT V

General Mechanism of transcription in eukaryotes and prokaryotes; 0.75
 Brief idea of post transcriptional modifications.
 Prokaryotic and eukaryotic ribosome
 Mechanism of translation in prokaryotes and eukaryotes.

**Paper XXXVII: IBTC 37 Biochemistry****No. of Credits = 3****UNIT - I**

Enzymes: Classification (rationale, overview and specific examples) 0.5
 Zymogens and their activation (Protease and Prothrombin)
 Enzyme substrate complex: Concept of E-S complex, binding sites, active site, specificity, Lock and Key Hypothesis, Induced-Fit Hypothesis, Michaelis-Menten equation and its derivation, Different plots for the determination of K_m and V_{max} , Enzyme Inhibition

UNIT - II

Carbohydrate – Classification, structure and functions 0.75
 Carbohydrate Metabolism I: Pathway and regulation of Glycolysis, Gluconeogenesis, Glycogenolysis, Glycogenesis
 Carbohydrate Metabolism II: Citric acid cycle and its regulation, Electron transport Chain and Oxidative phosphorylation, Pentose phosphate pathway and its regulation.

UNIT - III

Amino acids – structure and functional group properties, peptides and 0.75
 covalent structure of proteins, primary and higher order structures, Ramachandran plot.
 Protein – Classification, structure and functions
 Amino Acid Metabolism: overview of amino-acid biosynthesis and degradation
 Urea cycle (Linkage between urea cycle and citric acid cycle) and its regulation.
 Conversion of nitrogen to ammonia by microorganisms

UNIT - IV

Fatty Acids - Classification and structure. 0.5
 Fatty Acid Metabolism: Fatty Acid Oxidation and regulation, β -oxidation, Oxidation of unsaturated fatty acids and odd chain fatty acids, β -oxidation in peroxisomes, Ketone bodies and their overproduction.
 Fatty Acid Biosynthesis and Regulation. Reactions of fatty acid synthase, Synthesis of triglycerols, Cholesterol biosynthesis and regulation.

UNIT - V

Nucleic Acid - structure and functions. Nucleic Acid Metabolism: Purine 0.5
 biosynthesis and its regulation, Pyrimidine biosynthesis and its regulation.
 Formation of deoxyribonucleotides. Salvage pathway for Purine and Pyrimidine nucleotides, Degradation of purines and pyrimidines into uric acid and urea.

Recommended Books: -

1. Lehninger: Principles of Biochemistry, 4th ed., Nelson & Cox, WH Freeman and Company, 2007
2. Voet & Voet: Biochemistry, 2nd ed., Wiley & Sons.
3. Berg, Tymoczko, Stryer: Biochemistry, 5th ed., WH Freeman and Company, 2003.
4. Garrett & Grisham: Biochemistry, 4th ed., Brooks/Cole Cengage learning, 2010.
5. Murray, Granner, Rodwell: Harper's Illustrated Biochemistry, 27th ed. McGraw Hill, 2006.
6. Conn & Stumpf: Outlines of Biochemistry, 5th ed., Willey India, 2007.



Integrated 5 Yrs M.Sc. Biotech 7th Sem.

Paper XXXVIII: IBTC 38 Cell Biology & Membrane Biophysics

No. of Credits = 3

UNIT - I

Plasma membrane: Structure, Organisation, Lipid bilayer, Proteins and Glycoconjugates, Liposomes, lipid protein interactions, membrane rafts, hydrophobic effect. Elasticity of the membrane. Function- ionic transport, Types of transport (symport, antiport, active & passive), Channel proteins-Introduction. 0.5

UNIT - II

Intracellular compartmentalization: Structure, organization and functions of Nucleus, Mitochondria, Lysosome, Golgi body, Chloroplast, Peroxisome, Endoplasmic reticulum (Rough and smooth). Cell motility and Shape: Structure and functions, Microfilament, Microtubules and Intermediate filament. 0.5

UNIT - III

Protein Sorting: Anterograde & Reterograde mode of protein trafficking, Vesicular traffic in the secretory and Endocytic pathway: Transport from Endoplasmic reticulum through the Golgi network to Lysosome, Endocytosis, Exocytosis, Molecular mechanisms of vesicular transport and maintenance of compartments diversity. Cell signaling : General principles (Types of signaling), Cell surface receptor mediated signaling (ion channel, G protein and enzyme linked). 0.75

UNIT - IV

Cell cycle: Molecular events and regulation. Cell division: General strategy & regulation, Molecular mechanism of mitosis and meiosis. Cancer- Biology: Types of cancer, Onset of cancer, Proto-oncogenes and tumor suppressor genes, Oncogenic mutations affecting cell proliferation, Cell cycle and Genome stability, Programmed cell death, Apoptosis 0.5

UNIT - V

Membrane transport, diffusion, electro-diffusion, types of transportation, thermodynamic model, chemical potential, osmotic pressure, water permeability, structure, selectivity & permeability of channel proteins, Voltage-gated channels, Ligand-gated channels, Na⁺, K⁺ and Ca²⁺ channels, pumps as channels. Conduction of electrical activity Spread of electrical signals: passive vs. active, the action potential and its propagation through nerves, chloride channels and muscle excitability, Target cell adaptation 0.75

Recommended Books: -

1. Lodish et al.: Molecular Cell Biology (4thed.)
2. Alberts et al.: Molecular Biology of the cell (3rded.)
3. Scott F. Gilbert: Developmental Biology (5thed.)
4. Zubay, Parson & Vance: Principles of Biochemistry
5. Joshua Zimmerberg, Membrane Biophysics. Current Biology Vol 16 No 8 R272, [https://www.cell.com/current-biology/pdf/S0960-9822\(06\)01347-9.pdf](https://www.cell.com/current-biology/pdf/S0960-9822(06)01347-9.pdf)
6. Mohammad Ashrafuzzaman and Jack Tuszynski: Membrane Biophysics, Part of the Biological and Medical Physics, Biomedical Engineering book series (BIOMEDICAL), Springer



Paper XXXIX: IBTC 39 Molecular Biology & Genetics

No. of Credits = 3

UNIT - I

Chemical and physical properties of nucleic acids 0.5
 Structure and types of RNA and DNA, The Watson-Crick model. DNA as genetic material. Different forms of DNA.
 Topological properties of DNA. DNA renaturation kinetics.

UNIT - II

Mechanism of DNA replication in prokaryotes and eukaryotes. 0.75
 Mechanism of transcription in prokaryotes and eukaryotes. Reverse transcription.
 Post transcriptional processing of RNA: (capping, polyadenylation, splicing, RNA editing)
 Mechanism of translation in prokaryotes and eukaryotes.

UNIT - III

Concept of genetic code, Gene expression and regulation in prokaryotes (Lac operon and trp operon). Gene expression and regulation in eukaryotes. 0.5
 Introduction to various types of DNA damage and repair.

UNIT - IV

Mendelism: Basic principles and applications of inheritance, exceptions to 0.75
 Mendelian law. Chromosomal basis of Mendelism (chromosomal theory of heredity)
 The molecular structure of chromosome in eukaryotes: structure of chromatin and higher order packaging in chromosome. Centromere and Telomere,
 Giant chromosome: Polytene and Lampbrush chromosome.
 Linkage, recombination and chromosome mapping in eukaryotes. Cytoplasmic inheritance.

