Dr. Vishwanath Karad
MIT WORLD PEACE UNIVERSITY | PUNE
TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS

COURSE STRUCTURE

Course Code	UOB1001B			
Course Category	Basic Science			
Course Title	Biology for Engineers			
Teaching Scheme and Credits	**Lectures**	**Tutorial**	**Laboratory**	**Credits**
Weekly load hrs	02 hours	--	--	02+00+00=02

Pre-requisites: HSC (Science), 12th Std CBSE/ICSE/IB, Biology till 10th Std. Knowledge of prokaryotic and eukaryotic cells, macromolecules, DNA, RNA, proteins, enzymes and their functions.

Course Objectives:

To equip the student with an appreciation for the interface between technology and the life sciences.

To acquaint with the order of magnitude of biology, its complexity and optimization;

To understand Physical, Chemical and Mathematical principles in the context of development of biology.

To communicate the relevance and importance of biology for engineering.

To emphasize the importance of interdisciplinary aspect of biology.

Course Outcomes:

After learning Biology, the engineering students shall demonstrate ability to:

1) be able to predict and apply the working of biological unit, systems and processes (CL-II).
2) to identify complexity and conservative and redundant approach of Life and biological processes at different levels from molecule to organism (CL-III).
3) to relate biological processes, adaptation, optimization, coordination and hierarchy and their technical aspects as engineering systems (CL-III).
4) to apply knowledge of function, organization of biological systems across all levels (CL-IV)
   to illustrate application of specific biological systems and processes in emerging frontiers of engineering, technology and vice versa (CL-III).

Course Contents:

The Facts of Life: Learning biology by numbers; Making a Cell: Construction of Cells and Organism; Cell census; Machines and signals.

Life at Rest: Equilibrium: Rates and duration; Energy, Entropy and Forces, Biological Membranes.

Life in Motion: Dynamics, Kinetics and dynamic properties; Fluid dynamics, Diffusion in the cell, FRAP and FCS; Molecular Motors, Biological electricity.

Biological networks: Organization of Biological Networks; Biological Patterns; Introduction to Model Building in Biology.

Biological Information and errors; Relationship between biology and engineering

Laboratory Exercises / Practical:

NIL

Learning Resources:

Reference Books:

1. Rob Phillips, Jane Kondev, Julie Theriot, Hernan G. Garcia, (2013). **Physical biology of the cell**. – Second edition, Garland Science, Taylor & Francis Group, LLC.
2. Ron Milo, Rob Phillips, (2016). **Cell biology by the numbers.** Garland Science, Taylor & Francis Group, LLC.

Supplementary Reading:

3. Reece, Jane B. & Meyers, Noel. & Urry, Lisa A. & Cain, Michael L. & Wasserman, Steven A. & Minorsky, Peter V. & Jackson, Robert B. & Cooke, Bernard J. & Campbell, Neil A. (2015). **Campbell biology.** Frenchs Forest, NSW: Pearson.
4. Arthur T. Johnson, (2010). **Biology for Engineers**, CRC Press.
5. Y C Fung. Introduction to Bioengineering, World Scientific, 2001
6. Current research articles and literature shared in the class

Additional Reading:

Web Resources:

https://ocw.mit.edu/courses/biology/

MOOCs: Online courses for self-learning

https://www.edx.org/course/subject/biology-life-sciences

https://ocw.mit.edu/courses/biological-engineering/

http://nptel.ac.in/courses/121106008/

Pedagogy:

7. Lectures through Co-teaching approach
8. Power point presentations
9. Videos
10. Systematic use of group work and project-based learning

Assessment Scheme:

Class Continuous Assessment (CCA): 50 marks

Assignments	Test	Presentations	Case study	MCQ	Oral	Any other

		(Group activity)				**(Attendance and initiative)**
15/50 marks (30%)	15/50 marks (30%)	15/50 marks (30%)	--	--	--	5/50 marks (10%)

Term End Examination: 50 marks

Syllabus:

Module No.	Contents	Workload in Hrs		
		Theory	Lab	Assess
1	**The Facts of Life** **Learning biology by numbers:** Size and Geometry of cells, viruses and molecules; measurements in biology; Cellular building blocks: four classes of macromolecules, nucleic acids and proteins are polymer languages with different alphabets. **Making a Cell: Construction of Cells and Organism** - Spatial organization, Temporal organization. **Cell census:** Concentrations and members of metabolites and molecules. mass density of cells; **Machines and signals:** Key model factors, molecules and organisms	6	--	--
2	**Life at Rest** Thermodynamics and Static Properties of cells **Equilibrium:** Mechanical and Chemical Equilibrium in the Living Cell; Cells as Chemical Factories; Chemical equilibrium, rate of reaction. The concept of steady state equilibrium. **Rates and duration:** Time scales of small molecules; central dogma, Life cycle of cells. **Energy, Entropy and Forces:** Thermal energy, photons and photosynthesis; energy currencies and budget. **Electrostatics** **Biological Membranes:** membrane permeability: pumps and channels, action potential.	6	--	--
3	**Life in Motion** **Dynamics, Kinetics and dynamic properties** **Fluid dynamics:** hydrodynamics of water and other fluids, fluid dynamics of blood. Diffusion in the cell, FRAP and FCS **Molecular Motors:** Actin-Myosin, Flagellar motor, Proton pump. **Biological electricity:** The role of electricity in cells, Biological Electricity and introduction to Hodgkin–Huxley Model.	6	--	--
4	**Biological networks:** Organization of Biological Networks; **Biological Patterns** - Order in Space and Time: Coordinate	6	--	--

	system in bacteria, phyllotaxis; Self-similarity of tissues and organs; Control and stability. **Introduction to Model Building in Biology:** Models as Idealizations; Quantitative, physical and mathematical models in Biology.			
5	**Information and Errors:** Genome, mutation and errors **Relationship between biology and engineering**: Systems approach; Bionics; Biomimetics; Biomechanics, Biotechnology; Nanobiotechnology, Computational Biology, Bioprocess Engineering, Biological engineering; Biomedical engineering.	**6**	**--**	**--**

Prepared by	Checked by	Approved by
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