



INDRASHIL UNIVERSITY

(Established by an Act under the Gujarat Private Universities Act, 2009)

A Life Sciences University

Sustained Excellence with Relevance



योग: कर्मसु कौशलम्

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DEPARTMENT OF BIOSCIENCES

PROGRAM STRUCTURE & DETAILED SYLLABUS

B.Sc. BIOSCIENCES (Hons) 2019-2022



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SEMESTER – I			
Subject code	Subject Name	L-T-P	Credits
BIO1 101	Physics	3-1-0	4
BIO1 102	Communication Skills I	1-1-0	2
BIO1 103	Biological Diversity of Gujarat	3-1-0	4
BIO1 104	Environmental Science	3-1-0	4
BIO1 105	Laboratory I (Electronics and Instrumentation)	0-0-8	4
BIO1 106	Laboratory II (Analytical Techniques in Biological Sciences)	0-0-8	4
	Total	10L+4T+16P	22
SEMESTER – II			
Subject code	Subject Name	L-T-P	Credits
BIO1 201	Evolutionary Biology	3-1-0	4
BIO1 202	Physiology (Plant and Animal)	3-1-0	4
BIO1 203	Structure and Function of Biomacromolecules	3-1-0	4
BIO1 204	Chemistry (Bioorganic, Bioinorganic and Physical)	3-1-0	4
IU1 001	Soft Skills I	1-0-0	0
BIO1 205	Laboratory I (Biomolecules, Evolutionary Biology)	0-0-8	4
BIO1 206	Laboratory II (Physiology, Chemistry)	0-0-8	4
	Total	13L+4T+16P	24



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SEMESTER – III			
Subject code	Subject Name	L-T-P	Credits
BI02 101	Biophysics	3-1-0	4
BI02 102	Ecology	3-0-0	3
IU2 000	Community Connect Project	0-0-2	1
BI02 103	Metabolism and Tissue Function	3-1-0	4
BI02 104	Cell Biology	3-1-0	4
IU2 001	Communication Skills I	1-1-0	0
BI02 105	Laboratory I (Biophysics, Ecology)	0-0-8	4
BI02 106	Laboratory II (Cell Biology)	0-0-8	4
	Total	13L+4T+18P	24
SEMESTER – IV			
Subject code	Subject Name	L-T-P	Credits
BI02 201	Growth and Reproduction in Plants	3-1-0	4
BI02 202	Enzymology	3-1-0	4
BI02 203	Light and Life	3-1-0	4
BI02 204	Microbiology	3-1-0	4
IU2 002	Soft Skills II	1-0-0	0
BI02 205	Laboratory I (Enzymology)	0-0-8	4
BI02 206	Laboratory II (Microbiology)	0-0-8	4
	Total	13L+4T+16P	24



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SEMESTER – V			
Subject code	Subject Name	L-T-P	Credits
BI03 101	Differentiation and Morphogenesis in Animals	3-1-0	4
BI03 102	Membrane Biology	3-1-0	4
BI03 103	Molecular Biology	3-1-0	4
BI03 104	Biomaterials	3-1-0	4
BI03 105	Laboratory I (Introductory Computational Biology)	0-0-4	2
BI03 106	Laboratory II (Molecular Biology, Differentiation and Morphogenesis in Animals)	0-0-12	6
	Total	12L+4T+ 16P	24
SEMESTER – VI			
Subject code	Subject Name	L-T-P	Credits
BI03 201	Project/Industrial Visit/Comprehensive Viva	0-0-12	6
BI03 202	Defense Mechanisms	3-1-0	4
BI03 203	Genetics	3-1-0	4
BI03 204	Organic Chemistry	3-1-0	4
BI03 205	Recombinant DNA Technology	2-0-0	2
IU CCID	Innovative project (Concept, Conceive, Implement and Deliver)		02 *
	Total	11L+3T+12P	22

***Student can take it up this innovative project in-between 3-4 semesters.**

Credit to hours calculation:

Lecture: 1h = 1C

Practicals: 2h = 1C

Total Credits = 140



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B.Sc. Biosciences (Hons)

SEMESTER - I

BIO1 101 Physics (L-T-P-C: 3-1- 0-4)

Unit 1: Vector Physics

Introduction to Scalar and Vectors, Dot and Cross Products, Triple Products and Its Physical Interpretation, ∇ Operator, Vector Operations: Gradient, Divergence and Curl, Their Physical Interpretation, Gauss' Divergence Theorem, Stokes Theorem, Problems.

Unit 2: Modern Optics

Two slit Interference, Diffraction, Resolving power, Resolution of the eye, Laser characteristics, Principle, Population inversion, Application of laser in medical science, Polarization of EM wave, Malus Law, Polarizing materials, Polarizer, Analyzer, Dipole properties of cell.

Unit 3: Membrane Physics

Colloidal solution, Micelles, reverse micelles, bilayers, liposomes, phase transition of lipids, active, passive and facilitated transport of solutes and ions, Fick's Laws, Nernst Planck Equations, Diffusion, Osmosis, Donnan effect, permeability coefficient. Ionophores, transport equation, membrane potential, water potential.

Unit 4: Material Science and Nanotechnology

Band theory of solids: Introduction, Metals, Insulators and Semiconductors, Energy band gap, Fermi Level and Fermi energy, Types of magnetic materials, Superconductivity, Properties of superconductors, Types of superconductors (Type I and Type II), London's Penetration depth, Applications of Superconductors.

Introduction to Nano-science and Nano-technology, Method of Producing, Properties, Physics of Nano material, Quantum Confinement, Synthesis of Nano materials, Shape Memory Alloys and Metallic Glasses.

Text Books:

- (1) Fundamentals of Physics By David Halliday, Robert Resnick and Jearl Walker (Wiley India Edition)
- (2) Engineering Physics by G. Vijaykumari (Vikas Publishing House Pvt. LTD.)
- (3) Introduction to Solid State Physics by Charles Kittel (John Wiley & Sons).
- (4) A Textbook of Nano-science and Nano-technology Textbook by T. Pradeep (Tata Macgraw Hill Education Private Limited).
- (5) Principles of Biochemistry by Albert L. Lehninger, David L. Nelson, Michael M. Cox, University Michael M Cox, W. H. Freeman, 2005.

Reference Books:

1. Physical Biochemistry, David Freifelder, Applications to Biochemistry and Molecular Biology, 2nd Edition, W.H. freeman and Company, 2005.
2. Hoppe et. al., Biophysics, Translation of 2nd German Edition, Springer Verlag, 1983.
3. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition, Cambridge University Press, 2005.



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BI01 102 Communication Skills I (L-T-P-C: 1-1-0-2)

Unit 1: Communication Skills

Importance of Communication Skills, Communication Cycle, Types, Flows, Barriers, Non-verbal communication

Unit 2: Listening Skills

Types of Listening, Barriers to Effective Listening, Tips to improve Listening Skills

Unit 3: Grammar

Articles, Prepositions, Tenses, Concord, Adjectives & degrees of Comparison, Adverbs

Unit 4: Speaking Skills

Impromptu, Short situational dialogues/conversation, Short speeches, Presentations

Unit 5: Reading Skills

Difference between Skimming & Scanning, Identifying main idea and topic, guessing the meanings of words

Text Books:

1. *"Communication Skills"*, - Dr.Sanjay Kumar and Dr.PushpLata, Oxford University Press
2. *"Technical Communication; Principles and Practice"* – Meenakshi Raman & Sangita Sharma (Oxford University Press)

Reference Books:

1. *"Effective Technical Communication"* -M Ashraf Rizvi
2. *"Macmillan Foundation English"* – R.K. Dwivedi & A. Kumar, MacMillan India Limited
3. *"High School English Grammar"* –Wren & Martin
4. *"Communication Skills"* –Asha Kaul, Tata McGraw Hill, 2nd Ed.
5. *"Text Book of Communication Skills"*-Vitthal Patel and Unnat Patel, Ria Publishing House

Note: Tutorials and Lab sessions will be based on the above course.



