


Name:			
Enrolment No:			
UPES End Semester Examination, December 2024			
Course: Systems Biology		Semester : V	
Program: B.Tech Biotechnology		Duration : 3 Hours	
Course Code: HSBT3005		Max. Marks: 100	
Instructions: Attempt all questions			
S. No.	Section A Short answer questions/ MCQ/T&F (20Qx1.5M= 30 Marks)	Marks	COs
Q 1	Which omics technology is most suitable for studying post-translational modifications? a) Metabolomics b) Proteomics c) Genomics d) Lipidomics	1.5	CO1
Q 2	The rate of an enzyme-catalyzed reaction is directly proportional to: a) Substrate concentration b) Enzyme concentration c) Both enzyme and substrate concentration d) Product concentration	1.5	CO1
Q 3	Which metabolic pathway synthesizes glucose from non-carbohydrate sources? a) Glycogenesis b) Glycolysis c) Gluconeogenesis d) Pentose phosphate pathway	1.5	CO1
Q 4	Gene expression can be regulated post-transcriptionally by: a) Promoter methylation b) RNA interference c) DNA methylation d) Histone acetylation	1.5	CO1
Q 5	Describe the role of feedback inhibition in metabolic pathways.	1.5	CO1
Q 6	Pathway enrichment analysis is used to: a) Annotate non-coding regions b) Identify over-represented pathways in datasets c) Sequence whole genomes d) Compare protein domains	1.5	CO2
Q 7	Which tool is widely used for genome annotation?	1.5	CO2

	<ul style="list-style-type: none"> a) BLAST b) RAST c) CRISPR/Cas9 d) ClustalW 		
Q 8	<p>Why do extremophiles have unique metabolic pathways?</p> <ul style="list-style-type: none"> a) To enhance photosynthesis b) To adapt to extreme environments c) To reduce energy requirements d) To perform horizontal gene transfer 	1.5	CO2
Q 9	<p>Metabolic pathways in halophiles often involve:</p> <ul style="list-style-type: none"> a) Reduced osmotic stress b) Increased glycolysis rates c) Specialized ion transport mechanisms d) Anaerobic respiration 	1.5	CO2
Q 10	<p>The study of organism-specific metabolic pathways can help in:</p> <ul style="list-style-type: none"> a) Constructing phylogenetic trees b) Identifying novel enzymes and biocatalysts c) Developing RNA vaccines d) Determining ribosome structures 	1.5	CO2
Q 11	<p>Metabolic control analysis (MCA) focuses on identifying:</p> <ul style="list-style-type: none"> a) Pathways involved in cell division b) Key enzymes regulating metabolic flux c) The structure of DNA d) Gene expression patterns 	1.5	CO3
Q 12	<p>In <i>Drosophila melanogaster</i>, the regulatory network is crucial for:</p> <ul style="list-style-type: none"> a) Protein folding b) Developmental processes c) Metabolite transport d) Gene expression regulation 	1.5	CO3
Q 13	<p>The MAP kinase cascade is an example of a:</p> <ul style="list-style-type: none"> a) Metabolic pathway b) Signaling pathway c) Genetic network d) Protein interaction network 	1.5	CO3
Q 14	<p>Which of the following best describes a mechanical network in cell biology?</p> <ul style="list-style-type: none"> a) A network of cell signaling pathways b) A network governing the cytoskeleton dynamics c) A network of enzyme interactions d) A network involving metabolic reactions 	1.5	CO3
Q 15	<p>The key assumption in flux balance analysis is:</p> <ul style="list-style-type: none"> a) The system reaches equilibrium at steady-state b) All reactions are reversible c) Enzyme concentrations are uniform 	1.5	CO3

	d) Gene expression is linear		
Q 16	What happens in the lac operon when lactose is present in the environment? a) The repressor binds to the operator b) The repressor is inactivated and transcription proceeds c) The RNA polymerase is inhibited d) The gene for the repressor is activated	1.5	CO4
Q 17	In systems biology, which approach is used to model large-scale gene regulatory networks? a) Stochastic modeling b) Linear regression c) Genome-scale metabolic modeling d) Principal component analysis	1.5	CO4
Q 18	Which of the following is an open-source tool for modeling biological systems? a) MATLAB b) Ecell c) Excel d) AutoCAD	1.5	CO4
Q 19	BioNets is used for: a) Protein structure analysis b) Modeling gene regulatory networks c) Gene expression profiling d) Metabolic pathway analysis	1.5	CO4
Q 20	What is the purpose of the E. coli chemotactic pathway? a) To promote DNA repair b) To enable movement toward attractants and away from repellents c) To regulate protein synthesis d) To control bacterial growth rate	1.5	CO4
Section B: Short-Answer Questions (4Qx5M=20 Marks)			
Q 1	Define systems biology? Discuss its importance in predicting phenotypic behavior in an organism using omics data.	5	CO1
Q 2	Discuss the role genome annotation plays in predicting metabolic pathways? Explain the importance of functional gene annotation.	5	CO2
Q 3	List various factors affecting distribution of fluxes across metabolic pathways	5	CO3
Q 4	Describe the primary function of the DAVID software in functional genomics, and how does it assist in biological research?	5	CO4
Section C: Case study			

