

Detailed Outline:

Part 1: Cellular Metabolism and Transport Processes

- A. Introduction
- B. Central Metabolic Pathways
 - 1. Glucose uptake
 - 2. Glycolysis
 - 3. Pentose phosphate pathway
 - 4. Tricarboxylic acid cycle
 - a. Charging the TCA cycle
 - b. The TCA cycle
 - c. Anaplerotic pathways
 - 5. Other important pathways
 - 6. Balancing the electrons
 - a. In the presence of O₂
 - b. In the absence of O₂
 - 7. Summary of principal carbon flow
- C. Effect of Knockouts
 - 1. *zwf* – glucose-6P 1-dehydrogenase
 - 2. *pgi* – phosphoglucose isomerase
 - 3. *pykF* – pyruvate kinase
- D. Material Balances
 - 1. Material balances around metabolic nodes

Part 2: Behavior of Cells in a Bioreactor

- A. Models to describe cell growth
 - 1. Introduction
 - 2. Empirical models to describe cell growth rate
- B. Model to describe substrate utilization
 - 1. Maintenance
 - 2. Cell mass
 - 3. Products
 - a. Growth associated
 - b. Non-growth associated
 - c. Mixed-growth associated
 - d. My personal preference
 - 4. Summary
- C. General material balances
 - 1. Derivation
 - 2. Common simplifications
- D. Batch operation
 - 1. Introduction
 - 2. Incorporating growth and substrate utilization models
 - 3. Simulation

4. Conclusions
- E. Chemostat operation
 1. Cells
 2. Substrate
 3. Biomass yield
 4. Calculation of maintenance coefficient and true biomass yield
 5. More on maintenance
 6. Product
 7. Calculating substrate concentration in a chemostat
 8. Calculating biomass concentration in chemostat
 9. Calculating Monod constant
 10. Industrial use of a chemostat
 11. Why conduct a laboratory chemostat experiment?
 12. Example calculations
 13. How much time is required to reach steady-state?
 14. Competition
 15. Other thoughts
 - a. What does maximum growth rate really mean?
 - b. Practical matters for conducting chemostat experiments
- F. Acclerostat
 1. Motivations
 2. Simulation
- G. Physiological consequences of nutrient limitation
 1. Introduction
 2. Respiratory capacity
 3. Nitrogen limitation
 4. Shift between C-limited and N-limited conditions
 5. Multiple carbon/energy sources
 6. Phosphorus limitation
- H. Exponential fed-batch operation
 1. Motivations
 2. Derivation
 3. Example calculations
- I. Constant feed fed-batch operation
 1. Derivation
 2. Volume
 3. Biomass
 4. Substrate
 5. Example calculations