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BI01 103 Biological Diversity of Gujarat (L-T-P-C: 3-1-0-4)

Unit 1: Classification of Living Organisms

Nomenclature, Principles of classification, Taxonomy, Taxonomical aids. Five kingdom classification: Monera, Protista, Fungi, Plantae and Animalia. Classification of Plant kingdom: Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms (Dicotyledons and Monocotyledons)

Unit 2: Flora of Gujarat in Relation to India

Plant species diversity, Species recorded, Endemism and rarism, Plant taxonomical studies, Biogeographic zones, Threatened species, distribution and abundance of floraistic diversity, Wild relatives of cultivated plant; Domesticated diversity; Spice diversity; Checklist of flowering plants (Different Districts). Structural and functional attributes of vegetation. Plant succession: concepts and processes. Techniques of vegetation surveys and quantification

Unit 3: Fauna of Gujarat

Classification of Animal Kingdom- Animal sub-kingdom, Phylum, Sub-phylum, Super-class, Class. Forest diversity and wild life in Dry deciduous forests (Gir), Majestic grasslands, vast landscapes, Wetland habitats, Marine ecosystems and Rich moist deciduous forests

Unit 4: Biodiversity Conservation

Biodiversity, India as a mega biodiversity nation, ex-situ, in-situ conservation, Biotechnology and Conservation, hot spots of biodiversity. National and zoological parks, biosphere reserves, sustainable ecological processes (ecotourism sacred groves, germplasm banks), Island biogeography, Sacred flora and fauna. Germplasm banks, National Parks, Botanical Gardens; Wildlife Sanctuaries, Bio resources; Restoration Ecology; Importance of biodiversity in daily life. Biodiversity and climate change; Red data book; endangered extinct and endemic species of plants and animals. Value of biodiversity: Consumptive use and productive use.

Suggested Readings:

1. Shah, G. L. (1978), Flora of Gujarat State Vol. I-II. Sardar Patel University, VallabhVidyanagar –
2. Patel, R. I. (1984), Forest flora of Gujarat state (2nd Edition) Forest Department, Gujarat State, Baroda –
3. Gaston, K.J. & Spicer, J.I. (1998) Biodiversity. An Introduction. Oxford: Blackwell- Wilson EO, Peter FM, editors) Biodiversity.. Washington (DC): National Academies Press (US); 1988
4. Mark J. Lewis (2010), Classification of Living Organisms. The Rosen Publishing Group



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BI01 104 Environmental Science (L-T-P-C: 3-1-0-4)

Unit 1: Ecosystem

a. Concept of an ecosystem b. Structure and functions of an ecosystem c. Producers, consumers and decomposers d. Food chain, food webs and ecological pyramids e. Characteristic features of the following ecosystems: Forest ecosystems, Desert ecosystem, Aquatic ecosystems.

Unit 2: Natural Resources

Definition, scope and importance. Need for public awareness: a. Forest resources: Uses and over-exploitation. Deforestation, mining and construction of dams. b. Water resources: Uses and over-utilization. Effects of over utilization of surface and ground (sub- surface) water. c. Mineral resources: Uses and exploitation, environmental effects of extraction and use of mineral resources. d. Food resources: World food problems, Effects of modern agriculture: by using fertilizers and pesticides. e. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.

Unit 3: Environmental Pollution & Toxicology

a. Definition b. Causes, effects and control measures for i. Air pollution ii. Water pollution iii. Soil pollution iv. Noise pollution. Global warming and Ozone layer depletion. Environmental protection Act. c. Role of individual in prevention of pollution
Adverse effects of chemicals (pollutants) on living organisms, Effect of toxins on biotic & abiotic component of environment.

Unit 4: Social Issues and the Environment

- a. Water conservation, rain water harvesting and watershed management.
- b. Population explosion and its impact on environment.
- c. Environmental and human health
- d. Role of Information Technology in Environmental and human health.

Reference Books:

1. Environmental Studies by Dr. M. Satyanarayana, Dr. M.V.R.K. Narasimhacharyulu, Dr. G. Rambabu and Dr. V. Viveka Vardhani Published by Telugu Academy, Hyderabad.
2. Environmental Studies by R.C. Sharma, Gurbir Sangh published by Kalyani Publishers.
3. Environmental Studies by Purnima Smarath published by Kalyani Publishers.



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BI01 105 Laboratory I (Electronics and Instrumentation) (L-T-P-C: 0-0-8-4)

1. Study of components, functioning of pH meter and it's use in biological sciences
2. Understanding and working of electron conductivity (EC) meter
3. Principles, understanding of components and working of colorimeter and spectrophotometer
4. Principles, components, working of centrifuges and its use in biological sciences
5. Sterilization techniques: Principles & operations –
 - a. Autoclave
 - b. Hot air oven
 - c. Laminar air flow
6. Principles & operations of Incubators & Shakers.
7. Basic measurement techniques using Vernier Callipers and Micrometer Screw Gauge.
8. Refractive index of a liquid.
9. To study p-n junction characteristics.
10. Newton's rings.



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BI01 106 Laboratory II (Analytical Techniques in Biological Sciences) (L-T-P-C: 0-0-8-4)

1. Understanding the concept of pH, Molarity, Normality and operation of pH meter
2. Preparation of various buffers ranging from 1M NaCl, 1N NaOH, Tris HCl with different pH values preparation of Phosphate buffers
3. Estimation of Oxalic acid by titrating it with KMnO_4
4. Estimation of Fe (II) ions by titrating it with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal indicator
5. Determination of pKa, iso-electric point of Amino Acid (Glycine)
6. Field work on finding and taxonomical labeling of the plants in campus
7. Field work on finding and taxonomical labeling the Animals/insects/birds in/around campus
8. Building University Biodiversity register/data bank
9. Taxonomy, study through charts of representative Plants/Animal/Microbes
10. Field study and biodiversity indices (α , β diversity, sp. richness, sp. evenness, Shannon's index etc.)

Suggested Readings

1. Hand book on GLP by Dr. Deborah Kiyo, product research Development, TDR/WHO.
2. Nelson, D. L. and Cox, M.M. (2008). Lehninger, Principles of Biochemistry, 5th Edition, W.H.Freeman and Company, N.Y., USA.
3. Voet, D. and Voet, J.G. (2004). Biochemistry, 3rd Edition, John Wiley & Sons, Inc. USA



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SEMESTER II

BIO1 201 Evolutionary Biology (L-T-P-C: 3-1-0-4)

Unit 1:

History of Evolutionary thought-Pre-Darwinian concepts, Darwinism, post Darwinian concepts, Modern synthetic theory

Unit 2:

Evolution as seen in Geological record-Types of fossils, dating of fossils, Evolution of Plants and Fungi- Origin of land plants, Bryophytes (alternation of generations), early vascular plants (stellar evolution, sporangium evolution), Angiosperms (Phylogeny of major forms of plants), Fungi.

Unit 3:

Process of Evolutionary change - Concept of population, gene pool, gene frequency-conservation allele frequency (Hardy-Weinberg equilibrium), Change in gene frequencies (Genetic drift, gene flow, genetic load). Product of Evolutionary process- Speciation, concept of species, sub species, isolation mechanisms, modes of speciation (allopatric, sympatric, peripatric), anagenesis & cladogenesis, levels of evolutionary change (micro & macroevolution).

