SRI VENKATESWARA COLLEGE OF ENGINEERING

COURSE DELIVERY PLAN - THEORY

Department of Biotechnology	LP: BY22102 Rev. No: 00
~~B.E/B.Tech/M.E/~~M.Tech : Biotechnology Regulation: 2022 PG Specialisation : Not Applicable Sub. Code / Sub. Name : BY22102 / Computational and Systems Biology Unit : 1	Date: 04.01.2023

Unit Syllabus: Tools and databases for computational systems biology 9+6

Tools and databases for modelling: Pathway databases KEGG, EMP, Metacyc, Enzyme kinetics, Database BRENDA, Gene expression databases, Biomodels database, Basics of Systems Biology Markup Language (SBML), SBML editors.

1. Biological databases: DNA, Protein and Enzymes
2. Databases for computational systems biology: Genomes, Pathways and Reactions.

Objective: To impart knowledge on databases and tools used in computational biology.

Session No *	Topics to be covered	Ref	Teaching Aids
1.	Introduction to computational systems biology	TB2 (139-166)	GCR/LCD/BB
2.	Overview of databases in systems biology	TB1 (47-56)	GCR/LCD/BB
3.	Overview of Pathway databases in systems biology	TB2 (24-25)	GCR/LCD/BB
4.	Overview of Enzyme kinetics database in systems biology	TB3 (49-53)	GCR/LCD/BB
5.	Gene expression databases in systems biology	TB1 (6-7)	GCR/LCD/BB
6.	Introduction to Systems Biology Markup Language	TB2(74-81)	GCR/LCD/BB

Content beyond syllabus covered (if any):

* Session duration: 50 minutes

Sub. Code / Sub. Name : BY22102/ Computational and Systems Biology
Unit : 2

Unit Syllabus : Machine learning and applications in biology 9+6

Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Systems Biology and its applications in whole-cell modelling, Microarrays and Clustering techniques for microarray data analysis, Informatics in Genomics and Proteomics, DNA computing.

1. Gene expression analysis
2. Microarray analysis using open-source tools

Objective: To illustrate practical aspects and application of systems biology.

Session No *	Topics to be covered	Ref	Teaching Aids
7.	Machine learning techniques	TB2(149 - 184)	GCR/LCD/BB
8.	Artificial Neural Networks	TB2(189- 232)	GCR/LCD/BB
9.	Hidden Markov Models	TB2(30- 36)	GCR/LCD/BB
10.	Systems Biology	TB2(43- 46)	GCR/LCD/BB
11.	Whole-cell modelling	TB2(49 - 72)	GCR/LCD/BB
12.	Microarrays	TB2(37-43)	GCR/LCD/BB
13.	Clustering techniques	TB3(176- 209)	GCR/LCD/BB
14.	Microarray data analysis	TB2(47 - 48)	GCR/LCD/BB
15.	DNA computing	TB3(571-581)	GCR/LCD/BB
16.	Informatics in Genomics and Proteomics,	TB3(582-594)	GCR/LCD/BB

Content beyond syllabus covered (if any): Nil

* Session duration: 50 mins

Sub. Code / Sub. Name : BY22102/ Computational and Systems Biology
Unit : 3

Unit Syllabus : Modelling of biological systems 9+6

Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Kinetic modelling of biochemical reactions, describing dynamics with ODEs, rate equations, deriving a rate equation, incorporating regulation of enzyme activity by effectors, E-cell platform and erythrocyte modelling, applications in whole cell modelling.

1. Solving ODEs using a mathematical tool box.
2. Solving enzyme kinetics using ODEs

Objective: To impart knowledge on solving ODEs using computational tools.

Session No *	Topics to be covered	Ref	Teaching Aids
17.	Kinetic modelling of biochemical reactions	TB3 (137-139)	GCR/LCD/BB
18.	Machine learning techniques in	TB 1 (27-29,31-32, 35-46, 49)	GCR/LCD/BB
19.	Kinetic modelling of biochemical reactions	TB 1 (96 - 100)	GCR/LCD/BB
20.	ODEs in biochemical reactions dynamics	TB 1 (89-95)	GCR/LCD/BB
21.	Rate equations in biochemical reactions	TB1 (373-391)	GCR/LCD/BB
22.	Regulation of enzyme activity by effectors	TB5 (40-42)	GCR/LCD/BB
23.	E-cell platform and erythrocyte modelling	TB5 (43-46)	GCR/LCD/BB
24.	Artificial Neural Networks and Hidden Markov Models	TB4 (453-456) TB3 (134-136)	GCR/LCD/BB
25.	Applications in whole cell modelling	TB4 (458-466)	GCR/LCD/BB

Content beyond syllabus covered (if any): Nil

* Session duration: 50 mins

Sub. Code / Sub. Name : BY22102/ Computational and Systems Biology

Unit : 4

Unit Syllabus : Biological networks 9+6

Complex Biological Systems, Types of Biological networks, Intra-cellular networks: Gene-regulatory network, Protein-interaction network, Metabolic networks and Signaling network; Inter-cellular networks: Neuronal networks, Network motifs, Network medicine.

