a. What is the probability of a successful sterilization?

b. What fraction of the vitamin remains undegraded?

c. What fraction of the vitamin is degraded in the sterilization period?

d. What fraction of the vitamin is degraded in the heat-up and cool-down periods?

e. What is the fraction of spores deactivated in the heat-up and cool-down cycles?

10.10. *E. coli* have a maximum respiration rate, $q_{O_2 max}$, of about 240-mg O_2/g-dry wt-h. It is desired to achieve a cell mass of 20 g dry wt/l. The k_La is 120 h^{-1} in a 1000-l reactor (800 l working volume). A gas stream enriched in oxygen is used (i.e., 80% O_2) which gives a value of C^* = 28 mg/L. If oxygen becomes limiting, growth and respiration slow; for example,

$$q_{O_2} = \frac{q_{O_2 max} C_L}{0.2 \text{ mg/l} + C_L}$$

where C_L is the dissolved oxygen concentration in the fermenter. What is C_L when the cell mass is at 20 g/l?

10.11. The temperature history of the heating and cooling of a 40,000-l tank during sterilization of medium is: 0 to 15 min, T = 85°C; 15 to 40 min, T = 121°C; 40 to 50 min, T = 85°C; 50 to 60 min, T = 55°C; > 60 min, T = 30°C. The medium contains vitamins, the most fragile of the vitamins has an activation energy for destruction of 10 kcal/g-mol, and the value of α (see eq. 10.18) is $1 \cdot 10^4$ min^{-1}. Assume vitamin destruction is first order and the initial concentration is 50 mg/l. R is 1.99 cal/g-mol-°K. The medium contains $2.5 \cdot 10^3$ spores/l. The spores have an E_{0d} = 65 kcal/g-mol, and k_d at 121°C is 1.02 min^{-1}. *Estimate:* (a) the probability of a successful sterilization, and (b) what fraction of the vitamin remains active?

10.12. Estimate k_La from Fig. 10.5 if C^* is 35 mg/l due to the use of nearly pure oxygen rather than air.

10.13. In cultivation of baker's yeast in a stirred and aerated tank, lethal agents are added to the fermentation medium to kill the organisms immediately. Increase in dissolved oxygen (DO) concentration upon addition of lethal agents is followed with the aid of a DO analyzer and a recorder. Using the following data, determine the oxygen transfer coefficient (k_La) for the reactor. Saturation DO concentration is C^* = 9 mg/l.

Time (min)	DO (mg/l)
1	1
2	3
2.5	4
3	5
4	6.5
5	7.2

10.14. A stirred-tank reactor is to be scaled down from 10 m^3 to 0.1 m^3. The dimensions of the large tank are: D_t = 2 m; D_i = 0.5 m; N = 100 rpm.

a. Determine the dimensions of the small tank (D_t, D_i, H) by using geometric similarity

b. What would be the required rotational speed of the impeller in the small tank if the following criteria were used?

1) Constant tip speed

2) Constant impeller Re number