Unit 4:

Adaptations and extinction. Osmotic regulation and excretion of nitrogenous waste, protective coloration, mimicry. Periodic and mass scale, possible causes

Suggested Readings:

1. Ridley, M. (2004) Evolution. III Edition. Blackwell Publishing
2. Barton, N. H., Briggs, D.E.G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold Spring Harbour Laboratory Press.
3. Hall, B.K. and Hallgrimsson, B. (2008) Evolution. IV Edition. Jones and Bartlett Publishers
4. Stricberger, M.W. Evolution. Jones& Bartlett, USA 1996



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BI01 202 Physiology (Plant and Animal) (L-T-P-C: 3-1-0-4)

Unit 1: Photosynthesis

Light harvesting complexes: PS I, PSII; mechanism of electron transport, photooxidation of water, proton electrochemical potential-photophosphorylation. RuBisco, CO₂ fixation-Calvin cycle. Photorespiration, role of photorespiration in plants. C₄ cycle, CAM pathway. Photoprotective mechanism, photosynthetic quantum yield and energy conversion efficiency, factors affecting photosynthesis.

Respiration: Aerobic and anaerobic respiration (fermentation), Glycolysis, Krebs cycle, Plant mitochondrial electron transport and ATP synthesis –electron transfer complexes (complex I – IV). ATPas, oxidative phosphorylation, respiratory quotient (RQ)

Unit 2: Nitrogen Metabolism

Biological N fixation: free living and symbiotic bacteria in N fixation, structure of nitrogenase complex, biochemistry of N fixation – nodule formation, leghaemoglobin. Nitrate and ammonium assimilation.

Plant growth regulators and elicitors: Physiological effects and mechanism of action of auxins, gibberellins, cytokinins, ethylene and abscisic acid.

Unit 3: Digestion and Excretion

Digestion and absorption of carbohydrates, proteins and lipids in the alimentary canal. Classification of Animals on the basis of excretory products- Ammonotelic, Uricotelic and Ureotelic. Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit 4: Endocrine System

Endocrine glands - secretions and functions of Pituitary, Thyroid, Parathyroid, Adrenal glands and Pancreas, Hormone action and concept of secondary messengers, Male and female hormones.

Suggested Readings: (Physiology)

1. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
2. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XI Edition., McGraw Hill
3. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
4. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
5. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H. Freeman and Co.



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6. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.
7. R1. V.K. Jain. (2015). Fundamentals of plant physiology. 19th Edition. S. Chand
8. R2. S. K. Verma and Mohit Verma. (2007). Textbook of Plant Physiology and Biochemistry and Biotechnology. 6th Edition S. Chand
9. R3. H.N. Srivastva. (2005). Plant physiology. Pradeep publication
10. R4. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XI Edition., McGraw Hill

Suggested Readings: (Behaviour)

1. David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
2. Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge University Press, UK. 3. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
3. Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA



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BI01 203 Structure & Function of Biomacromolecules (L-T-P-C: 3-1-0-4)

Unit 1: Carbohydrates

Classification, Conformation of monosaccharides- cyclization of aldoses and ketoses, conformations, concept of mutarotation, anomers, epimers, general properties of monosaccharides, derivatives-sugar phosphate, sugar alcohol, sugar acids, deoxy and amino sugars, ascorbic acid (examples from biomolecules).

Disaccharides-Structure and functions of reducing and non-reducing sugars. Polysaccharides: Structural polysaccharides-cellulose and chitin. Storage polysaccharides-starch and glycogen.

Unit 2: Amino Acids and Peptide Conformation

Structure and classification of amino acids and proteins, ionization, essential and non-essential amino acids, chemistry of peptide bond, non-ribosomal peptide bond formation, amino acids as precursors of other bioactive compounds, zwitterion, isoelectric point, optical properties of amino acids, Beer-Lambert Law.

Protein structures:

Primary structure: Definition of a peptide, peptide unit, peptide group, bond length, cis and trans conformation

Secondary structures: (alpha helix, beta sheet, beta turn, collagen helix, Ramachandran Plot,

Tertiary structures: Forces Stabilizing tertiary structures

Quaternary structures (with examples).

Unit 3: Lipids

Classification, Fatty acid, Saturated and Unsaturated, essential fatty acids- ω -3/6 derived essential fatty acids, eicosanoids, Jasmonic acid and Traumatin. Triacylglycerols, glycerophospholipids, sphingolipids, steroids (cholesterol and its derivatives).

Unit 4: Nucleotides

Structure of Sugars and Bases, conformation of sugar phosphate backbone, hydrogen bonding by bases, Types of DNA (A, B and Z DNA), tautomers of bases, nucleotide derivatives, nucleotides as regulating molecules, concept of anti-sense molecules.

Unit V: Vitamins

Water soluble and fat-soluble vitamins. Structure, dietary requirements, deficiency conditions, co-enzymes.

Suggested Readings:

1. Concise Inorganic Chemistry, 5th edition (1999), J. D. Lee; Wiley-Blackwell, ISBN-13: 9780632052936.
2. Organic Chemistry, 6th edition (1996), I L Finar; ELBS, Longman Higher Education. ISBN13: 978-0582305601.
3. Lehninger: Principles of Biochemistry, 5th edition (2008), David L. Nelson and Michael M. Cox; Prentice Hall Publishers, ISBN-13: 978-0321707338



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4. Biochemistry, 4th edition (2003), Campbell, M. K. and Farrel, S. O.; Brooks/Cole, Cengage Learning (Boston), ISBN: 0030348498.
5. An Introduction to Practical Biochemistry, 3rd edition (1987), Plummer, McGraw-Hill College; ISBN-13: 978-0070841659
6. Organic Chemistry, 6th edition (1992), R. T. Morrison and R. N. Boyd; Pearson Education. ISBN-13: 9780136436690. 7. Biochemistry, J. M. Berg, J. L. Tymoczko and L. Stryer, 6th edition (2006), W. H. Freeman and Co., ISBN-13: 978-0716787242
7. Bioorganic Chemistry, 3rd edition (1999), Hermann Dugas; Springer Verlag. ISBN-13: 978- 0387989105



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BI01 204 Chemistry (Bioorganic, Bioinorganic and Physical) (L-T-P-C: 3-1-0-4)

Unit 1: Chemical Bonding and Molecular Forces

Introduction to ionic interactions and covalent bond, inter-molecular and intra-molecular forces, types of intermolecular forces and their characteristics: ion-dipole, dipole-dipole, dipole-induced dipole and dispersion (London) forces, hydrogen bond (intra-molecular and inter-molecular), effect of inter/intra-molecular forces on structure of different biomolecules.

Unit 2: Stereochemistry

Optical isomerism: Optical activity, specific rotation, enantiomerism, D and L designation, racemic modification, R and S sequence rules, diastereoisomers. Conformational isomers: conformation of ethane and butane, interconversion of projection formula, cyclohexane (mono- and di-substituted), resolution, optical purity, Walden inversion, enantiotopic and diastereotopic hydrogens and prochiral centers. Geometrical isomerism: Definition, nomenclature– E and Z.

Unit 3: Reaction Mechanisms

Ionic, radical and pericyclic (definition and example); reaction type: addition, elimination and substitution reactions (definition and example); nature of bond cleavage and bond formation: homolytic and heterolytic bond fission, homogenic and heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagent type: electrophiles and nucleophiles (elementary idea); electrophilicity and nucleophilicity, carbocations (carbenium and carbonium ions), carbanions, carbon radicals, carbenes: generation and stability, structure using orbital picture and electrophilic/nucleophilic behavior of reactive intermediates (elementary idea).

Unit 4: Redox Reactions

Oxidation reaction, reduction reactions, Redox reactions, Balancing of redox reactions (ion-electron and oxidation state methods). Standard electrode potential, Reference electrode, determination of electrode potential, electrochemical series, uses of electrode potential data, reaction feasibility, comparison of oxidation with combustion using glucose as an example. Redox potentials of some biologically important half reactions. Calculation of energy yield from biological redox reaction (oxidation of NADH by oxygen, reduction of acetaldehyde by NADH).

