Critical Thinking Questions - Anaerobic Digestion

I. Introduction to Anaerobic Digestion

1. Define anaerobic digestion.
2. List examples of wastes that are candidates for conversion using this approach. What makes these wastes candidates for this conversion?
3. Draw and describe the inputs and outputs of a typical AD facility.
4. List reasons for conducting AD. Which reason do you feel is most important? Why?
5. If you were tasked with designing an AD system for your community, what factors/issues should be taken into account? List them and provide a short description of their importance/impact on the process.
6. Summarize one of the case studies. List the types of wastes and outputs associated with the study and determine how conducting AD is more beneficial than landfilling that waste.

II. History of Current State of Anaerobic Digestion in the U.S. and Europe

1. Briefly discuss differences associated with AD use in the US and Europe.

III. Overview of Anaerobic Digestion Processes

1. Describe how the following factors influence the anaerobic degradation of waste:
   a) Temperature
   b) Nutrients
   c) Toxic compounds
2. Draw a diagram illustrating how organics are converted to methane and carbon dioxide. Include all relevant microbial processes.
3. Define the following terms:

Term	Definition
Hydrolysis	
Anaerobic	
Aerobic	
Autotroph	
Chemotroph	
Phototroph	
Heterotroph	
Fermentation	
Methanogenesis	
Mesophilic	
Thermophilic	

IV. Anaerobic Digestion Biogas Production

1. Calculate the methane potential (m^3/tonne) and volume of biogas generated if 1 Mg of food waste is anaerobically digested. Assume 100% of the food waste degrades. What is the electricity generation from the anaerobic digestion of organics?

2. Estimate the volume of biogas generated from the anaerobic digestion of 100 g of mixed paper. What assumptions did you make to perform this calculation? Is this estimate realistic? Why or why not?

3. A local restaurant is generating 1 Mg/week of an organic waste stream with the composition listed below. They plan to send this waste to an anaerobic digester for conversion to biogas and assume that 90% of the organics biodegrade. Calculate the following:

   a) Methane potential of this waste (m^3/tonne waste)
   b) Volume (m^3) of biogas generated from one year worth of waste
   c) Electricity (kWh) generated from one year worth of waste

Waste Component	Composition of waste (%, by weight)
Food Waste	80
Paper	10
Cardboard	10

4. A community currently sends 1,000 Mg/year of waste to their landfill. They are considering diverting a fraction of their currently landfilled food waste to a newly constructed AD unit. The fraction of this waste stream that is food waste is 20%. Construct a graph that illustrates how the fraction of diverted food correlates with energy production (kWh/year). Clearly list all assumptions.

V. Types of Anaerobic Digestion Systems

1. Define the following terms:

Term	Definition
Low-solids AD	
High-solids AD	
Dry AD	
Wet AD	
Single stage AD	
Mulit-stage AD	
Organic loading rate	
Process Water	
Batch reactor	
Continuous reactor	

2. The City Engineer has decided to construct and operate an AD unit to divert waste from the landfill. You have been asked to develop a plan to integrate the AD process within their current solid waste management process and to write a memo describing this plan to the City Engineer. You should provide at least two possible alternatives for this integration. For each alternative, include:

    1. A diagram that clearly illustrates what wastes will be treated at the AD facility and how they will get there.
    2. A justification.
    3. Advantages and disadvantages.

    To accomplish this, assume that the waste generated in this city is the same as the average waste composition (as found on the EPA website) and that they are currently landfilling, recycling, composting, and incinerating the waste, according to the national averages reported by EPA.