# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE-6 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK**

## Subject Name & Code:

## BIOCHEMICAL ENGINEERING (3160512)

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## Unit 1: Introduction to Biochemical Engineering & Microbiology Fundamentals

**Repeated Questions:**

1. **Compare/Differentiate Chemical and Biochemical processes.** (S25 - Q.1(a), 03 marks) (W25 - Q.1(c), 07 marks) (S22 - Q.1(c), 07 marks)
2. **List/Discuss various unit operations in bioprocessing/biochemical processes.** (W25 - Q.1(a), 03 marks) (S24 - Q.2(a), 03 marks) (S23 - Q.1(c), 07 marks) (W22 - Q.1(a), 03 marks)
3. **Differentiate between Prokaryotic and Eukaryotic cells.** (S25 - Q.1(a), 03 marks) (W25 - Q.1(a), 03 marks) (S24 - Q.2(c), 07 marks)
4. **Explain/Discuss an Integrated Bioprocess System.** (S23 - Q.1(c), 07 marks) (W25 - Q.1(c), 07 marks)

**Other Important Questions (Newest to Oldest):**

1. **Distinguish between bioprocess engineering and biochemical engineering.** (S25 - Q.1(a), 03 marks)
2. **State the function of following in Eukaryotic cell: 1. Golgi bodies 2. Endoplasmic reticulum 3. Chloroplasts.** (W25 - Q.1(a), 03 marks)
3. **For animal and plant cells, mention the following differences: 1. Cell wall 2. Chloroplast 3. Vacuoles 4. Endoplasmic reticulum.** (S25 - Q.1(b), 04 marks)
4. **Explain Polysaccharides with its examples.** (W24 - Q.1(a), 03 marks)
5. **What is carbohydrate? Explain the types and function of carbohydrates.** (S24 OR - Q.2(c), 07 marks)
6. **State the important differences between prokaryotes and eukaryotes.** (W22 - Q.1(a), 03 marks)
7. **Biochemical engineering is an interdisciplinary course. Justify.** (S23 - Q.1(b), 03 marks)
8. **Draw a schematic of a fermentation vessel. Label the major components and briefly explain their functions.** (S24 OR - Q.4(c), 07 marks) [Diagram likely included - refer Question paper]
9. **Explain the biological process with a suitable block diagram. State the merit and demerit of biological process.** (W25 - Q.1(c), 07 marks) [Diagram likely included - refer Question paper]
10. **You as a chemical engineer will decide on which general requirements of Fermentation process.** (W22 - Q.2(b), 04 marks)

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# Unit 2: Chemicals of Life (Biomolecules)

**Repeated Questions:**

1. **Define/Explain Carbohydrates, their types and functions.** (S24 - Q.2(a), 07 marks)
   (W24 - Q.1(a), 03 marks)
   (S25 - Q.2(a), 03 marks)
2. **Explain/Types of Proteins with examples. Discuss factors affecting protein denaturation.** (S24 - Q.5(c), 07 marks)
   (S25 - Q.2(c), 07 marks)
   (W24 OR - Q.2(c), 07 marks)
3. **Classify proteins based on structure.** (S25 - Q.2(b), 04 marks)
   (W25 - Q.2(c), 04 marks)
4. **Classify lipids and discuss their functions/importance.** (S23 OR - Q.2(c), 07 marks)
   (W25 OR - Q.2(c), 07 marks)

**Other Important Questions (Newest to Oldest):**

1. **Define and write chemical reactions for the synthesis of: 1. Fat 2. Sucrose 3. Amylose.** (S25 OR - Q.2(c), 07 marks)
2. **What is the denaturation of protein? List out the five major biological functions of proteins.** (S25 OR - Q.2(c), 07 marks)
3. **Define the quaternary structure of protein? Classify the following protein based on their structure: 1. Insulin 2. Hemoglobin 3. Glycine 4. Fibrous protein. Discuss the three important characteristics of protein.** (W25 - Q.2(c), 07 marks)
4. **Differentiate between primary, secondary and tertiary protein ? List out the characteristics of protein.** (S23 - Q.2(c), 07 marks)
5. **Define polysaccharides. Differentiate between amylose and amylopectin in terms of their structure, composition, and function.** (S25 OR - Q.2(c), 07 marks)
6. **Differentiate between Monosaccharides and Polysaccharides.** (W25 - Q.2(a), 03 marks)
7. **Specify building blocks and bond formation for the following: (1) Protein, (2) Disaccharides, (3) Fat, and (4) Nucleotide.** (W25 - Q.2(b), 04 marks)
8. **State the role of chelator, buffer and antifoam in the microbiological process.** (S25 - Q.2(a), 03 marks)
9. **Define the following: (1) carbohydrates, (2) Protein, and (3) Lipid.** (S23 - Q.2(a), 03 marks)