Text Books:

1. Organic Chemistry by Morrison and Boyd: 6th Edition.
2. Principles of Physical chemistry by Puri, Sharma and Pathania; 5th Edition



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IU1 001 Soft Skills I (L-T-P-C: 1-0-0-0)

Unit 1: Self Analysis and Attitude

- SWOT Analysis
- Who am I?
- Factors influencing Self Perception
- Self Esteem
- Understanding positive and negative attitude

Unit 2: Goal Setting

- Types of Goals: Immediate, Short term, Long term
- Strategies to Achieve Goals

Unit 3: Creativity

- Out of box thinking
- Lateral Thinking
- Innovative Thinking

Unit 4: Corporate Etiquettes

- E-mail etiquette, Telephone etiquette,
- Dining etiquette, Office meeting etiquettes, Dress etiquette

Text Books:

1. Soft Skills for Everyone by Jeff Butterfield, Cengage publications

Reference Books:

1. Personality Development and Soft Skills by Barun K Mitra
2. Lateral Thinking: Creativity Step by Step by Edward de Bono



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BI01 205 Laboratory I (Biomolecules, Evolutionary Biology) (L-T-P-C: 0-0-8-4)

1. Analysis of water: estimation of Ca & Mg by EDTA method
2. Estimation of inorganic phosphate by Fiske Subbraow method
3. Estimation of total sugars by Anthrone method
4. Estimation of sugars by DNS method
5. Estimation of Amino acids by ninhydrin method
6. Estimation of proteins by Lowry method
7. Estimation of RNA by Orcinol method
8. Determination of saponification & acid values of oil/fat
9. Separation of amino acids by TLC
10. Qualitative analysis of carbohydrates
11. Qualitative analysis of Amino acids
12. Models & Charts
13. Formation of earth with minerals
14. Primitive & developed plants



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BI01 206 Laboratory II (Physiology, Chemistry) (L-T-P-C: 0-0-8-4)

1. Color tests and precipitation reactions of food stuffs:
2. Enzymatic digestion of carbohydrates, proteins and fats. Action of inverses on sugar solution.
3. Respiratory system: Rate of oxygen consumption. Tissue respiration through Warburg photo-respirometer. Assay of enzymes involved in respiration (Succinic dehydrogenase).
4. Blood: Preparation of hemin crystals, osmotic hemolysis: Demonstration of effect of isotonic, hypotonic and hypertonic solutions on RBCs.
5. Estimation of hemoglobin content in human blood
6. Determination of blood groups of man based on antigen and antibody reaction
7. Quantitative analysis of human urine for the presence of sugar and albumin. (optional)
8. Study of the effect of various environmental factors on transpiration in an excised twig/leaf (optional)

Suggested Readings:

1. Knut Schmidt-Nielsen , Animal Physiology , Cambridge University Press
2. David Randall, Eckert's Animal Physiology, W.H. Freeman and Co.
3. Philips Withers; Comparative Animal Physiology. Books Cole Publishers



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SEMESTER - III

BI02 101 Biophysics (L-T-P-C: 3-1-0-4)

Unit 1: Mechanics

Galilean invariance and Newton's Laws of motion. Dynamics of a system of particles, Conservation of momentum and energy, work energy theorem. Conservation of angular momentum, torque, Motion of a particle in central force field. Kepler's Laws, Satellite in circular orbit and applications (Synchronous satellite, GPS, Artificial gravity, apparent weightlessness).

Unit 2: Chemical Binding

Quantum mechanics, Pauli exclusion principle, ionization energy, electron affinity and chemical binding, electron negativity and strong bonds.

Energies, forces and bonds: Inter atomic potentials for strong bonds and weak bonds. Non-central forces. Bond energies.

Unit 3: Electromagnetic Radiations

Basic principles of electromagnetic radiation, energy, wavelength, wave numbers and frequency. Review of electronic structure of molecules (Molecular Orbital theory), absorption and emission spectra. Beer-Lambert's law, light absorption and its transmittance. UV and visible spectrophotometry-principles, instrumentation and applications.

Unit 4: Spectroscopic Techniques

fluorescence spectroscopy, static & dynamic quenching, energy transfer, fluorescent probes in the study of protein, nucleic acids, Infra-red spectroscopy, light scattering in biology, circular dichroism, optical rotatory dispersion, Magnetic resonance Spectroscopy.

Suggested Readings:

1. Physical Biochemistry, David Freifelder, Applications to Biochemistry and Molecular Biology, 2nd Edition, W.H. freeman and Company, 2005.
2. Hoppe et. al., Biophysics, Translation of 2nd German Edition, Springer Verlag, 1983.
3. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition, Cambridge University Press, 2005.



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BI02 102 Ecology (L-T-P-C: 3-0-0-3)

Unit 1: Ecology

History, definition, ecological factors (abiotic and biotic factor), ecological range. Stress and adaptation (morphological, physiological, anatomical and biochemical), biotic interaction, phenotypic and genotypic plasticity, canalization.

Unit 2: Ecosystem

Concept, components, (e.g., aquatic, marine, forest, grassland, desert, fish tank, axenic cultures, complete and incomplete ecosystem), energy flow (GFC, DFC), food web, niche, gauss's exclusion principle, Liebig's law, ecological pyramids, Autecology and Synecology, r- & k-selections, carrying capacity, population dynamics, (exponential & logistic growth curves), keystone species.

Unit 3: Pollution

Pollution of Soil, water, air (types of pollutants and sources), noise pollution, radiation pollution, remedial measures, bio amplification. Disaster management- Types of disasters & Management strategy

Unit 4: Behavioral Ecology

Social, reproductive & territorial behavior, evolution of optimal life history, reproductive structure and mating system. .

Suggested Readings:

1. Wilkenson DM – 2007 – Fundamental Processes in Ecology
2. Dodson S.I. – 1998 - Ecology
3. Odum E.P. - Ecology
4. Clapham. Biomes
5. Raven PH *et al* 2008 – Environment

IU2 000 Community Connect Project (L-T-P-C: 0-0-2-1)



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BI02 103 Metabolism and Tissue Function (L-T-P-C: 3-1-0-4)

Unit 1: Concept of Metabolism

Principles of Bioenergetics-Standard free energy change, metabolic roles of ATP-Phosphoryl group transfer, nucleotidyl group transfer. Experimental approaches to study of metabolism; Primary and secondary metabolism. Energetics.

Unit 2: Carbohydrate Metabolism

Glycolysis, alcoholic and lactic acid fermentation, Pasteur Effect, gluconeogenesis, Cori cycle, glucose-alanine cycle, futile cycle. TCA cycle, HMP shunt, glycogenolysis & glycogen synthesis. Disorders associated with defects in carbohydrate metabolism- a brief account on fructose intolerance, lactose intolerance, lactic acidosis, disorders related to glycogen metabolism, genetic deficiency of Glucose-6-phosphate dehydrogenase, Galactosemia, Diabetes Mellitus (NIDDM and IDDM). i) Protein-PKU, Alkaptonuria and Maple syrup and Gauchers. Nutritional disorder-PEM (kwashiorkar and marasmus), Obesity.

Unit 3: Lipid Metabolism

Mobilization of triglycerides, metabolism of glycerol, β -oxidation of saturated, monounsaturated and poly-unsaturated fatty acids, Oxygenation of PUFAs in plants (Jasmonic acid and Traumatol) and animals (Prostaglandin & Leukotrienes). Ketogenesis and significance, Biosynthesis of C-16 palmitic acid.

Unit 4: Overview of Amino Acid Metabolism

Nitrogen cycle, incorporation of ammonia into biomolecules. Metabolic fates of amino groups. Digestion and absorption of dietary proteins. Protein calorie malnutrition - Kwashiorkar and Marasmus. Nitrogen balance, transamination, role of pyridoxal phosphate, glucose-alanine cycle, Krebs cycle, urea cycle and inherited defects of urea cycle.