(2Qx15M=30 Marks)

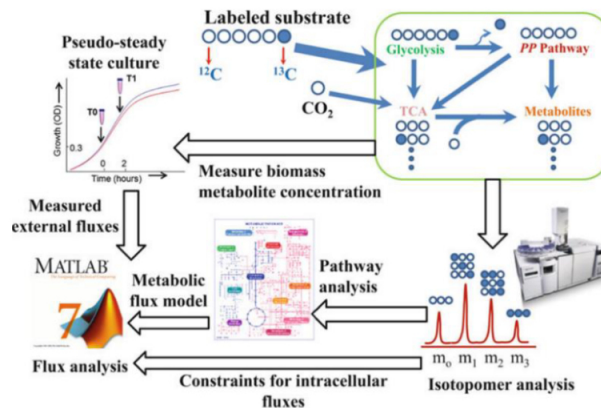
Q 1

The goal of metabolic engineering is to design and build engineered biological systems that can produce chemicals, materials, food, and drugs at high yield using the appropriate microorganisms. However, the lack of fundamental understanding of cellular responses during industrial bioprocesses often prevents metabolic engineers from achieving satisfactory goals in biochemical production. In the past decade, ^{13}C -MFA has been widely used to provide insightful information on metabolism of various microorganisms, thus helping metabolic engineers to successfully improve biochemical production.

Stable isotope labeling is a powerful technique with promising applications. Depending upon this powerful technology, labeled tracers can sensitively and accurately track changes according to the location and quantity of peptides, amino acids, or carbohydrates containing isotope-labeled in vivo or in vitro. It enables direct analysis of nutrient distribution, metabolism, conversion into metabolites, and the fate of the resulting metabolites. In contrast to radioactive labeling, there are no dangers or safety concerns, making this technique particularly well suited for metabolism studies in humans. As a result, isotope labeling technology has received progressively more recognition in the fields of medicine and biochemistry.

15 marks
(3 marks each)

CO2



Look at the diagram carefully and answer the following:

- A) Which approach is depicted in the diagram to estimating metabolic fluxes for biochemical production. Explain this approach and its significance in metabolic engineering.
- B) With the help of the given diagram, list five key procedural steps in estimating the metabolic fluxes
- C) Define isotopomers? Why is isotopic labelling important?

	<p>D) Explain isotopomer analysis and two primary analytical methods used for measuring the labelled metabolites.</p> <p>E) List any two promising applications of stable isotope labeling.</p>		
Q 2	<p>A biotech startup is developing a novel gene therapy for the treatment of rare genetic disorders. The startup uses gene editing technologies, like CRISPR-Cas9, and combines them with systems biology to model the effects of gene modification on cellular pathways. They aim to personalize gene therapies based on the patient's genetic profile, ensuring more effective and safer treatments.</p> <p>Based on case study, answer the following:</p> <p>A) Discuss the significance of gene editing technologies like CRISPR-Cas9 in biotechnology? How does systems biology contribute to the development of personalized gene therapies?</p> <p>B) What challenges are faced when developing gene therapies for rare genetic disorders? Discuss the role of patient genetic profiling in personalized gene therapy.</p> <p>C) Which ethical considerations must be addressed when using gene editing technologies in gene therapy?</p>	15 marks (5 marks each)	CO4
<p>Section D: Long-Answer Questions (2Qx10M=20 Marks)</p>			
Q 1	<p>A) Explain the significance of promoter regions in genome regulation. How do mutations in promoter regions affect gene expression?</p> <p>B) Explain the role of mRNA stability in post-transcriptional regulation. What factors influence mRNA degradation?</p>	5+5 marks	CO3
Q 2	<p>Explain the importance of mathematical models in representing cell biological systems. How can metabolic network analysis be used to identify drug targets in pathogenic bacteria?</p>	10 marks	CO4