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# Unit 3: Enzyme Science and Engineering

**Repeated Questions:**

1. **Derive Michaelis-Menten equation / rate expression.** (S24 - Q.3(b), 04 marks)
   (S25 - Q.3(c), 07 marks)
   (W24 - Q.3(b), 04 marks)
2. **Explain/Differentiate Competitive, Non-competitive, Uncompetitive inhibition.** (W22 OR - Q.2(c), 07 marks)
   (S25 OR - Q.3(c), 07 marks)
   (W24 - Q.3(c), 07 marks)
3. **What is enzyme inhibition? List types.** (W25 - Q.3(a), 03 marks)
   (S25 - Q.3(c), 03 marks)
4. **Explain/Discuss Lock and Key model and Induced Fit model.** (S24 - Q.3(c), 07 marks)
   (W22 - Q.1(c), 07 marks)
5. **What is enzyme immobilization? List/Discuss methods, merits & demerits.** (W25 OR - Q.3(c), 07 marks)
   (S23 OR - Q.3(b), 04 marks)
   (W22 - Q.3(a), 03 marks)

**Other Important Questions (Newest to Oldest):**

1. **A substrate is converted to a product by the catalytic action of an enzyme... What should be the size of a steady-state CSTR to convert 95% of incoming substrate... What should be the size of the reactor if a plug flow reactor is used...?** (S25 - Q.3(c), 07 marks) [Numerical data given - refer Question paper]
2. **Evaluate the Michaelis-Menten kinetic parameters by employing (a) the Langmuir plot (b) the Lineweaver-Burk plot (c) the Eadie-Hofstee plot.** (S25 OR - Q.3(c), 07 marks) [Table data given - refer Question paper]
3. **Write assumptions involved in enzyme kinetics for the Michaelis-Menten approach.** (S25 OR - Q.3(a), 03 marks)
4. **Explain: 1) Proximity effect of enzyme 2) Orientation effect of enzyme 3) specific activity.** (W24 - Q.3(a), 03 marks)
5. **Discuss 'Entrapment' for immobilization of Enzymes with its types.** (W24 - Q.3(c), 07 marks)
6. **What is Damkohler number? Give its significance.** (W24 - Q.3(a), 03 marks)
7. **The following data have been obtained for initial enzyme concentration [E0] for an enzyme-catalysed reaction. a. Find Km. b. Find maximum forward velocity Vm. c. Find rate constant k2.** (W24 - Q.2(b), 04 marks) [Table data given - refer Question paper]
8. **Following sequence describes the reactions of two different substrates catalyzed by one enzyme... 1. Derive the rate equation by making the Michaelis-Menten assumption. b. What is the rate equation if the concentration of S1 is much higher than that of S2?** (W25 - Q.3(c), 07 marks) [Reaction scheme given - refer Question paper]
9. **How are enzymes classified? Discuss importance of Industrial enzymes.** (S23 - Q.3(a), 03 marks)
10. **List out the factor affecting enzymatic activity.** (S23 - Q.3(c), 04 marks)
11. **Explain Allosteric enzymes.** (W24 - Q.2(a), 03 marks)
12. **Define the term 'Enzyme immobilization'. How the function of an enzyme is altered due to immobilization.** (S25 OR - Q.3(b), 04 marks)
13. **Discuss the following plots for estimation of kinetic parameters: 1. Langmuir plot 2. Lineweaver-Burk plot.** (W25 OR - Q.3(b), 04 marks)

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# Unit 4: Microbial Kinetics & Sterilization