UNIT - V

Chromosomal Aberrations: Change in number and structure 0.5
 Allelic variation and gene function. Sex chromosome and sex determination.
 Dosage compensation of X-linked gene. Sex linked genes in human. Pedigree analysis.

Recommended Books: -

1. Lewin: Genes, Vol. VII Oxford, 1998, Indeed.
2. Snustad et al: Principles of Genetics 1997, John Wiley & Sons,
3. De Robertes & Robertis: Cell & Molecular Biology, 1987, Lee & Fabiger Philadelphia
4. Strickberger: Genetics, 1996, Prentice Hall
5. Friefelder: Molecular Biology (2nd ed.), 1996 Narosa Publ. House,
6. Alberts et al: Molecular biology of the cell (4th ed.) 1994, Garland Publ. New York.
7. Elliott & Elliott: Biochemistry and Molecular Biology, 1996, Oxford

**Paper XL: IBTC 40 Bio-Analytical Techniques****No. of Credits = 3****UNIT - I**

Chromatography - General principles and applications. 0.75
 Adsorption chromatography, Partition chromatography, Gas chromatography,
 Liquid chromatography, Paper chromatography, Thin layer chromatography,
 Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography,
 HPLC (High Performance/Pressure Liquid chromatography).

UNIT - II

Electrophoresis - General principle and applications 0.5
 Paper electrophoresis, Moving boundary method, Gel electrophoresis (Native,
 Denaturing & Reducing), Disc gel electrophoresis, Slab gel electrophoresis,
 Isoelectric focussing (IEF), Isotachophoresis

UNIT - III

Centrifugation: Basic principles, Common centrifuges used in laboratory, Clinical 0.5
 High speed & Ultra centrifuges. Sedimentation rate, Sedimentation coefficient, Zonal
 Centrifugation, Equilibrium density gradient centrifugation. Types of rotors (fixed angle, swinging
 bucket), Types of centrifugation: Preparative, Differential & Density gradient

UNIT - IV

Basic knowledge of the principles and applications of Microscopy: Light, Phase 0.5
 Contrast, Fluorescence and Confocal Microscopy, Scanning and Transmission Electron
 Microscopy. Biosensors: Introduction & principles, Cell based biosensors, Enzyme immunosensors.

UNIT - V

Spectroscopic methods: Principle and applications of UV-visible, IR, NMR, ESR 0.75
 Spectroscopy. Principle & applications of X-ray crystallography. Applications of
 radioisotopes in biology. Properties and units of radioactivity. Radioactive isotopes and
 half life. Measurement of radioactivity: GM Counter, Gamma & Liquid scintillation counter.

Recommended Books: -

1. Sharma, V.K.: Techniques in Microscopy and Cell Biology Tata McGraw Hill, 1991.
2. Alberts et al.: Molecular Biology of the cell (2nd ed.), Garland, 1989.
3. Biochemical Technique: Theory & Practical J.F. Robyt & B.J. White. Waveland Press, Inc.
4. Wilson & Walker: Practical Biochemistry (4th ed) University of Hertfordshire Cambridge University Press
5. Jayraman: Laboratory Manual in Biochemistry
6. Arnold L. Demain & Julian E. Davies: Manual of Industrial Microbio. & Biotech. 2nded.



Integrated 5 Yrs M.Sc. Biotech 8th Sem.

Paper XLIII: IBTC 43 Immunology

No. of Credits = 3

UNIT - I

Overview of the Immune system; Cells and organs of the immune system 0.5
Antigens, Antigenicity vs. Immunogenicity; Haptens & Epitopes;
Immunoglobulins: Structure and function

UNIT - II

Organization & Expression of Immunoglobulin Genes: Multigene organization of 0.75
Genes, variable- region gene rearrangements, Generation of antibody diversity,
Class switching among constant-region genes, Expression of Ig genes
Major Histocompatibility Complex; Antigen processing and presentation

UNIT - III

Structure and functions of BCR & TCR. Cytokines, Properties, General physiology, 0.75
Interferons, Application of cytokine for therapy. The complement system
Cell mediated cytotoxicity: Mechanism of T cell & NK cell mediated lysis,
Ab-dependent cell mediated cytotoxicity (ADCC)

UNIT - IV

Overview of hypersensitivity, Autoimmunity and there types 0.5
Organ transplantation: Introduction, Types and Challenges, Graft rejection
Vaccines: Active and Passive Immunization

UNIT - V

Overview of Monoclonal Antibodies and Hybridoma Technology, 0.5
Types of Antigen-Antibody Interactions: Precipitation reaction, Agglutination reactions,
RIA, ELISA, Western Blotting, Immuno-precipitation, Immuno-fluorescence

Recommended Books: -

1. Roitt, Male & Brostoff : Immunology (3rd ed).
2. Kuby : Immunology (4th ed.)
3. Elgert & Elgert : Immunology
4. Wilson & Walker: Practical Biochemistry (4th ed.)
5. Practical Immunology, 4th Ed., F.C. Hay, O.M.R. Westwood, Blackwell Publishing, 2002
6. Selected Methods for Antibody and Nucleic Acid probes, Vol. 1, S. Hockfield, S. Carlson, C. Evans, P. Levitt, J. Pintar, L. Silberstein, Cold Spring Harbor Laboratory Press, 1993.
7. Antibodies Laboratory Manual, Ed Harlow, David Lane, Cold Spring Harbor, Laboratory Press, 1988.



Paper XLIV: IBTC 44 Microbiology & Microbial Genetics

No. of Credits = 3

UNIT - I

Classification of living organisms and general account of microorganisms: Bacteria, Fungi and Viruses. 0.75
 Introduction to bacteriology: Classification; Fine structure of bacteria; Laboratory identification and staining techniques
 Introduction to Mycology: Classification, general structure, characteristics of fungi.

UNIT - II

Media for microbial culture, Selective, Differential and Enriched media, Pure culture techniques, Sterilization techniques. 0.5
 Introduction to virology: Classification, General structure and reproduction of viruses.
 Cultivation of bacteriophages, Plant Viruses, Animal Viruses.

UNIT - III

Microbial growth: Synchronous & Diauxic, Factors affecting microbial growth, Measurement of microbial growth (cell number & cell count). 0.5
 Modes of nutrition: Photoautotrophs, Photo-organotrophs, Chemolithotrophs, Chemo-organotrophs.
 Microbial metabolism: Overview of energy production and utilization, N₂ fixation.

UNIT - IV

Modes of genetic recombination in bacteria: Conjugation, F-factor, conjugal transfer process, high frequency recombination (Hfr) strains. 0.75
 Transformation – competence, DNA uptake by competent cells.
 Mechanism of transformation.

UNIT - V

Transduction – General & specialized transduction. 0.5
 Genetics of bacteriophages: Lytic and lysogenic cycle, expression of phage genes
 In regulation of lytic and lysogenic circuit.

Recommended Books: -

1. Tortora, Funke, Case: Microbiology, (9thed.) Pearson Education, Inc, 2009.
2. Prescott, Harley & Kliens: Microbiology (7thed.) McGraw-Hill International Edition, 2008.
3. Michael J. Peleazar, E.C.S. Chan, Noel R. Krieg: Microbiology (5thed.) Tata McGrall-Hill, 2008.
4. Alcamo's Jeffrey C. Pommerville: Fundamental of Microbiology (8thed.) Jones & Bartlet Publ. 2007.