Unit 5: Inborn Errors of Metabolism, Integration and Tissue Specific Metabolism

Protein-PKU, Alkaptonuria, Maple syrup and Gaucher's disease

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).

Suggested Readings:

1. Principles of Biochemistry, Lehninger, Nelson and COX., fifth Edition
2. Thomas M. Devlin, Text Book of Biochemistry with Clinical Correlations, 6th edition, 2006, Wiley-Liss
3. Peter W. Hochachka, George N. Somero, Biochemical adaptation, Amazon Publishers



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BI02 104 Cell Biology (L-T-P-C: 3-1-0-4)

Unit 1: An Overview of Cell

Basics of Microscopy, Cell; History, Cell theory, Overview of Prokaryotic and Eukaryotic Cells, Plant and Animal cells, exceptions to cell theory, Phages, Virioids, Mycoplasmas, Prions, Plasma membrane: various models (Fluid mosaic model), structure, transport across membranes: Active and Passive transport, Facilitated transport, Cell junctions: Tight junctions, Desmosomes, Gap junctions, Cell wall, distribution, chemical composition, functions and variations in prokaryotic and eukaryotic cells (primary and secondary wall).

Unit 2: Cell Organelles

Nucleus; Nuclear envelope, structure of nuclear pore complex, nuclear lamina, transport across nuclear membrane, Nucleolus, Structural organization, function, marker enzymes of Mitochondria, Chloroplasts, Lysosomes, Glyoxysomes and peroxisomes, semiautonomous nature of mitochondria and chloroplast

Unit 3: Cytoskeleton and Protein Sorting and Transportation

Structure and organization of actin, myosin and intermediate filaments, microtubules, and their role, Structure and functions of Endoplasmic reticulum and Golgi apparatus, GERL

Unit 4: Cell Cycle, Cell Death and Cell renewal

Eukaryotic cell cycle, restriction point, and checkpoints. Cell division. Apoptosis and necrosis - brief outline. Salient features of a transformed cell.

Suggested Readings:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition, John Wiley & Sons. Inc.
2. De Robertis, E. D. P. and De Robertis R. E. 2009. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper G. M. Hausman R. E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinauer Academic Press.
4. Becker W. M., Kleinsmith L.J. and Bertni G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco



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IU2 001 Communication Skills - II (L-T-P-C: 1-1-0-0)

Unit 1: Business Communication

Types of Letters and format, complaint letters and letters of regret and adjustment, E-mail-Dos and Don'ts

Unit 2: Resume and Job Application

Unit 3: Speaking Skills

Presentations based on case lets, Group Discussion & Personal Interview

Unit 4: Report Writing

References:

1. Business Communication: Asha Kaul
2. Business Correspondence and Report Writing – R.C. Sharma, Krishna Mohan (Tata McGraw)



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BI02 105 Laboratory I (Biophysics, Ecology) (L-T-P-C: 0-0-8-4)

1. Logic Gates
2. e/m ratio by Thomson's Method
3. Specific rotation of sugar solution
4. Hall Effect and its measurement
5. Numerical aperture of Fiber optics
6. Study of a Transformer
7. Study of magnetic field of Solenoid
8. Separation of amino acids by paper chromatography
9. Estimation of proteins by Biuret method
10. Estimation of proteins by Lowry's method
11. Estimation of RNA by Orcinol method.
12. Qualitative tests for carbohydrates to identify the given unknown carbohydrate solution: Molisch's, Barfoed's, Fehling's/ Tollen's/ Benedict's, Selivanoff's, Osazone, Bial's tests.
13. Estimation of total soluble sugars by Anthrone method.
14. Estimation of amino acids by ninhydrin method.

Suggested Readings:

1. Methods for Protein Analysis A Practical Guide for Laboratory Protocols. Editors: Copeland, Robert A. (Ed.) 1994



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BI02 106 Laboratory II (Cell Biology) (L-T-P-C: 0-0-8-4)

1. Microscopy- Theoretical knowledge and demonstration of Light microscope
2. Separation of nucleic acid bases by paper chromatography
3. Study of polyploidy in Onion root tip by colchicine treatment.
4. Study of mitosis and meiosis from permanent slides
5. Preparations of temporary mount of Grasshopper testis / onion flower bud anthers and study the different stages of Meiosis.
6. Cytochemical staining of DNA-Feulgen.
7. Cytochemical staining of DNA and RNA- Methyl Green Pyronin (MGP).
8. Cytochemical staining of Polysaccharides-Periodic Acid Schiff's (PAS).
9. Cytochemical staining of Total proteins- Bromophenol blue.
10. Cytochemical staining of Histones -Fast Green



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SEMESTER - IV

BI02 201 Growth and Reproduction in Plants (L-T-P-C: 3-1-0-4)

Unit 1: Introduction

General growth patterns in animals and plants: the plant cell as a model of growing system; biophysical basis of plant cell growth; the role of cell wall in cell growth; extension growth of multicellular organs in plants. Juvenile, vegetative and reproductive phases in growth: Primary meristem: concept of stem cell; shoot apical meristem- dynamics of shoot apical meristem; homeobox genes and meristem identity; root apical meristem as an organized structure; Post - embryonic meristems in plants with special reference to Arabidopsis embryogenesis.

Unit 2: Pollen Germination

Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia. Ovule; Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonum type); Organization and ultrastructure of mature embryo sac. Pollination and fertilization; Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

Unit 3: Parthenogenesis

Concept of parthenogenesis and its types, advantages and disadvantages by taking suitable examples such as Bermuda grass, biology of apomixes, maturation division restitution nucleus, how is sex determined in parthenogenesis? Types of asexual reproduction in plants.

Unit 4: Seed Germination and Development

Six types of embryogeny; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in Paeonia Seed; Structure, importance and dispersal mechanisms. Gluconeogenesis and its role in mobilisation of lipids during seed germination

Suggested Readings:

1. Raghavan, V. 2000 Developmental Biology of Flowering plants, Springer, Netherlands.
2. Raghavan, V. 1997 Molecular embryology of flowering plants. Cambridge, University Press.
3. Shivanna, K.R. 2003 Pollen Biology and Biotechnology, Science Publishers.
4. Bhojwani, S.S. and Bhatnagar SP 2004 The Embryology of Angiosperms, Vikas Publishing House
5. Johri, B.M. I;1984 Embryology of Angiosperms, Springer-Verlag, Netherlands



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BI02 202 Enzymology (L-T-P-C: 3-1-0-4)

Unit 1: Proteins

Classification of proteins on the basis of composition, conformation and function-functional diversity of proteins. The amino acid building blocks-classification, structure and physical properties of the standard amino acids. Proteinaceous and non-proteinaceous, essential and non-essential amino acids. Primary, secondary, tertiary and quaternary structure of proteins.

Unit 2: Enzymes

Enzymes as biological catalysts. Enzyme classification and nomenclature. Chemical nature of enzymes, ribozymes. Concept of active site, specificity. Co-enzymes, co-factors and prosthetic groups.

Unit 3: Enzyme Kinetics

Kinetics of enzyme catalyzed reactions – Michaelis Menten equation. Determination of K_m and V_{max} . Factors influencing the rate of enzyme catalyzed reactions. Enzyme inhibitions-competitive, non-competitive and uncompetitive inhibitions. Catalytic mechanism of lysozyme or chymotrypsin. Regulation of enzyme activity allosteric enzymes, feedback inhibition with ATPase as an example.

Unit 4: Isolation and Purification of Enzymes

Methods of enzyme isolation and purification. Introduction to enzyme immobilization.

Unit 5: Role of Metal Ions in Biology

Metalloprotein, Metalloenzymes, metal base drug interaction and inhibition; metallo porphyrins, Redox carriers in mitochondrial electron transport chain.