**Repeated Questions:**

1. **Explain/Draw phases of microbial growth in batch culture.** (S24 - Q.3.5(c), 07 marks)
   (W22 - Q.3(c), 07 marks)
   (S25 - Q.4(c)(2), Part of 07 marks)
2. **State/Explain Monod Equation / Monod growth kinetics.** (W24 - Q.4(a), 03 marks)
   (S25 - Q.4(b), 04 marks)
   (S23 - Q.4(b)(1), Part of 04 marks)
3. **Define/Discuss: Sterilization & its methods / cell death kinetics.** (S25 - Q.4(a)(1), Part of 03 marks)
   (W25 - Q.4(a)(1), Part of 03 marks)
   (S23 - Q.3(a), 03 marks)
   (W22 - Q.3(c), 07 marks)
4. **Define/Discuss Yield coefficient, Respiratory Quotient (RQ), Oxygen Uptake Rate (OUR).** (S25 - Q.4(b)(2,3), Part of 04 marks)
   (W25 - Q.4(a)(3), Part of 03 marks)
   (S23 - Q.4(b)(2,3), Part of 04 marks)

**Other Important Questions (Newest to Oldest):**

1. **Aerobic degradation of benzoic acid by a mixed culture... a. Determine a,b,c,d, and e if respiratory quotient RQ = 0.9 b. Determine the yield coefficients, YX/S and YX/O.** (S25 OR - Q.4(c), 07 marks) [Reaction given - refer Question paper]
2. **How mass transfer limitations in bioreactors are prevented? List out the variant of it.** (S25 OR - Q.4(a), 03 marks)
3. **Discuss sodium sulfite method for oxygen absorption rate... Calculate the oxygen uptake and KLa.** (S25 OR - Q.4(c), 07 marks) [Numerical data given - refer Question paper]
4. **Define the following: 1. Cultivation 2. Inoculation 3. Sterilization.** (S25 - Q.4(a), 03 marks)
5. **The following data were obtained from enzymatic oxidation of phenol... a. What type of inhibition is this? b. Determine Vm and Km. c. Determine oxidation rate at [S]=70 mg/l.** (W25 - Q.4(c), 07 marks) [Table data given - refer Question paper]
6. **Aerobic degradation of an organic compound by a mixed culture... a. Determine a,b,c,d, and e, if YXS = 0.4 g X/g S. b. Determine YXO2 and YXNH3. c. Determine RQ.** (W25 OR - Q.4(c), 07 marks) [Reaction given - refer Question paper]
7. **What is isoelectric focusing? State mechanism and use.** (W25 OR - Q.4(a), 03 marks)
8. **Briefly Discuss: (1) cell death kinetics (2) Monod Equation.** (W25 OR - Q.4(b), 04 marks)
9. **Explain critical dilution rate and wash out in context with continuous culture.** (S25 OR - Q.5(b), 04 marks)
10. **Draw schematic diagram for growth of microorganism in batch culture.** (W24 - Q.4(b), 04 marks) [Diagram likely included - refer Question paper]
11. **Discuss 'Chemostat continuous culture' with dilution rate.** (W24 OR - Q.4(a), 03 marks)
12. **Explain static method of gassing out for determination of mass transfer coefficient KLa value.** (W24 OR - Q.4(c), 07 marks)
13. **Explain range of fermentation process.** (S24 - Q.4(a), 03 marks)
14. **Discuss briefly various constituents of a liquid media used for growth of yeast and give examples.** (S24 - Q.4(b), 04 marks)
15. **Explain the importance of pH in fermentation or enzymatic process for product formation.** (S24 OR - Q.4(a), 03 marks)
16. **Outline the different methods used for measurement of microbial growth?** (W22 OR - Q.3(b), 04 marks)
17. **Explain the phenomenon of thermal-death kinetics of cells and spores.** (W22 OR - Q.3(c), 07 marks)
18. **Discuss various problems that may arise if DO level falls down in an aerobic process.** (W22 - Q.4(b), 04 marks)

19. **Outline the method of the graphical evaluation of kinetic parameters derived from the Michaelis-Menten equation?** (W22 - Q.1(b), 04 marks)
20. **Discuss the air sterilization process for a large scale aerobic fermentor with a schematic diagram. Name a few materials used as air filters.** (S24 OR - Q.3(c), 07 marks) [Diagram likely included - refer Question paper]
21. **Discuss types of sterilization of media in detail.** (W24 - Q.4(c), 07 marks)

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# Unit 5: Bioreactor Design & Analysis

