TABLE 10.1 Typical Respiration Rates of Microbes and Cells in Culture

Organism	q_{O_2} (mmol O_2/g dw-h)
Bacteria	
E. coli	10–12
Azotobacter sp.	30–90
Streptomyces sp.	2–4
Yeast	
Saccharomyces cerevisiae	8
Molds	
Penicillium sp.	3–4
Aspergillus niger	ca. 3
Plant cells	
Acer pseudoplatanus (sycamore)	0.2
Saccharum (sugar cane)	1–3
Animal cells	
HeLa	$0.4 \frac{\text{mmol } O_2/\text{l-h}}{10^6 \text{ cells/ml}}$
Diploid embryo WI-38	$0.15 \frac{\text{mmol } O_2/\text{l-h}}{10^6 \text{ cells/ml}}$

A value of P_g can be estimated from other correlations, such as

$$P_g = K\left(\frac{P_u^2 \cdot N \cdot D_i^3}{Q^{0.56}}\right)^{0.45} \tag{10.3}$$

where K is a constant based on reactor geometry, P_u is the power required in the ungassed fermenter, D_i is the impeller diameter, and Q is the aeration rate (volume of gas supplied per minute divided by the liquid volume in the reactor).

The preceding correlations are not very good for Newtonian systems and are even worse for non-Newtonian or highly viscous systems. They also neglect the effects of medium components on k_La. The presence of salts and surfactants can significantly alter bubble size and liquid film resistance around the gas bubble. These factors also can affect *oxygen solubility* (C^*). Temperature and pressure also affect k_La and C^*. Finally, on the supply side, it should be noted that C_L is maintained at a value above the critical oxygen concentration (see Chapter 6) but at a low enough value to provide good oxygen transfer. For many bacterial fermentations, a C_L of about 1 mg/l provides a good margin of safety if mixing is incomplete and yet allows a good rate of oxygen transfer.

Although k_La is difficult to predict, it is a measurable parameter. Four approaches are commonly used: unsteady state, steady state, dynamic, and sulfite test. The way in which these methods are applied depends on whether the test is being made on the system in the presence or absence of cells.

A new reactor prior to operation can be filled with pure water or a medium in which C^* can be accurately measured. Oxygen is removed from the system by sparging with N_2.