Suggested Readings:

1. Nelson, D. L. and Cox, M.M. (2008). Lehninger, Principles of Biochemistry, 5th Edition, W.H. Freeman and Company, N.Y., USA.
2. Voet, D. and Voet, J.G. (2004). Biochemistry, 3rd Edition, John Wiley & Sons, Inc. USA.



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BI02 203 Light and Life (L-T-P-C: 3-1-0-4)

Unit 1: Light

Nature of light, spectrum of light which is useful/ harmful (ionizing radiation) for various biological processes in life of plants and animals. Unit of light energy (Photon, quantum), the different Photo Biological reactions. Measurement of light (Lux, Foot Candle). Comparative account of chemistry and functional roles of pigments associated with harvesting light energy: pigments/receptors of light, chlorophylls, carotenoids, phycobilino proteins, bacteriochlorophylls, phytochromes rhodopsin etc. Photoreception in animals, evolution of eye and visual processing in vertebrate retina.

Unit 2: Photosynthesis

History, Photosynthetic equation, Light and dark reactions, mechanism of photolysis of water and oxygen evolution, Q cycle, O₂ evolving complex; C₃, C₄, CAM plants, spectrum of photoautotrophs, photoautotroph vs photoheterotroph; Photoautotroph vs. chemoautotroph, structure of chloroplast and quantasome, Anoxygenic and oxygenic photosynthesis, reaction centers. Bacterial Photosynthesis

Unit 3: Bioluminescence

Definition, discovery, diversity of organisms (plants and animals), photoreceptors - distribution, mechanism; General account of effect of light on morphology and physiology (stomatal opening and closing, transpiration, respiration, growth and differentiation) Phytochrome mediated photomorphogenesis phenomena - seed germination etc..Photoperiodism: LDP, SDP, DNP plants, vernalization, vernalin, etiolation and deetiolation. Light as an ecological factor affecting distribution of plants and animals (Phyto and Zoo geography), in terrestrial and aquatic ecosystems: Morphological, Anatomical, Physiological and Behavioural adaptations to extreme light conditions by organisms. Changes during fruit ripening process as affected by light.

Unit 4: Behavioural Aspects of Ecology and Physiology

Circadian rhythms, jetlag, rhythm of heart beat, melanocytes and skin colour, chromatophores and colour changes in animals. Light as an inducer for biosynthesis of enzymes, hormones and other biomolecules.

Suggested Readings:

1. Hawes C & Satiat-Jeunemaitre - 2001 Plant Cell Biology : Practical approach
2. Buchanan B, Gruissem G & Jones R - 2000 - Biochemistry and Molecular Biology of Plants.
3. Bjorn, Lars Olof (Editors) , Photobiology: The science of light and life, Springer
4. Randall, Burggren, French : Eckert , Animal Physiology-mechanisms and adaptations, W H Freeman and company
5. Elli Kohen, Rene Santus, Joseph G. Hirschberg: Photobiology Academic press Peter A. Ensminger: Life under the sun , Yale University Press



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BIO2 204 Microbiology (L-T-P-C: 3-1-0-4)

Unit 1: Fundamental Concepts

History of microbiology, Discovery of microorganisms, Contributions of Louis Pasteur and Robert Koch in Medical Microbiology.

Molecular methods of assessing microbial phylogeny- molecular chronometer, phylogenetic trees, rRNA, DNA and proteins as indicators of phylogeny. Major Divisions of life Domains, Kingdoms.

Requirements for microbial growth, growth factors, culture media- synthetic and complex, types of media. Obtaining Pure Cultures, Preserving Bacterial Cultures, Growth Curves and generation time, Control of microbial growth, general concept of effect of environmental factors on growth of microbes.

Unit 2: Bacterial Cells - Fine Structure and Function

Size, shape and arrangement of bacterial cells. Cell membrane, cytoplasmic matrix, inclusion bodies (magnetosomes), nucleoid, Ultrastructure of Gram +ve and Gram -ve bacterial cell wall, Pili, Capsule, Flagella and motility.

Unit 3: Principles of Diseases and Epidemiology

Relationship between Normal microbiota and host, Opportunistic microorganisms, nosocomial infections, Development and spread of infectious disease: invasion, pathogen, parasite, pathogenicity, virulence, carriers and their types. Respiratory tract infections: Diphtheria and Tuberculosis, Gastrointestinal tract infections, staphylococcal food poisoning and *E. coli* gastroenteritis, Urinary tract infections: gonorrhea and syphilis. Classification of medically important parasites. Common protozoan disease: Malaria, Infections caused by *Taeniasolium* / *Taeniasaginata*, *Fasciola hepatica* and *Ascarislumbricoides*. Introduction to Probiotics, the good bacteria with Examples. Effect of Probiotics on human physiology and diseases.

Unit 4: Viruses, Viroids, Prions

General characteristics of viruses, structure, isolation, cultivation and identification of viruses, viral multiplication, one step multiplication curve, lytic and lysogenic phages (lambda phage), concept of early and late proteins, clinical virology with reference to HIV virus and hepatitis virus (Life cycle and clinical symptoms), viroids and prions.

Unit 5: Antimicrobial Chemotherapy and Emerging Antimicrobial Resistance

Spectrum of antimicrobial activity, action of antimicrobial drugs, inhibitors of cell wall synthesis, anti-mycobacterial antibiotics, inhibitors of protein synthesis and nucleic acid synthesis, competitive inhibitors of essential metabolites, antifungal, antiviral, anti-protozoan drugs; effectiveness of chemotherapeutic agents, concepts of antimicrobial resistance, novel methods to combat increasing antimicrobial resistance. Applications in aquaculture, poultry, dairy forms, humans and opportunities.



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Suggested Readings:

1. Microbiology: An Introduction, 9th edition (2008), Gerard J. Tortora, Berdell R. Funke, Christine L. Case; Benjamin Cummings. ISBN-13: 978-0321733603.
2. Prescott, Harley, and Klein's Microbiology, 8th edition, (2011), Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw Hill International. ISBN-13:978-0071313674.
3. Bailey and Scott's Diagnostic Microbiology, 12th edition (2007), Betty A. Forbes, Daniel F. Sahm and Alice S. Weissfeld; Mosby Elsevier Publishers, ISBN-13: 978-0808923640.
4. Microbiology, 6th edition (1993), Pelczar, Chan and Krieg; McGraw Hill International, ISBN-13: 978-0070492585.
5. Brock Biology of Microorganisms, 13th edition (2010), Michael T. Madigan, John M. Martinko, David Stahl and David P. Clark, Pearsons, Benjamin Cummings, ISBN-13: 978- 0321649638.
6. Microbiology: A Laboratory Manual, 10th edition, (2013), James Cappuccino and Natalie Sherman, Benjamin Cummings. ISBN-13: 978-0321840226



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IU2 002 Soft Skills-II (L-T-P-C: 1-0-0-0)

Unit 1: Interpersonal Skills

- Understanding Professional Relationship
- Respecting Social Protocols
- Handling Social Media
- Showing Basics Office Courtesies
- Image Building

Unit 2: Personal Skills

- Body Language
- Time Management
- Negotiation Skills
- Persuasion Skill

Unit 3: Making Effective Presentations

- Patterns & Methods of Presentation, Oral Presentation: Planning & Preparation
- To learn the skill of presentation, How to prepare the presentation,
- Knowing the audience and their requirements
- Effective ways to deliver presentation
- How to prepare multi-media presentation

Unit 4: Group Discussions

- Purpose (Intellectual Ability, Creativity, Approach to a Problem, Solving, Tolerance)
- Group Behavior
- Analyzing Performance

Text Books:

1. Soft Skills for Everyone by Jeff Butterfield, Cengage publications

Reference Books:

1. Personality Development and Soft Skills by Barun K Mitra
2. Lateral Thinking: Creativity Step by Step by Edward de Bono
3. Teach Yourself to Think by Edward de Bono
4. Six Thinking Hats by Edward de Bono