**Repeated Questions:**

1. **What is Fed-Batch Reactor? Explain with diagram/configurations.** (S24 - Q.4(c), 07 marks)
   (S25 - Q.5(c), 07 marks)
2. **Compare Batch vs. Continuous biomass culture.** (S25 - Q.5(b), 04 marks)
   (W25 OR - Q.5(b), 04 marks)
   (S23 OR - Q.4(c), 07 marks)
3. **Explain/Discuss Continuous Stirred Tank Reactor (CSTR) / Stirred Tank Reactor in series / with recycle.** (W25 OR - Q.5(c), 07 marks)
   (S23 - Q.5(c), 07 marks)
4. **Define/Explain: Critical Dilution Rate & Washout.** (W22 - Q.4(a), 03 marks)
   (S25 OR - Q.5(b), 04 marks)

**Other Important Questions (Newest to Oldest):**

1. **Sketch a single stirred tank reactor and write a cell and substrate mass balance. Derive an expression for dilution rate.** (S25 OR - Q.5(c), 07 marks) [Diagram likely included - refer Question paper]
2. **What is foaming in a bioreactor? What are adverse impacts? How prevented?** (S25 - Q.5(a), 03 marks)
3. **List source of probable contamination in a bioreactor. How prevented?** (S25 - Q.5(b), 04 marks)
4. **Discuss the plug flow reactor for biomass processing with a suitable diagram.** (W25 - Q.5(c), 07 marks) [Diagram likely included - refer Question paper]
5. **Differentiate between chemostat and turbidostat.** (W25 OR - Q.5(a), 03 marks)
6. **Discuss the continuous stirred tank reactor biomass using a suitable diagram.** (W25 OR - Q.5(c), 07 marks) [Diagram likely included - refer Question paper]
7. **Name different types of solid media used for growth.** (S24 - Q.3.5(a), 03 marks)
8. **Explain growth of a typical microbial culture in a batch conditions.** (S24 - Q.3.5(c), 07 marks)
9. **Discuss the limitation of bio-catalyzed reaction.** (S24 OR - Q.3.5(a), 03 marks)
10. **How is fed-batch process carried out for fermentation.** (W22 - Q.5(a), 03 marks)
11. **Explain the method of manufacturing of industrial alcohols using biotechnology route?** (W22 - Q.5(c), 07 marks)
12. **Define aerobic and anaerobic fermentation process with an example of each.** (W22 OR - Q.5(a), 03 marks)
13. **Discuss the different types of fermenter used in batch and continuous process.** (W22 OR - Q.5(c), 07 marks)
14. **List the various configurations for fermentation process. Draw the Fed batch reactor showing important components.** (S23 OR - Q.4(b), 04 marks) [Diagram likely included - refer Question paper]

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# Unit 6: Aeration, Agitation & Fermenter Design

**Repeated Questions:**

1. **Role/Importance of Aeration and Agitation in fermentation.** (S25 - Q.1(b), Part of 04 marks)
   (W24 OR - Q.4(b), 04 marks)
   (S23 - Q.2(b)(3), Part of 04 marks)
2. **Discuss/Draw Fermenter vessel and label components/parts.** (S24 OR - Q.4(c), 07 marks)
   (W24 - Q.5(c), 07 marks)
3. **State factors affecting Volumetric Oxygen Transfer Coefficient (KLa).** (S23 OR - Q.4(a), 03 marks)
   (W25 - Q.5(b), 04 marks)
4. **Methods for determination of KLa value.** (S25 - Q.4(c), 07 marks)
   (W22 - Q.4(c), 07 marks)