Paper XLV: IBTC 45 Genetic Engineering & Applications

No. of Credits = 3

UNIT - I

Introduction to Recombinant DNA technology and applications. 0.75
 Cloning vectors: Plasmids, Phages, Cosmids, Yeast cloning vectors,
 Animal and plant viruses as vectors. BAC, PAC & YAC.
 Nucleic acid modifying enzymes. Restriction endonucleases.
 Isolation of nucleic acid from Plant, animal & bacteria.

UNIT - II

Basic steps of gene cloning: Cloning strategies. 0.75
 Synthesis of cDNA. Construction of cDNA and genomic libraries.
 Selection of r DNA clones and their expression products, Chromosome walking.
 Expression of cloned genes in heterologous host.

UNIT - III

DNA sequencing: Chemical and enzymatic methods. 0.5
 PCR: Types and applications. Real Time PCR. Site directed mutagenesis.
 Ribonuclease protection assay, Gel retardation assay,
 DNA foot printing, DNA finger printing, DNA profiling.

UNIT - IV

Genomic analysis: S-1 mapping, RFLP, RAPD, AFLP. 0.5
 Probe labeling and hybridization. Blotting techniques: Southern, Northern and
 Western blotting (Methodologies and applications)

UNIT - V

Transgenic Technology: Types, approaches & applications (Plant & Animals), 0.5
 Gene therapy: Principles, strategies and ethics of gene therapy.
 Genome editing technologies: Principles and applications.

Recommended Books: -

1. Gene cloning T.A Brown:
2. Molecular Biotechnology, Glick & Pasternak: Panima Publ. Corporation, 1994
3. Molecular biology & Biotechnology (3rded), Walker &Gingold: Panima Publ. Corporation, 1999
4. Lewin: Genes, Vol. VII Oxford, 1998, Inded.
5. Straehan & Read: Human Molecular Genetics 1999, John Wiley & Sons Pte. Ltd.
6. Gene cloning, Glover: 1984
7. Recombinant DNA, Watson et al: 1983
8. Genetic Engineering Vol. 1-4, Villiamson (ed)
9. Genetic Engineering Vol. 1-7 Setton and Bolanden (ed)



Paper XLVI: IBTC 46_Biostatistics & Bioinformatics

No. of Credits = 3

UNIT - I

Importance of statistics in biological research. 0.75
 Primary and Secondary data, Methods of data collection. Mean, Mode, Median, Range, Mean deviation, Standard deviation.
 Standard error, Skewness & Kurtosis. Correlation & Regression, Probability

UNIT - II

Characteristics, Validity and Applications of Chi square test 0.5
 Test for significance- comparison of means of two samples, Comparison of means of three or more samples (f-test, t-test).
 Tabulation and Graphical representation of Statistical data.
 Data calculation in MS Excel & Power point presentation.

UNIT - III

Introduction to bioinformatics: Objectives, application and scopes, 0.5
 Information technology in biology, Bioinformatics resources on NET, Internet, Word wide web, Web Browsers.
 Biological databases-Primary, Secondary database, GEN BANK, EMBL, DDBJ, PDB, UNIPROT. Search engine-Entrez, SRS, Web Server-NCBI, EBI.

UNIT - IV

Sequence alignment and applications: Sequence similarity searching tools – 0.75
 FASTA, BLAST; Statistical and biological significance.
 Multiple sequence alignment and applications, Software and tools for MSA.
 Phylogenetic analysis, Tools for phylogenetic analysis, Applications

UNIT - V

Protein Structure Prediction Tools, Molecular Modeling (Homology modeling); 0.5
 Refinement, Validating structural model; Visualization tools, Pymol, Chimera, Ligplot.
 Annotation of proteins, Assignment of function to proteins.

Recommended Books: -

1. Lesk: Introduction to Bioinformatics, Wiley Publication.
2. ROM and Holmas EC: Molecular Evolution: a phylogenetic approach, Blackwell science.
3. Des Higgins and Willie Taylor: Bioinformatics: Sequences, structure and databanks, Oxford University Press
4. Sharma, Munjal, Shankar: A Text Book of Bioinformatics, Rastogi Publication
5. Bioinformatics: Methods and Applications Genimics Proteomics and Drug Discovery, S C Rastogi, N Mendiratta, P. Rastogi: Prentice Hall of India Private Ltd
6. Mahajan: Methods in Biostatistics (4thed.) Jaypee Bros. 1984.
7. Sokal & Rohlf: Introduction to Biostatistics, Freeman, Toppan, 1993

**IBTSS 01_Epigenetics & Cancer Biology****No. of Credits = 3****UNIT - I**

Introduction: Growth characteristics of cancer cells; Morphological and ultrastructural properties of cancer cells. Types of growth: Hyperplasia, Dysplasia, Anaplasia and Neoplasia. Nomenclature of neoplasms. Differences between benign and malignant tumors. 0.75

UNIT - II

Cancer biology and biochemistry: Aberrant metabolism during cancer development; Para-neoplastic syndromes; Tumor markers; Cellular proto oncogenes- oncogene activation. Growth factors-EGF, TNF, TGF and growth factor receptors. Signal transduction in cancer. Role of transcription factors. 0.5

UNIT - III

Carcinogenesis: Radiation and chemical carcinogenesis, Stages in chemical carcinogenesis- Initiation, promotion and progression. Free radicals, Antioxidants in cancer. Cell Cycle Regulation: Tumor suppressor genes p53, p21, Rb, BRACA1 and BRACA2. Telomeres, Telomerase, and Immortality; Cell adhesion-invasion and metastasis - VEGF signaling, angiogenesis. 0.75

UNIT - IV

Epigenetics-Role of DNA methylation in gene silencing- epigenetic silencing of tumor-suppressor genes; Apoptosis in cancer-Cell death by apoptosis, Role of caspases; Death signaling pathways-Mitochondrial and death receptor pathways. 0.5

UNIT - V

Detection of Cancer, Prediction of aggressiveness of Cancer, Different forms of therapy, Chemotherapy, Radiation therapy, and Immuno therapy: Advantages and limitations. Epigenetics of cancer, Identification of targets for drug development. 0.5

Recommended Books: -

1. The Biological Basis of Cancer: R. G. McKinnell, et al 2nd Ed, Cambridge University Press, 2006.
2. The Biology of Cancer: R. A. Weinberg. Garland Science. 2006.
3. The Molecular Biology of Cancer: S. Pelengaris, M. Khan. Blackwell Publication.
4. Introduction to modern Virology, Dunmock N.J and Primrose.S.B., Blackwel Scientific Publications. Oxford, 1988.
5. An Introduction to Cellular & Molecular Biology of Cancer, Oxford Medical publications, 1991
6. Gene expression systems. Joseph M. Fernandez & James P. Hoeffler. Academic Press, 1999.
7. Cancer Biology IV Ed Volume 2 Raymond W Ruddon M.D.(2007)
8. Cancer Biology (3rd_Edition) Roger J.B. et al (2006)
9. Advances in Cancer Stem Cell Biology, Roberto Scatena, Alvaro Mordente& Bruno Giardina (Ed) – Springer (2012)

**IBTSS 02 Biomedical Technology****No. of Credits = 3****UNIT - I**

Cellular Pathology: Causes of cell injury, necrosis, biochemical mechanism, Ischemic and hypoxic injury. Apoptosis (Biochemical features, mechanisms)
 Immunological basis of diseases: Hypersensitivity (I – IV). Autoimmune diseases
 Preparation of polyclonal antisera: Characterization of antisera,
 Immunodiagnostic techniques

0.75

UNIT - II

Mutations and Genetic disorders. Single gene disorders, Receptor proteins (hypercholesterolemia). Cytogenic disorders (Trisomy, Klinefelters).
 Mutation in mitochondrial genes (LHDN), Fragile X-Syndrome.