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BI02 205 Laboratory I (Enzymology) (L-T-P-C: 0-0-8-4)

1. Determination of total activity of pea esterase.
2. Determination of K_M and V_{max} of pea esterase.
3. Determination of optimum pH of pea esterase.
4. Determination of optimum temperature and activation energy of pea esterase.
5. Determination of type of inhibition (reversible or irreversible) of pea esterase.
6. Determination of I50 of pea esterase using organophosphate inhibitor (optional)
7. Determination of total activity of salivary K-amylase /L-amylase (sweet potato or germinated ragi).
8. Determination of K_m and V_{max} of K-amylase / L-amylase.
9. Determination of K_m and V_{max} of alkaline phosphatase (potato).
10. Determination of I50 of alkaline phosphatase.
11. Determination of I50 of alkaline L-asparagenase
12. Determination of optimum temperature and activation energy of urease (horsegram) (optional)

Suggested Readings:

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry: Trevor Palmer, Horwood, (2001).
2. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis: Robert A.Copeland, by Wiley-VCH Inc. (2000).
3. Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis: Robert A. Copeland , John Wiley & Sons (2000).
4. Enzyme Kinetics: A Modern Approach: Alejandro G. Marangoni, John Wiley & Sons (2002).
5. Enzyme Kinetics: Principles and Methods: Hans Bisswanger, Wiley-VCH (2002).
6. Fundamentals of Enzyme Kinetics: 4th ed. Athel Cornish-Bowden, Wiley-Blackwell (2012).
7. Fundamentals of Enzyme Kinetics: Athel Cornish-Bowden, Portland Press (2004)
8. Practical Enzymology: Hans Bisswanger, Wiley-VCH (2004).
9. Practical Enzymology, Second Revised Edition [PDF] [Storm RG]: Hans Bisswanger, Wiley Blackwell; 2 edition (2011).



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BI02 206 Laboratory II (Microbiology) (L-T-P-C: 0-0-8-4)

1. Methods of sterilization
2. Media preparation
3. Isolation of coliform bacteria from waste water
4. Isolation of *Bacillus* sp. from soil sample
5. Staining methods
6. Determination of Growth curve
7. Effect of UV radiation on pigment production of *Serratia marcescens*
8. Determination of MIC
9. Biochemical tests



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SEMESTER - V

BI03 101 Differentiation and Morphogenesis in Animals (L-T-P-C: 3-1-0-4)

Unit 1:

Major events in animal development. Experimental embryology. Gametogenesis-process and significance. Spermatogenesis-structure of sperms. Endocrine regulation of spermatogenesis. Oogenesis- in amphibians and insects. Types of eggs. Hormonal regulation of vitellogenesis. Egg membranes. Polarity and symmetry.

Unit 2:

Fertilization-chemotaxis, sperm-egg interactions, poly spermy blockade. Activation of egg. Parthenogenesis. Early cleavage-patterns of embryonic cleavage. Cell lineage. Gastrulation- types and mechanism of cell movement. Fate maps. Neurulation in amphibians. The process of cellular differentiation. Developmental gradients.

Unit 3:

Organogenesis. Development of immune system and brain. Pattern formation and development of limb. Extraembryonic membranes. Placentation- formation and types.

Unit 4:

Experimental embryology-mammalian reproductive cycles, hormonal regulation. Induced ovulation. *In vitro* fertilization. Embryonic cloning. Embryo transfer technology. Cryopreservation.

Unit 5:

Metamorphosis in amphibians and insects. Regeneration of tissues in animal species. Planarian regeneration. Urodele limb regeneration. Pattern formation in the blastema. Programmed cell death. Ageing and senescence.

Suggested Readings:

1. Subramonium, T. (2002) Developmental Biology, Narosa Publications, Chennai.
2. Scott Gilbert (2013) Developmental Biology



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BI03 102 Membrane Biology (L-T-P-C: 3-1-0-4)

Unit 1: Introduction to Biomembranes

Composition of biomembranes - prokaryotic, eukaryotic, neuronal and subcellular membranes. Study of membrane proteins. Fluid mosaic model with experimental proof. Monolayer, bilayer and liposomes as model membrane systems.

Unit 2: Membrane Structures

Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. CMC, critical packing parameter. Membrane asymmetry. Macro and micro domains in membranes. Membrane skeleton, lipid rafts, caveolae and tight junctions. RBC membrane architecture.

Unit 3: Membrane Dynamics

Lateral, transverse and rotational motion of lipids and proteins. Techniques used to study membrane dynamics - FRAP, TNBS labeling etc. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity.

Unit 4: Membrane Transport

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins. Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactose permease, Na⁺-glucose symporter. ABC family of transporters - MDR, CFTR. Group translocation. Ion channels - voltage-gated ion channels (Na⁺/K⁺ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin.

Unit 5: Vesicular Transport and Membrane Fusion

Types of vesicle transport and their function - clathrin, COP I and COP II coated vesicles. Molecular mechanism of vesicular transport. Membrane fusion. Receptor mediated endocytosis of transferrin.

Suggested Readings:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1/ISBN:10:1-4641-0962-1.
2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2.
3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
4. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2



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BI03 103 Molecular Biology (L-T-P-C: 3-1-0-4)

Unit 1: Genes and Genomic Organization

Genome sequence and chromosome diversity, definition of a gene, organization of genes in viruses, bacteria, animals and plants. DNA structure, different forms of DNA, types of genomes, genomes & genetic variation, comparison of different genomes, genome evolution. Nucleosome structure and packaging of DNA into higher order structures

Unit 2: Genome Projects

An overview of genome projects of human and other model organisms of Human Genome Project (HGP) – an overview of the project, goals of the project, major scientific strategies & approaches used in HGP, expected scientific & medical benefits of this project, about the organizations behind this project

Unit 3: Human Genome Map

Physical mapping, genetic mapping, gene ontology, gene annotation. Technologies used in HGP – RFLP, microsatellite markers, STS, EST, DNA sequencing, DNA microarray.

Unit 4: Managing and Distributing Genome Data

Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases

Suggested Readings:

1. General Jonathan Pevsner (2009) Bioinformatics and Functional Genomics. Wiley-Blackwell; 2nd Edition, 992 pages.
2. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN:978-0-321-50781-5.
3. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W. H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.
4. R. S. Verma (1998). Genes and genome. Jai Press Inc.



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BI03 104 Biomaterials (L-T-P-C: 3-1-0-4)

Unit 1: Introduction to Biomaterials

Classification, Chemistry and characterization of biomaterials. The state of the art of biomaterials and the challenges. Disciplines involved in biomaterials science and the path from a need to a manufactured medical device. Material selection requirements for biomaterials – metals, composites, ceramics and polymers. Tissue environment of the implanted biomaterial: unit cell processes. Tissue responses to implants. Nanomaterials: fullerenes, carbon nanotubes, nanomembranes. Synthesis of bio-materials, Characterization of chemical, physical, mechanical properties, visco elasticity, end group analysis, determination of molecular weight of a polymer.

Unit 2: Biocompatibility

Biocompatibility of Bio-materials, wound-healing process, body response to implants, blood compatibility. Tests to assess biocompatibility of a polymer, modifications to improve biocompatibility. Reactions of biomaterials with cellular and extra cellular components

Unit 3: Modified Biomaterials

Biodegradable biomaterials, Bioactive polymers and biosynthetic polymers, inert biomaterials, genetically engineered biomaterials

Unit 4: Applications of Biomaterials

Tissue Replacement Implants, Acute Wound Healing, Blood Clotting, Chronic Wound Healing and Foreign Body Response. Soft-tissue replacements, sutures, surgical tapes, adhesive, percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal Fractures fixation devices, joint replacements. Artificial Organs Artificial Heart, Prosthetic cardiac Valves, Limb prosthesis, Externally Powered limb, prosthesis, Dental Implants, Other applications. Liposomes, hydrogels and Nano materials in drug delivery. Biomaterials in diagnostics and bioanalytical techniques.