**Other Important Questions (Newest to Oldest):**

1. **Justify: "Agitator is important component for fermenter design". Write flow pattern for: 1. Disc turbine 2. Pitched blade agitator.** (W25 - Q.1(b), 04 marks)
2. **List out various agitation units used in a typical fermenter.** (S25 - Q.1(b), Part of 04 marks)
3. **What is volumetric oxygen transfer coefficient? State factor affecting it.** (W25 - Q.5(b), 04 marks)
4. **State important points in designing and constructing a fermenter.** (W25 OR - Q.3(a), 03 marks)
5. **Why aeration and agitation is required for fermentation process.** (W24 OR - Q.4(b), 04 marks)
6. **Discuss various parts and controls of fermenter using suitable diagram.** (W24 - Q.5(c), 07 marks) [Diagram likely included - refer Question paper]
7. **Explain oxygen needs to be supplied at a sufficient rate during aerobic fermentation.** (S24 - Q.3(a), 03 marks)
8. **Discuss the role of impellers used for agitation in fermentor in brief.** (W25 - Q.1(b), 04 marks)
9. **List various types of valves used in biochemical process industry.** (S24 OR - Q.3(a), 03 marks)
10. **Discuss the aseptic condition. State important considerations for maintenance of aseptic conditions.** (S24 OR - Q.3(b), 04 marks)
11. **Explain the importance of pH in fermentation or enzymatic process for product formation.** (S24 OR - Q.4(a), 03 marks)
12. **Control of process parameters is essential in the fermentation unit. Please explain how the controlled conditions are kept fermentation.** (S25 OR - Q.3(a), 03 marks)
13. **Discuss the use of a valve and steam trap in the fermentation unit.** (S25 - Q.4(b), 04 marks)
14. **For the fermentation, write the importance of (1) Nutrient, (2) Agitator, (3) Aeration, and (4) Steam.** (S23 - Q.2(b), 04 marks)
15. **Specify application of the following in fermentation: (1) Sterile air, (2) Steam trap, (3) Controller, and (4) valve.** (S25 - Q.2(b), 04 marks)
16. **Outline the various challenges faced during the scale-up process at different level.** (W22 OR - Q.5(b), 04 marks)

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# Unit 7: Downstream Processing & Product Recovery

**Repeated Questions:**

1. **List/Discuss methods for product recovery / separation & purification.** (S25 - Q.5(a), 03 marks)
   (W25 - Q.5(a), 03 marks)
   (W22 - Q.4(c), 07 marks)
2. **Differentiate/Explain Microfiltration and Ultrafiltration.** (S25 - Q.5(a), Part of 03 marks)
   (S23 - Q.5(b), 04 marks)
   (S25 OR - Q.5(b), 04 marks)
3. **What is Chromatography? List/Discuss types & role in product recovery.** (S25 - Q.4(a), 03 marks)
   (S25 OR - Q.5(c), 07 marks)
   (W25 - Q.4(b), 04 marks)
4. **What is Cell Disruption? Explain importance & methods.** (S24 - Q.2(a), 03 marks)
   (S25 OR - Q.5(a), 03 marks)
   (W25 - Q.5(a), Part of 03 marks)

**Other Important Questions (Newest to Oldest):**

1. **List out procedures involved in separation and purification of intracellular enzymes. Tabulate unit operations and their range for recovery based on: 1. Size 2. Diffusivity 3. Surface activity 4. Density.** (S25 - Q.1(c), 07 marks)
2. **List out methods used for separation of soluble products.** (S25 OR - Q.5(a), 03 marks)
3. **Explain the importance of centrifugation operation in product recovery.** (S23 - Q.4(a), 03 marks)
4. **List product recovery method? Discuss single stage and multistage extraction.** (S23 OR - Q.5(b), 04 marks)
5. **Explain variant of cell disruption method with merit and demerit of each.** (S23 OR - Q.5(c), 07 marks)
6. **Explain Ultrasonication technique for cell disruption.** (W24 - Q.5(a), 03 marks)
7. **Discuss adsorption chromatography for separation and purification of products.** (W24 OR - Q.5(c), 07 marks)
8. **Explain any method of membrane separation used for product recovery?** (W22 - Q.5(b), 04 marks)
9. **Define crystallization and state its application in biochemical industry.** (S24 - Q.3.5(b), 04 marks)
10. **Explain Electrophoresis process in biochemical processing.** (S25 OR - Q.4(a), 03 marks)
11. **List out unit operations involved for separation of products based on: 1. Size 2. Solubility 3. Diffusivity 4. Vapour pressure.** (W25 - Q.3(b), 04 marks)
12. **State mechanism and application of: 1. Adsorption chromatography 2. Gel-filtration chromatography.** (W25 - Q.4(b), 04 marks)
13. **Discuss the plug flow reactor for biomass processing with a suitable diagram.** (W25 - Q.5(c), 07 marks) [Diagram likely included - refer Question paper]

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