0.5

UNIT - III

Types and grading of cancer. Introduction to molecular diagnosis of cancer. (Southern & Northern blot analysis, PCR based diagnosis).
 Gene therapy, immunotherapy and chemotherapy of cancer cells.

0.75

UNIT IV

Chemical mutagens.
 Carcinogenic agents and their cellular interactions.
 Radiation as health hazard. (Types, measurements, effects & protective measures)
 Introduction to DNA damage and repair mechanism.

0.5

UNIT - V

Molecular diagnosis (genetic disease, gene diagnosis, gene tracking & other diagnostic application of RDT) MRI, CT-SCAN. Reproductive Health Technologies – Intracytoplasmic sperm injection (ICSI), In-vitro fertilization (IVF).

0.5

Recommended Books: -

1. Biomedical Technology and Devices Handbook, James E Moore, George Zouridakis, CRC Press(2004)
2. Palermo GD, O'Neill CL, Chow S, et al. Intracytoplasmic sperm injection: state of the art in humans. *Reproduction*. 2017;154(6):F93-F110. doi:10.1530/REP-17-0374
3. Alukal JP, Lamb DJ. Intracytoplasmic sperm injection (ICSI)--what are the risks?. *UrolClin North Am*. 2008;35(2):277-x. doi:10.1016/j.ucl.2008.01.004
4. Wang J, Sauer MV. In vitro fertilization (IVF): a review of 3 decades of clinical innovation and technological advancement. *TherClin Risk Manag*. 2006;2(4):355-364. doi:10.2147/tcrm.2006.2.4.355

**Paper XLIX: IBTC 49 Plant Biotechnology****No. of Credits = 3****UNIT - I**

Laboratory and materials requirement for plant tissue culture technologies, 0.5
 Aseptic techniques, Plant tissue culture media-composition & preparation, Totipotency
 Clonal propagation / micropropagation, types and its applications
 Meristem culture, Callus culture, organogenesis, suspension culture,
 Conservation of plant genetic resources *in vitro*, its applications and limitations.

UNIT - II

Haploid culture: Androgenesis & Gynogenesis, Embryo culture 0.75
 & Embryo rescue, Protoplast culture & protoplast fusion – Cybrids, Symmetric &
 Asymmetric hybrid. Somatic embryogenesis and Somaclonal variation, cryo-preservation,
 production of synthetic seeds. Selection of stress tolerant cell lines: resistance to cold, high
 temperature, salt, drought, diseases and inhibitors.

UNIT - III

Transformation techniques, *Agrobacterium* mediated gene transfer, Biolistics, 0.5
 Comparison of DNA delivery techniques in plants, Integration of transgenes,
 action of transgenes, Antisense RNAi, and Overexpression approach for transgenics,
 Biotechnology related to fruit ripening, miRNA and stress response

UNIT - IV

Insect resistance, Bt crops, Cry protein and action, Molecular mechanisms- 0.75
 Flavr-savr tomato, Golden Rice and, Terminator gene technology.
 Plant pathogen interactions, strategies utilized by pathogens, genetic basis of plant
 pathogen interactions, Resistance genes (R genes) in plants, Phytohormones and
 cross talk, Molecular mechanisms of Oxidative stress and
 heat stress (HSPs etc.) in plants and genes related for stress tolerance.

UNIT - V

Plant growth promoting bacteria, PGPR traits, uses and applications, Biofertilisers, 0.5
 Phyto-priming for stress responses, Plants for cleaning contaminated soils-
 phytovolatilization, phytodegradation, phytostabilization, phytoextraction,
 Arsenic related biotechnological aspects

Recommended Books: -

1. P.K. Gupta: Elements of Biotechnology, Rastogi and Co. Meerut, 1996
2. R.J. Hanry: Practical Application of Plants Molecular Biology, Champan and Hall, 1997
3. H.D. Kumar: Modern Concepts of Biotechnology, Vikas Publ. Pvt. Ltd.
4. B.D. Singh: Biotechnology, Kalyani Publ.
5. Bhojwani SS and Razdan MK: Plant Tissue Culture: Theory and Practice- Elsevier
6. Stewart CN. Plant Biotechnology and Genetics. 2007. Wiley.

**Paper L: IBTC 50 Intellectual Property Rights, Bioethics, Bio-entrepreneurship****No. of Credits = 3****UNIT - I**

Introduction to intellectual property (IP); History and evolution of patent law, types of IP: patents, trademarks, copyright & related rights, Idea-expression dichotomy, industrial design, traditional knowledge, geographical indications, Significance of IPR. Introduction & Classifications of Patents, Patentability criteria. 0.75

UNIT - II

International conventions and Treaties- History of GATT & TRIPS Agreement, World Trade Organization, Post TRIPS scenario, Madrid Agreement; Hague Agreement; Budapest Treaty; Patent Cooperation Treaty; Indian Patent Act 1970 & recent Amendments, International framework for the protection of IP, India's IPR policy, World Intellectual Property Organization (WIPO) 0.5

UNIT - III

Discovery vs Invention, concept of 'prior art', invention in context of "prior art" Complexity arising in IP of Biotechnology, Case studies- Diamond vs Chakraborty IP as a factor in R&D; IPs of relevance to biotechnology, Legal and IPR issues in Biotechnology, Different Categories of IPR Instruments to Protect a Biotechnology IP, Licensing and compulsory licensing; Patent infringement, legal action, 0.5

UNIT - IV

Introduction to bioethics- definition, scope, Principles, significance. Issues of- ownership, monopoly, biodiversity, traditional knowledge access & benefit sharing., Social ethical issues in biotechnology. Biological weapons and their social and ethical implications, Bioethical issues in GMOs, Ethical issues in human cloning 0.5

UNIT - V

Concept of entrepreneurship, Introduction and scope in Bio-entrepreneurship, Risk and Benefits. General idea of the strategy and operations of bio-sector firms, Steps involved in commercialization of a biotechnological product, Introduction to the entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), Incubation Centre, Start-Up India 0.75

Recommended Books: -

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
2. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
3. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
4. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. <http://www.ipindia.nic.in/>
5. Karen F. Greif and Jon F. Merz, Current Controversies in the Biological Sciences -Case Studies of Policy Challenges from New Technologies, MIT Press
6. World Trade Organisation. <http://www.wto.org>
7. World Intellectual Property Organisation. <http://www.wipo.int>



Paper LI (a): IBTE 01a Protein Engineering

No. of Credits = 3

UNIT - I

Protein engineering – Introduction, definition and applications; Protein engineering as a tool to alter affinity and specificity; Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, etc. Protein engineering with unnatural amino acids and its applications. 0.75

UNIT - II

Protein stability measurement; Spectroscopic study of physicochemical properties of proteins: Fluorescence; UV absorbance; CD & ORD; Hydrodynamic properties–viscosity, hydrogen-deuterium exchange; Introduction to NMR spectroscopy and its importance in protein studies 0.5

UNIT - III

Protein stabilizing forces – Van der Waals, electrostatic, hydrogen bonding and weakly polar interactions, hydrophobic effects; Entropy – enthalpy compensation; Experimental methods of protein engineering: directed evolution like gene site saturation mutagenesis; Module shuffling; Guided protein recombination, etc. 0.5

UNIT - IV

Optimization and high throughput screening methodologies like GigaMetrix, High throughput microplate screens etc., Engineering antibody affinity by yeast surface display; Applications to vaccines, Peptidomimetics and its use in drug discovery. 0.5

UNIT - V

Computational approaches to protein engineering: sequence and 3D structure analysis, Data mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles vis-à-vis those from mesophiles; Protein design, Directed evolution for protein engineering and its potential. 0.75

Recommended Books: -

1. Edited by T E Creighton, (1997), Protein Structure: a Practical Approach, 2nd Edition, Oxford university press.
2. Cleland and Craik, (2006), Protein Engineering, Principles and Practice, Vol 7, Springer Netherlands.
3. Mueller and Arndt, Protein Engineering Protocols, 1st Edition, Humana Press. Ed. Robertson DE, Noel JP, (2004), Protein Engineering Methods in Enzymology, 388, Elsevier Academic Press.
4. J Kyte; (2006), Structure in Protein Chemistry, 2nd Edition, Garland publishers.