Suggested Readings:

1. Sujata V. Bhat, Biomaterials , 2nd edition, Narosa Publishing House, New Delhi, 2006.
2. Buddy D. Ratner, B. D. Ratner, Allan S. Hoffman, Biomaterials Science: An Introduction To Materials In Medicine, 2nd Edition(2004) Publisher: Academic Press.
3. Fred W. Billmeyer, Text book of Polymer Science. 3rd edition John Wiley and sons publications.
4. Basic & Clinical Pharmacology, 10th ed B.G. Katzung, McGraw-Hill 2007



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BI03 105 Laboratory I (Introductory Computational Biology) (L-T-P-C: 0-0-8-4)

BI03 106 Laboratory II (Molecular Biology, differentiation Morphogenesis in Animals) (L-T-P-C: 0-0-8-4)

1. Preparation of solutions for Molecular Biology experiments.
2. Preparation of culture medium (LB) for *E.coli* (both solid and liquid) and raise culture of *E. coli*.
3. Isolation of chromosomal DNA from bacterial cells.
4. Isolation of Plasmid DNA by alkaline lysis method
5. Agarose gel electrophoresis of genomic DNA & plasmid DNA
6. Qualitative and quantitative analysis of DNA by spectrophotometer
7. Estimation of RNA by Orcinol method
8. Perform DNA amplification by PCR.
9. Study of the different types of placenta- histological sections through permanent slides or photomicrographs
10. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.
11. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.



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SEMESTER - VI

BI03 201 Project/Industrial Visit/Comprehensive Viva (L-T-P-C: 0-0-12-6)

BI03 202 Defense Mechanisms (L-T-P-C: 3-1-0-4)

Unit 1: Introduction

Overview of defence mechanisms in plants and animals; Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (mucosa-associated lymphoid tissue -MALT).

Unit 2: Innate Immunity in Plants and Animals

Chemical and morphological defense in plants; elicitors, receptors, Basal resistance and innate biochemical host defenses. Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (Pathogenic Recognition Receptor), connections between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response. Complement activation by classical, alternate and Mannose Binding lectin pathway, biological consequences of complement activation, regulation and complement deficiencies.

Unit 3: Adaptive Immunity in Plants

Abiotic- strategies and mechanisms; effect of UVB light on herbivory. Biotic- interactions with symbionts, pathogens. Biochemical host defenses, Basal resistance and basic compatibility; epidemiological and population genetics, co-evolution in natural plant pathogen systems. Gene for gene concept; interaction in host-pathogen systems, receptor-elicitor model, plant gene-gene interaction. Cytological protection and induced resistance. Passive and active defences; Jasmonic acid, MAP Kinases, SRO proteins, hydroperoxidelyase (HPL), systemins, Heatshock proteins, oxylipin, Basic ROS cycle and adaptation during stress, Phytoalexins, mechanism of production and scavenging of NO. Herbivory related signals and other induced signals.

Unit 4: Adaptive Immunity in Animals

Antigens and haptens, Factors that dictate immunogenicity, B and T cell epitopes. Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family. Generation of antibody Diversity. Monoclonal antibodies; Immunological methods- Antigen-antibody interactions; Histocompatibility antigens - HLA and Disease; T cell differentiation – Positive and Negative selection, Antigen Presentation, Activation of T and B cells. Cytokines and Chemokines.

Unit 5: Immune Dysfunction and Applications

Immunological tolerance; Immunological disorders – Hypersensitivity and autoimmune diseases. Immunodeficiencies; Transplantation Immunology; Immune response against major classes of pathogens. Applications in agriculture, pharmaceuticals, and biopest control.



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Suggested Readings:

1. Deverall, Brain J. 1977. Defences mechanisms of plants, Cambridge University Press.
2. T .J. Kindt, R. A. Goldsby, and B.A. Osborne. 2007. Kuby Immunology, W.H. Freeman and Co, New York.
3. K. Murphy, P. Travers, M. Walport. 2008. Janeway's Immunobiology, Garland Science, Taylor and Francis Group, LLC



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BI03 203 Genetics (L-T-P-C: 3-1-0-4)

Unit 1: Mendelian Genetics and Extension

Mendel's work on transmission of traits, Genetic variation, Molecular basis of genetic information. Principles of Inheritance, Chromosome theory of inheritance, Laws of probability, Pedigree analysis, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy

Unit 2: Linkage, Crossing over and Chromosomal Mapping

Linkage and crossing over, cytological basis of crossing over, Molecular mechanism of crossing over. Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence

Unit 3: Mutations

Chromosomal mutations, Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced v/s Spontaneous, Back v/s Suppressor mutations. Molecular basis of mutations in relation to UV light and chemical mutagens, Detection of mutations: ClB method, Attached X-method, DNA repair mechanisms

Unit 4: Extra Chromosomal Inheritance and Transposons

Chloroplast mutation/Variegation in four 'o clock plant and Chlamydomonas, Mitochondrial mutations in Neurospora and yeast, Maternal effects, Infective heredity- Kappa particles in Paramecium. Prokaryotic transposable elements-IS elements, Composite transposons, Tn3 elements; Eukaryotic transposable elements- Ac-Ds system in maize and P-elements in drosophila; Uses of transposons

Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.



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BI03 204 Organic Chemistry (L-T-P-C: 3-1-0-4)

Unit 1: Stereochemistry

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Unit 2: Chemistry of Halogenated Hydrocarbons

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1 , S_N2 and S_Ni mechanisms with stereochemical aspects and; nucleophilic substitution vs. elimination.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li – Use in synthesis of organic compounds. (With two examples).

Alcohols, Phenols,

Alcohols: preparation, properties and relative reactivity of 1° , 2° , 3° alcohols,

Phenols: Preparation and properties; Chemical reactions Reimer-Tiemann and Kolbe's-Schmidt Reactions,

Unit 3: Organic Reactions of Carbonyl Compounds

Structure, reactivity and preparation;

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol, Cannizzaro and Benzoin condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, oxidations and reductions (Clemmensen, Wolff-Kishner,

Unit 4: Heterocyclic Compounds

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Furan, pyrrole, Thiophene. Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine,

Text Books:

1. Text book of organic chemistry by Morrison and Boyd.
2. A Text Book of Organic Chemistry by Bahl and Arunbahl.
3. Stereochemistry of organic compounds E.L. Eliel.
4. Introduction to stereochemistry By Kurt Mislow.
5. Stereochemistry of organic compounds D. Nasipuri.
6. Stereochemistry: Conformation and mechanism P. S. Kalsi.



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BI03 205 Recombinant DNA Technology- RDT (L-T-P-C: 2-0-0-2)

Unit 1: Introduction to RDT

Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules.

Unit 2: Cloning Vectors for Prokaryotes and Eukaryotes

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on E. coli plasmids, pBR322, pUC8, pGEM3Z. Joining of DNA fragments: ligation of DNA molecules. DNA ligases, sticky ends, blunt ends, linkers and adapters.

Unit 3: Introduction of DNA into Cells

Uptake of DNA by cells, preparation of competent cells. Selection for transformed cells. Identification for recombinants - insertional inactivation, blue-white selection. Introduction of phage DNA into bacterial cells. Identification of recombinant phages. Methods for clone identification: The problem of selection, direct selection, marker rescue. Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene.

Unit 4: Applications of RDT

Applications in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. Gene therapy. Applications in agriculture - plant genetic engineering, herbicide resistant crops, problems with genetically modified plants, safety concerns. Introduction to DNA sequencing, polymerase chain reaction, expression vectors.

Suggested Readings:

1. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK).
2. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK).
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC).

IU CCID Innovative Project (Concept, Conceive, Implement and Deliver) (L-T-P-C: 0-0-0-2)