(CT 16002) Biology For Engineers Credits: 3

Teaching Scheme
Lectures: 3 hrs / week

Examination Scheme
Test 1: 20 marks; Test 2: 20 marks
End Semester: 60 marks

Course Outcomes:-

Students would be able to

1. correlate basic biological and engineering principles in the organizational structure of living systems at molecular, cellular and system level
2. appreciate the applications of energy transformations in biological systems in view of solving energy conservation targets
3. analyze information processing in biological systems
4. evaluate basic biological processes of transport, communication and defense mechanism with engineering perspectives
5. apply the modern developments in biology and engineering for society, human health and environmental sustainability

Unit I: **(06 Hrs)**

Biomolecules and biopolymers: Structure and Function Organic and inorganic molecules; Unique Properties of water, Vitamins and Minerals, Carbohydrates, Lipids, Amino Acids and proteins, Nucleic Acids (DNA and RNA)

Unit II: **(06 Hrs)**

Levels of organization of life: Cell as a basic unit of life, prokaryotic and eukaryotic cells, microbes, plant and animal cells; Cell organelles – structure and function; Cell membrane Levels of organization: cells, tissues, organs, systems & organism

Unit III: **(06 Hrs)**

Energy transformations in Chloroplast: Photosynthesis (photochemical & biochemical phase) and ATP generation, Aerobic and anaerobic systems Energy transformations in Mitochondria: Cellular respiration (glycolysis and Kreb cycle) and ATP generation Bioenergetics: Thermodynamic principles applied to biology, negative entropy changes in biological systems, Free Energy, Chemical Equilibrium

Unit IV: **(06 Hrs)**

Expression and Transmission of Genetic Information: DNA replication, Enzyme driven process of DNA cloning, Protein synthesis- Transcription & translation Techniques for optimization: a. At molecular level: Recombinant DNA Technology, DNA hybridization, PCR, DNA microarray

Unit V: **(06 Hrs)**

Transport Phenomena in Biological Systems: Membrane channels and ion channels; Fluid flow and mass transfer (nutrients & ions); In plants: Xylem and Phloem; In animals: Blood and Lymph Transport of gases: Oxygen and Carbon dioxide Heat Transport - Body temperature regulation. Communication: Cell junctions, Cell-cell communications – cell signaling, Hormones, Pheromones and cell behavior Defense mechanisms: In plants: Herbivory, secondary metabolites In animals: Innate and Adaptive immune systems

Unit VI: **(06 Hrs)**

Engineering perspectives of biological sciences: Biology and engineering crosstalk – At cell level: Hybridoma technology At tissue level: Plant Tissue Culture, Animal Tissue Culture; Tissue Engineering: Principles, methods and applications Introduction to Biomimetics and Biomimicry, nanobiotechnology

References:

1. Lodish H, Berk A, Zipursky SL, et al. (2000) Molecular Cell Biology. W. H. Freeman.
2. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2000). *Lehninger principles of biochemistry*. New York: Worth Publishers.
3. Rao CNR, et.al. Chemistry of Nanomaterials: Synthesis, Properties and Applications.
4. Eggins BR. (2006) Biosensors: An Introduction. John Wiley & Sons Publishers.
5. Palsson B.O. and Bhatia S.N. (2009) Tissue Engineering. Pearson.
6. Yoseph Bar-Cohen (2005). Biomimetics- Biologically Inspired Technologies
7. Joseph D. Bronzino, John Enderle, Susan M. Blanchard (1999) Introduction to Biomedical Engineering.
8. Routledge Taylor and Francis group (2012). Introduction to Bio-medical Engineeering technologies

Additional topics to be discussed with students (in branch-wise manner based on BM 600:Introduction to Biomedical Engineeringof the IITB syllabus)

Understanding various diseases/ disorders with respect to the physiology, diagnosis, therapeutics (biomaterials and instrumentation) and medical procedures e.g. Cardiovascular, Renal, Aurthopedicetc

Disease/ Disorder	**Physiology**	**Diagnosis**	**Therapeutics**		**Medical procedure**
			Biomaterials	**Instrumentation**	
Cardiovascular disease	Heart – electrical stimulation and mechanical pumping	ECG, Angiography	Stents for angioplasty	Heart lung machines	Angioplasty, By-pass surgery
Bone/skull injuries	Biomechanics of musculo-skeletal system	Medical imaging technologies Arthroscopy	Prosthetics	Arthroscope Biomechanics Prosthetics	Joint replacement Total hip replacementre habilitati-on engg
Kidney disorders	Functioning of Kidney	Medical imaging technologies	Filtration membranes	Dialyser	Dialysis