Paper LI (b): IBTE 01b Immunotechnology

No. of Credits = 3

UNIT - I

Antigen – Antibody Interactions: Precipitation Reactions and application, Immunological Assays: Immunodiffusion, Immunoelectrophoresis, Immunohistochemistry, Immunohistopathology; Agglutination Reactions and application, Complement Fixation, RIA, ELISA, Immunofluorescence, Western Blotting 0.5

UNIT - II

Introduction & production of monoclonal antibodies and hybridoma technology, Advantages and limitations of monoclonal Antibodies, Characterization & storage of monoclonal Antibodies, Commercial production of monoclonal antibodies, 0.5

UNIT - III

Monoclonal Ab production by recombinant DNA technology, Hybridoma technology vs RDT, application in diagnosis. 0.75
Engineered Monoclonal Antibodies: Chimeric and hybrid Monoclonal Antibodies, Monoclonal Antibodies constructed from Ig-gene libraries, Catalytic Monoclonal Antibodies (Abzymes). Cancer Immunotherapy

UNIT - IV

General physiology of cytokines, Application of cytokine for therapy, 0.5
Future development in cytokine therapy, Interferon colony stimulating factor, Preparation of lymphokines by r-DNA Technology.
Vaccines: Introduction and Types: Inactivated, Attenuated, Toxoid, Subunit And Multivalent vaccines, Purified macromolecules, Conjugate Vaccines.

UNIT - V

New generation vaccines: Synthetic peptide vaccines, Recombinant antigen vaccines, DNA vaccines. Immune stimulants, Adjuvants, Novel vaccine delivery systems. 0.75
Vaccines for specific diseases: Tuberculosis, Malaria, HIV/AIDS.
New emerging diseases and vaccine development: Ebola virus disease, SARS.

Recommended Books: -

1. Practical Immunology, 4th Ed., F.C. Hay, O.M.R. Westwood, Blackwell Publishing, 2002
2. Selected Methods for Antibody and Nucleic Acid probes, Volume1, S. Hockfield, S. Carlson, C. Evans, P. Levitt, J. Pintar, L. Silberstein, Cold Spring Harbor Laboratory Press, 1993.
3. Antibodies Laboratory Manual, Ed Harlow, David Lane, Cold Spring Harbor, Laboratory Press, 1988.
4. Spicuzza L, Spicuzza A, La Rosa M, Polosa R, Di Maria G. New and emerging infectious diseases. Allergy Asthma Proc. 2007 Jan-Feb;28(1):28-34. doi: 10.2500/aap.2007.28.2870. PMID: 17390754.
5. Trovato Maria, Sartorius Rossella, D'Apice Luciana, Manco Roberta, De BerardinisPiergiusepp. Viral Emerging Diseases: Challenges in Developing Vaccination Strategies . Frontiers in Immunology 2020 Vol. 11:2130
6. The Vaccine Book (2nd Ed.), Rafi Ahmed, Roy M. Anderson et. al. Editor(s): Barry R. Bloom, Paul-Henri Lambert, Academic Press, 2016, Pages xxi-xxiv, ISBN 9780128021743.



Paper LI (c): IBTE 01c Nanobiotechnology

No. of Credits = 3

UNIT - I

Introduction to Nanobiotechnology; Concepts, historical perspectives. 0.75
 Nanoparticles and nanotechnology, History, origin, principles.
 Chemical synthesis approach of nanoparticles, Physical synthesis of nanoparticles,
 Green synthesis approach for different nanoparticles applications and uses.
 Applications and limitations using physical and chemical approach.
 Advantages of using green synthesis using different examples

UNIT - II

Characterization of synthesized nanoparticles using XRD, SEM, TEM, HR-TEM, 0.5
 FTIR, UV spectrophotometer, Dynamic light scattering etc., Different types of
 nanoparticles and applications with examples, Safety and toxicity aspects of nanoparticles

UNIT - III

Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for 0.75
 suitability of administration through various routes of delivery, advantages, strategies
 for enhanced permeation through various anatomical barriers

UNIT - IV

Nanocomposites: Properties and applications; Nanoparticles for diagnostics and 0.5
 imaging (theranostics); Clinical Applications of Nanoparticles, Nanotech and cancer,

UNIT - V

Environmental impact of nanomaterials – Exposure and risk assessment – Mechanism 0.5
 of toxicity, Toxicological impacts of Nanomaterials-Ecotoxicological impact of
 Nanomaterials, Nanotechnology in Agriculture, Nanofactories

Recommended Books: -

1. Gero Decher, Joseph B. Schlenoff, (2003); *Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials*, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); *Bionanotechnology: Lessons from Nature*; Wiley-Liss
3. Neelina H. Malsch (2005), *Biomedical Nanotechnology*, CRC Press
4. Greg T. Hermanson, (2013); *Bioconjugate Techniques*, (3rd Edition); Elsevier
 Recent review papers in the area of Nanomedicine

**Paper LII (a): IBTE 02a_Food & Beverages Biotechnology****No. of Credits = 3****UNIT - I**

Food and Microorganism: Microorganism in food & beverage industry, contamination of food. General principles underlying spoilage and chemical changes 0.5

UNIT - II

Contamination and spoilage of different kinds of food & beverages: Cereals & Cereal products, sugar and sugar products, Vegetables and Fruits, Meat, Fish, Poultry & Eggs, Sea food, Milk & Milk products, Canned foods, Alcohol & alcoholic beverages, Fruit juices & soft drinks etc. 0.75

UNIT - III

Biotechnology of food and feed; Cultures & Fermentation, Beverage production: Alcohol & Alcoholic beverages, Fruit juices, Soft drinks, Feed production, SCP, Fats, Amino acid, Food additives. 0.5

UNIT - IV

Food, Beverages & Disease: Food borne illness due to bacterial food poisoning, Infection and Intoxication. Food-borne disease outbreaks, Disease-investigation, Materials & Equipments, Laboratory testing, Field analysis, Interpretation of data and preventive measures. 0.5

UNIT - V

Food hygiene: Food sanitation, Bacteriology of water and food products, Food manufacturing practice. Hazard analysis critical points. Food control: International agencies, Federal agency and law of state agencies, Processing industry and microbial criteria of food. Principles of food preservation, Preservation by high temperature, low temperatures, drying, food additives and radiation. 0.75

