5.10. OVERVIEW OF ANAEROBIC METABOLISM

The production of energy in the absence of oxygen can be accomplished by *anaerobic respiration* (see also Section 5.2). The same pathways as employed in aerobic metabolism can be used; the primary difference is the use of an alternative electron acceptor. One excellent example is the use of nitrate NO_3^-, which can act as an electron acceptor. Its product, nitrous oxide (N_2O^-), is also an acceptor leading to the formation of dinitrogen (N_2). This process, *denitrification*, is an important process environmentally. Many advanced biological waste-treatment systems are operated to promote denitrification.

Many organisms grow without using the electron transport chain. The generation of energy without the electron transport chain is called *fermentation*. This definition is the exact and original meaning of the term fermentation, although currently it is often used in a broader context. Since no electron transport is used, the organic substrate must undergo a balanced series of oxidative and reductive reactions. This constraint requires that the rates of conversion of NAD^+ and $NADP^+$ to NADH and NADPH must equal the rates of conversion of NADH and NADPH to NAD^+ and $NADP^+$. For example, with the EMP pathway the 2 mol of NAD reduced in this pathway in the production of pyruvate are reoxidized by oxidation of pyruvate to other products. Two prime examples are lactic acid and ethanol production (see Fig. 5.9). Both lactic acid and ethanol are important

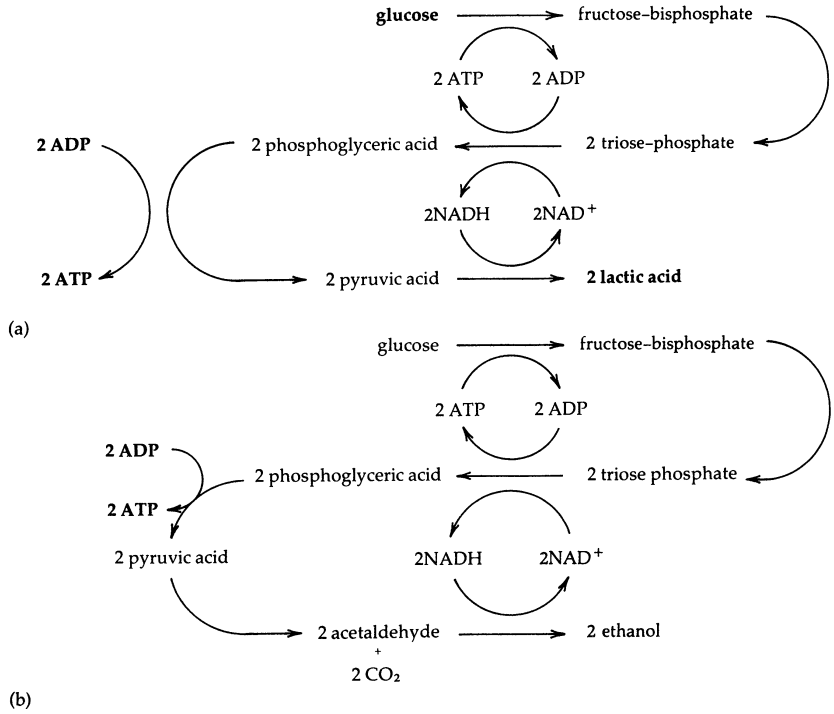

Figure 5.9. Comparison between (a) lactic acid and (b) alcoholic fermentations. (With permission, from R. Y. Stanier and others, *The Microbial World*, 5th ed., Pearson Education, Upper Saddle River, NJ, 1986, p. 94.)