1. Creating gene-regulatory and biochemical networks.
2. Simulation and analysis of biochemical networks.

Objective:To provide hands-on training on modelling biological pathways.

Session No *	Topics to be covered	Ref	Teaching Aids
26.	Complex Biological Systems	TB1 (129-135)	GCR/LCD/BB
27.	Types of Biological networks	TB1 (142-145)	GCR/LCD/BB
28.	Intra-cellular networks	TB1 (151-161)	GCR/LCD/BB
29.	Gene-regulatory network	TB1 (175-161)	GCR/LCD/BB
30.	Protein-interaction network	TB1 (199-200)	GCR/LCD/BB
31.	Metabolic networks	TB1 (223 -225) TB1 (244 -246)	GCR/LCD/BB
32.	Signaling network	TB1 (225-229)	GCR/LCD/BB
33.	Inter-cellular networks	TB1 (234-239)	GCR/LCD/BB
34.	Network motifs	TB1 (299-320)	GCR/LCD/BB
35.	Network medicine	TB1 (205-208)	GCR/LCD/BB

Content beyond syllabus covered (if any): Commercial applications Ig G

* Session duration: 50 mins

Sub. Code / Sub. Name : BY22102/ Computational and Systems Biology
Unit : 5

Unit Syllabus: CONSTRAINT-BASED MODELLING 9+6

Metabolic reconstruction, Flux Balance Analysis (FBA): Translating biochemical networks into linear algebra, Stoichiometric matrix, Elementary mode, Extreme pathways, Objective function, Optimization using linear programming. Genome-scale cellular models: Virtual Erythrocytes, Global human metabolic model.

1. Visualization of molecular interaction networks
2. Constraint-based modeling using Open-source tools.

Objective: To train students to work with genome-scale models.

Session No *	Topics to be covered	Ref	Teaching Aids
36.	Metabolic reconstruction	TB3 (1-20)	GCR/LCD/BB
37.	Flux Balance Analysis (FBA)	RB2 (1-3)	GCR/LCD/BB
38.	Translating biochemical networks into linear algebra	TB3 (140-145)	GCR/LCD/BB
39.	Stoichiometric matrix	TB3 (37-46)	GCR/LCD/BB
40.	Elementary mode analysis	RB2 (47-57)	GCR/LCD/BB
41.	Extreme pathways analysis	RB2 (61-67) RB3 (237-255)	GCR/LCD/BB
42.	Objective function	RB2 (72-74) RB 3 (87-124)	GCR/LCD/BB
43.	Optimization using linear programming	RB2 (75-79)	GCR/LCD/BB
44.	Genome-scale cellular models	TB3 (158-163)	GCR/LCD/BB
45.	Virtual Erythrocytes	RB2 (81-89)	GCR/LCD/BB

Content beyond syllabus covered (if any): Nil

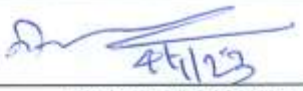
* Session duration: 50 mins

Sub. Code / Sub. Name : BY22102/ Computational and Systems Biology

REFERENCES:

1. Karthik Raman, An Introduction to Computational Systems Biology Systems-Level Modelling of Cellular Networks, CRC Press, 2021.
2. Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, 2nd Edition, CRC Press, 2019.
3. Wong, Ka-Chun, Computational biology and bioinformatics: Gene Regulation; gene, RNA, protein, epigenetics, CRC press 2016.
4. Sumeet Dua, Pradeep Chowriappa, Data Mining for Bioinformatics, CRC Press, 2012.
5. Bernhard O. Palsson. Systems Biology: Simulation of Dynamic Network States, 2nd Edition, Cambridge University Press, 2011.

TEXT BOOK	
1.	Eberhard O. Voit, A first course in systems biology, 2nd Edition, Garland Science, 2018.
2.	Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Systems Biology: A Textbook, 2nd Edition, 2016.
3.	Edda Klipp, Ralf Herwig, Axel Kowald, Christoph Wierling, Hans Lehrach, Systems Biology in Practice: Concepts, Implementation and Application, Wiley-Blackwell, 2015.
4.	Bernhard O. Palsson, Systems Biology Constraint-based Reconstruction and Analysis, 2nd Edition, Cambridge University Press, 2015.
5.	David W Mount, Bioinformatics: Sequence and Genome Analysis, 2nd Edition, Cold Spring Harbor Laboratory Press, 2004.

	Prepared by	Approved by
Signature		
Name	Mr. S. Naga Vignesh	Prof. E. Nakkeeran
Designation	Assistant Professor	Head of the Department
Date	4/1/23.	4/1/23

Remarks *:

This lesson plan is followed from previous year lesson plan and the same can be followed in future.