Recommended Books: -

1. Ashok Pandey, Guocheng Du, Maria Ángeles Sanromán, Carlos Ricardo Soccol, Claude-Gilles Dussap (2016) Current Developments in Biotechnology and Bioengineering. Food and Beverages Industry [1 ed.] Elsevier
2. Food Biotechnology. S.Bielecki, et al - (Ed) Elsevier Science (2000)
3. Food Biotechnology. Kalidas Shetty et al – CRC Press (2005)
4. Guadalupe Virginia Nevárez-Moorillón (editor), Arely Prado-Barragán (editor), José Luis Martínez-Hernández (editor), Cristobal Noé Aguilar (editor) (2016) Food Microbiology and Biotechnology: Safe and Sustainable Food Production [1 ed.] Apple Academic Press
5. Johnson-Green, Perry (2018) Introduction to Food Biotechnology Ed. 1. CRC Press



Paper LII (b): IBTE 02b Animal Biotechnology

No. of Credits = 3

UNIT - I

Animal cell culture: History; Basic requirements; Cell culture media and reagents; Animal cell, tissue and organ cultures; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Transfection and transformation of cells; Stem cells and their application; Induced Pluripotency. 0.5

UNIT - II

Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; embryo recovery and *in vitro* fertilization; cryopreservation of embryos; embryo transfer technology. Transgenic Animals: applications of transgenic animal technology; Techniques of gene transfer: Microinjection, Lipofection, Electroporation, Chemical based transformation, Viral Vectors. 0.75

UNIT - III

Animal Genomics: Introduction to animal genomics; Different methods for for characterization of animal genomes, SNP, STR, RFLP, RAPD, proteomics, metabolomics; Genetic basis for disease resistance; Gene knock out technology and animal models for human genetic disorders. Animal cloning - basic concept, cloning for conservation for conservation endangered species 0.75

UNIT - IV

Applications of Animal Cell Cultures: Cell Culture based products, Vaccines, Hybridoma technology, Monoclonal antibodies, *In vitro* testing of drugs; Production of pharmaceutical proteins; Stem Cells and their Use, Using Animals Cells for heterologous gene expression. Introduction to the concept of vaccines, conventional methods of animal vaccine production. 0.5

UNIT - V

Immunological and nucleic acid based methods for identification of animal species; DNA Barcoding; Detection of adulteration in meat using DNA based methods; Detection of food/feed adulteration with animal protein; Identification of wild animal species using DNA based methods. 0.5

Recommended Books: -

1. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press
2. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
3. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
4. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker
5. R.E. Spier and J.B. Griffiths (1985). Animal Cell Biotechnology. Vol I and II, Academic Press.



Paper LII (c): IBTE 02c Enzymology & Enzyme Technology

No. of Credits = 3

UNIT - I

Properties of enzymes : Catalytic power, specificity, Holoenzymes, Apoenzyme, Coenzyme and Cofactor. Nomenclature and classification of enzymes, active site- Fischer and Koshland models. Collision theory, activation energy and transition state energy, the law of mass action and order reaction. 0.5

UNIT - II

Enzyme kinetics: Kinetics of single substrate enzyme catalyzed reaction, Equilibrium steady state assumption (Michaelis-Menten), transformation of Michaelis Menten equation, Lineweaver Burk, Eadie-Hofstee, Hanes plots. Determination of V_{max} , K_m , K_{cat} and their significance. Effect of pH, temperature, enzyme and substrate concentration on enzyme activity. Single displacement and double displacement reaction. 0.75

UNIT - III

Enzyme Inhibition: Reversible inhibition- competitive, uncompetitive and non competitive inhibition, allosteric and irreversible inhibitions. Assay of enzymes: Coupled kinetic assay, units of enzyme activity (IU), Turnover number, purification of enzymes and criteria of purity. 0.5

UNIT - IV

Enzyme catalysis: Tapping the enzyme -substrate complex, use of substrate analogues, enzyme modifications by chemical procedures affecting amino acid chain, treatment with protease, site directed mutagenesis, Allosteric enzymes with special reference to aspartate transcarbamylase and phosphofructokinase. Concerted and sequential models. Isozymes- special reference to lactate dehydrogenase. Ribozymes. 0.75

UNIT - V

Mechanism of enzyme action: General mechanistic principle, Factors contributing to the catalytic efficiency-proximity and orientation, nucleophilic and covalent catalysis, acid-base catalysis, metal ion catalysis. 0.5
Mechanism of reactions catalyzed by enzymes: Specific examples (Chymotrypsin, Lysozyme, Ribonuclease and Carboxypeptidase).

Recommended Books: -

1. Lehninger Principles of Biochemistry, Seventh Ed. 2017, Nelson & Cox, Macmillan Publishers.
2. Text book of Biochemistry, West, E.S., Todd, Manson & Vanbruggen. Macmillan.
3. Organic Chemistry Vol 2: Stereochemistry and the Chemistry of Natural Products, 5th, Fifth Edition
4. Biochemistry, Zubay, G. Fourth Edition, Wm.C. Brown Publishers, 1998.
5. Enzymology, Devasena T. 2010. Oxford University Press.

**IBTSS 03 Research Methodology: Tools & Techniques****No. of Credits = 3****UNIT - I**

Importance and need of scientific research. 0.75
 Problem identification, objectives, significance, scope and limitations.
 Literature survey: Use of books, journals, libraries, online survey.
 Importance and designing of the problem to be undertaken.

UNIT - II

Field survey, site selection, source selection for data acquisition. 0.5
 Sampling techniques: Simple and random sampling,
 Systematic sampling, Stratified sampling, Multistage sampling,
 Cluster sampling, Multiphase sampling, Sample size,
 Frequency, Bias, Error.

UNIT - III

Methods: Data collection, types of data, qualitative and quantitative data. 0.75
 Primary and secondary data, data summarization
 Data representation: Tabular and diagrammatic representation of data.
 Measures of central tendency: Use of mean, mode, median. Data interpretation.

UNIT - IV

Measures of dispersion: Use of range, variance, standard deviation, standard error. 0.5
 correlation, multiple correlations,
 regression, multiple regressions, standard error of estimate.
 Test of significance: t-test, 95% confidence limit,
 Chi square test, F-test, Multivariate test.

UNIT - V

Project Report Preparation: Introduction of the problem, Materials and methods, 0.5
 Review of literature, Results, Discussion (interpretation of results),
 Referencing technique, Summary of research/Abstract etc.
 Publication of scientific data, writing research paper & report.

Recommended Books: -

1. Holmes, Moody, Dine: Research Methods for the Biosciences, 1st Indian ed., Oxford University Press, 2006.
2. N. Gurumani: Research Methodology for Biological Sciences, 1st ed., MJP Publishers, 2008.
3. Schmauder: Methods in Biotechnology, Taylor & Francis Publishers, 2003

**IBTSS 04 Science Communication & Scientific Writing****No. of Credits = 3****UNIT – I**

Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; 0.75

UNIT - II

Barriers to effective communication; power of effective listening; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; 0.5

UNIT - III

Use of ICT in Biology, Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; Keywords and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy for communication with peers and collaborators/scientists. 0.75

UNIT - IV

Importance of communicating science, problems during communication Importance of reading scientific communications 0.5
 Technical writing skills - types of reports; layout of a formal report;
 Scientific writing skills – types; importance
 Platforms for scientific reading

UNIT - V

Plagiarism, why there is need to plagiarize, Image and text plagiarism, softwares for plagiarism; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct. 0.5

Recommended Books: -

1. Valiela, I. (2001). *Doing Science: Design, Analysis, and Communication of Scientific Research*. Oxford: Oxford University Press.
2. *On Being a Scientist: a Guide to Responsible Conduct in Research*. (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. *The Science of Scientific Writing*. *American Scientist*, 78 (Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). *Speaking English Effectively*. Delhi: Macmillan India.
5. Movie: Naturally Obsessed, The Making of a Scientist



Paper LV: IBTC 52 Environmental Biotechnology

No. of Credits = 3

UNIT - I

Introduction to environment; pollution types and its control; pollution indicators; sources of wastes and pollutants of water and soil, waste management: Domestic, industrial treatment of liquid waste, aerobic and anaerobic waste water treatment, Treatment of solid waste, Landfills, hazards of landfill contributions of biotechnology to waste treatment 0.5

UNIT - II

Bioremediation: Fundamentals, methods and strategies 0.5
Phytoremediation: Fundamentals and description of major methods and application
Application of bacteria and fungi in bioremediation uses, advantages vs disadvantages.
Bioremediation of metals, radionuclides, organic pollutants (PAHs, PCBs, Pesticides, TNT, xenobiotic compounds), technological aspects of bioremediation (*in situ*, *ex situ*)

UNIT - III

Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; microorganisms involved and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers 0.5

UNIT - IV

Biofungicides: Description of mode of actions and mechanisms (e.g. *Trichoderma*, *Pseudomonas fluorescens*); Biofertilizers: Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems, PGPR and heavy metals, Halotolerant PGPR and prospects, Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration, phytostabilization), Biotechnological aspects of phytoremediation, biodegradation of xenobiotic compounds, 0.75

UNIT - V

Bioinsecticides and biopesticides: *Bacillus thuringiensis*, genetic modifications and aspects of safety in their use; Role of GMOs in environment clean-up, Dye removal using biotechnological interventions, Oil spillage and biotechnological remedies, Biosensors for environment monitoring and analysis, Nanotechnology and its applications, metallic nanoparticle uses, Green nanomaterials for environmental cleaning, Algal biotechnology- concepts, uses and applications, Use of mixed microbial populations 0.75

Recommended Books: -

1. Frederick W Pontinus, Water Quality & Treatment. American water works Association, MC Graw Hill
2. Fundamentals of Environmental Science: G. S. Dhaliwal, G. S. Sangha and P. K. Raina, Kalyani Publication
3. Perry L. McCarty; Bruce E. Rittmann (2020) Environmental biotechnology: principles & applications 2nd Ed Springer
4. Pramod Kumar; Vipin Kumar (2018) Textbook of Environmental Biotechnology. Woodhead Publishing India
5. Raman Kumar, Anil Kumar Sharma, Sarabjeet Singh Ahluwalia (eds.) (2017) Advances in Environmental Biotechnology [1 ed.] Springer Singapore



Integrated 5Yrs M.Sc. Biotech 10th Sem.

Paper LVI: IBTC 53 Fermentation & Bioprocess Technology

No. of Credits = 3

UNIT - I

Introduction to fermentation and its types, Isolation, screening, improvement and preservation of Industrially important microbes; Microbial growth kinetics in batch, continuous and fed-batch processes. 0.5

UNIT - II

Media formulation for industrial fermentation, Requirement of precursors, inducers and antifoam agents as media additives; Medium optimization; Volumetric mass-transfer coefficient and its measurement, Kinetics of sterilization. 0.5

UNIT - III

Types of bioreactors (CSTR, bubble column, airlift, fluidized bed, packed bed): General configuration and applications; Scale up and scale down; Measurement and control of bioprocess parameters 0.75

UNIT - IV

Down Stream Processing: Cell disruption techniques; Separation techniques: filtration, centrifugation, sedimentation, flocculation, liquid-liquid extraction, precipitation, reverse osmosis, ultrafiltration; Drying; Crystallization; Storage and packaging. 0.5

UNIT - V

Industrial production (Microorganisms and raw material/media used, fermentation conditions and purification steps) and uses of fermentation products: Ethanol, Butanol, Antibiotics (Penicillin, Tetracycline), Alcoholic beverages, Enzymes (Glucose isomerase, Protease), Xanthan gum, Baker's yeast. Solid state fermentation and its applications 0.75

Recommended Books: -

1. Shuler, M. L., &Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F. & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Blanch, H. W., & Clark, D. S. (1997). Biochemical Engineering. New York: M. Dekker.
4. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
5. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.

**Paper LVII (a): IBTE 04a_Advanced Bioinformatics****No. of Credits = 3****UNIT - I**

Introduction, definition and history of Bioinformatics. 0.5
 Introduction to Internet, bibliographic and non bibliographic search, PubMed
 Introduction biological databases (primary, secondary and composite databases).
 Biological information system: SRS, ENTREZ (Structure and use on web).

UNIT - II

Introduction to Data mining: Classification, clustering, data collection, 0.75
 data Warehousing, data preprocessing, Applications of data mining and genomes
 mining. Databases: Nucleotide sequence information sources: GenBank, EMBL,
 EBI, DDBJ, UCSC. Protein sequence information sources: PIR, ExpASY,
 UniProt KB, SwissProt, TrEMBL,
 Protein structure information sources: PDB, SCOP, CATH, HSSP.

UNIT - III

Biocomputing : Introduction to String matching algorithms, 0.75
 Database search techniques, sequence comparison and alignment techniques,
 Use of Biochemical scoring matrices, Introduction to Graph Matching Algorithms,
 Automated genome comparison and its implication, Automated gene prediction,
 Gene arrays, Analysis of gene arrays. Introduction to signaling pathways and
 pathway regulation (KEGG), Systems biology-an introduction

UNIT - IV

Genoinformatics, Genome Annotation: Introduction, ORF's. 0.5
 Gene mapping and applications: Genetic and physical mapping,
 Transcriptome and Proteome- General account. Sequence Alignment: Pairwise and
 multiple alignment, Dynamic programming. Softwares (SSearch, BLAST, FASTA,
 CLUSTAL W), Phylogenetic analysis: Phenetic and Cladistic approach.
 Phylogenetic tree construction (rooted and unrooted method),
 Completed Genomes: Bacterium, nematode, plant and human

UNIT - V

Production of protein structure & modeling. Protein primary & secondary structure, 0.5
 prediction Methods – Introduction to various methods. Tertiary structure prediction
 (Homology & Threading Methods) Profiles, Motifs – Regular expressions. Repeat finding
 and pattern recognition. Molecular modeling, Docking and rational Drug design.

Recommended Books: -

1. Moorhouse & Barry: Bioinformatics, Biocomputing and Perl (Wiley-liss publications).
2. Jones & Prvzner: Introduction to Bioinformatics Algorithm, Anne Press.
3. Pevsner: Bioinformatics & Functional Genomics, Wiley-publication.
4. Bourne & Weissig: Structural Bioinformatics, Wiley-Liss Publication.
5. Gustafson, Shoemaker, Snape: Genome Data Mining Exploitation: the Genome.
6. Richard S Larson: Bioinformatics and drug discovery, humana press.
7. Sharma, Munjal & Shankar: A Text Book of Bioinformatics, Rastogi Publication



Paper LVII (b): IBTE 04b Herbal Biotechnology

No. of Credits = 3

UNIT - I

Herbal medicines: history and scope. Local health traditions, ethnomedicines 0.5
Important Medicinal and aromatic plants (MAPs) of Garhwal Himalayas- their diversity, distribution, traditional knowledge,

UNIT - II

Phytochemistry - active principles of herbal drugs-Biological testing, phytochemical 0.75
screening for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds, fatty acids, tannins, glycosides and volatile oils etc.)
Knowledge of few important MAPs, their uses etc. *Aconitum*, *Andrographis*,
Nardostachys jatamansi, *Picrorhiza*, *Coleus*, *Rhododendron*, *Acorus calamus*,
Swertia chirata, *Tinospora cordifolia*, *Berberis* etc.

UNIT - III

Phytometabolites of medicinal importance, Important genes and proteins related to 0.5
metabolites, Signaling pathways, Transgenic plants- Overexpression and downregulation approach to manipulate the metabolite levels in few medicinal plants like *Andrographis paniculata* etc.

UNIT - IV

Diseases associated with raw/processed medicinal plants, and diagnostics related 0.75
Few initiatives for cultivation and conservation of medicinal plants,
Plant Tissue culture as an alternative for conservation of MAPs- prospects and challenges, Demand and supply, Herbal Industries at national and state levels.
Ministry of AYUSH, National/ State Medicinal plant board- Organization, aims, objectives and mandate Ayurveda Biology, Role of herbal drugs at International levels

UNIT - V

Economic importance, biotechnological applications and challenges of 0.5
herbal biotechnology. Green synthesis of nanoparticles using medicinal plants
Phytopharmaceuticals: examples and applications
Neutraceuticals: examples and applications

Recommended Books: -

1. B.D. Singh A textbook of biotechnology.
2. G. Patrick, Medicinal Chemistry. (2002)
3. Shah and Seth, Text book of Pharmacognosy and phytochemistry (2010) Elsevier publications



Paper LVII (c): IBTE 04c Genomics & Proteomics

No. of Credits = 3

UNIT - I

Basics of genomics and proteomics, Brief overview of prokaryotic and eukaryotic genome organization; Chromatin organization; Extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast. 0.5

UNIT - II

Genome mapping, Genetic and physical maps; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, comparative gene mapping 0.5

UNIT - III

Genome sequencing projects; Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web. 0.75
Comparative genomics; Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs.

UNIT - IV

Proteomics; Aims, strategies and challenges in proteomics; proteomics technologies: MALDI-TOF, yeast 2-hybrid system, Surface Plasmon Resonance (SPR), proteomics databases. 0.5

UNIT - V

Functional genomics and proteomics; Transcriptome analysis, functional annotation of gene, Contig assembly, mining functional genes in genome, gene function- forward and reverse genetics, protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics. 0.75

Recommended Books: -

1. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell Pub.
2. Liebler, D. C. (2002). *Introduction to Proteomics: Tools for the New Biology*. Totowa, NJ: Humana Press.
3. Campbell, A. M., & Heyer, L. J. (2003). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings

**IBTSS 05 Vaccines & Drug Development****No. of Credits = 3****UNIT - I**

Molecular Basis of Disease: Bacterial, Overview of Pathogenesis, diagnosis and treatment; Viral Overview of Pathogenesis, diagnosis and treatment, Host-virus Interaction, Progression of viral disease in host, Challenges in treatment. 0.5

UNIT - II

Biology of Parasites: Malaria, Dengue, Filariasis, Amebiasis. Parasite life cycle, Parasite-vector interactions, Parasite-Host Interactions, Pathogenesis, Diagnosis, Treatment and drug resistance. 0.5

UNIT - III

Drug Designing, Molecular Modeling, Molecular docking, Structure based Drug Designing, rational drug design, Lead Molecule Identification and optimization, validation. Drug Target Discovery, *in silico* drug discovery, Mechanism of action. Challenges 0.5

UNIT - IV

History of vaccines, Conventional vaccines; Bacterial vaccines; Viral Vaccines; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine, vector vaccines, anti-idiotypic vaccines; Multivalent subunit vaccines; immune stimulants. 0.75

UNIT - V

Vaccine delivery systems (liposome, microsphere and nanoparticle mediated) and immunostimulatory adjuvants, Edible vaccines. 0.75
General account of the different stages in development of new vaccines and clinical trials, Overview of the different steps in vaccine manufacture.

Recommended Books: -

1. Janeway, C. A., Travers, P., Walport, M., & Shlomchik, M. J. (2005). *Immuno Biology: the Immune System in Health and Disease*. USA: Garland Science Pub.
2. Kindt, T. J., Osborne, B. A., Goldsby, R. A., & Kuby, J. (2013). *Kuby Immunology*. W.H. Freeman.
3. Kaufmann, S. H. (2004). *Novel Vaccination Strategies*. Weinheim: Wiley-VCH.
4. Journal Articles (relevant issues) from: *Annual Review of Immunology*, *Annual Review of Microbiology*, *Current Opinion in Immunology*, *Nature Immunology*, *Expert review of vaccines*
5. <https://www.nature.com/subjects/structure-based-drug-design>
6. D.J. Abraham, *Structure-Based Drug Design – A Historical Perspective & the Future*, Ed(s): John B. Taylor, David J. Triggle, *Comprehensive Medicinal Chemistry II*, Elsevier, 2007, Page 65-86.
7. J.S. Mason, *Introduction to the Volume and Overview of Computer-Assisted Drug Design in the Drug Discovery Process*, Editor(s): John B. Taylor, David J. Triggle, *Comprehensive Medicinal Chemistry II*, Elsevier, 2007, Pages 1-11,

**IBTSS 06 Molecular Virology****No. of Credits = 3****UNIT - I**

History of Virology and Biosafety: History and principles of virology, Virus taxonomy. 0.75
 Structures of animal and plant viruses and their morphology.
 Principles of biosafety, containment facilities, maintenance and handling of laboratory animals, and requirements of virology laboratory.

UNIT - II

Virus Replication: Structure and replication strategies of bacteriophages - T7, λ, ΦX174, 0.5
 and plant viruses - ss RNA virus (TMV) and ds DNA virus (CaMV). Structure and replication strategies of animal viruses - Influenza virus, Adeno virus and Retro virus.

UNIT - III

Interferon and Antiviral Agents: Viral Interference and interferons. Nature and source of 0.5
 interferons, Classification of interferons. Induction of interferon.
 Antiviral agents (chemical and biological) and their mode of actions.

UNIT - IV

Cultivation of Viruses and Viral Vaccines: Cultivation of viruses in embryonated egg, 0.5
 Tissue culture and Laboratory animals. Conventional vaccines - Killed and attenuated.
 Modern vaccines - Recombinant proteins, subunits, DNA vaccines, peptides,
 Immunomodulators (cytokines). Vaccine delivery and adjuvants, Large-scale manufacturing.

UNIT - V

Virological Methods: Methods for purification of viruses with special emphasis on 0.75
 ultracentrifugation methods. Quantitative diagnostic methods - Haemagglutination,
 Complement fixation, neutralization,
 Nucleic acid based diagnosis - PCR, microarray and nucleotide sequencing.

Recommended Books: -

1. General Virology - Luria and Darnel Virology and Immunology - Jokli
2. Text book of Virology - Rhodes and Van Royen
3. Genetics of bacteria and their viruses - W. Hayes
4. Molecular Biology of the gene - Watson, Roberts, Staitz and Weiner
5. Virological Procedures - MitchalHaskingVirology - Wilson and Topley
6. Infection and Immunity DH Davies, MA Halablab,, et al (1998) Taylor & Francis Ltd, 1, London