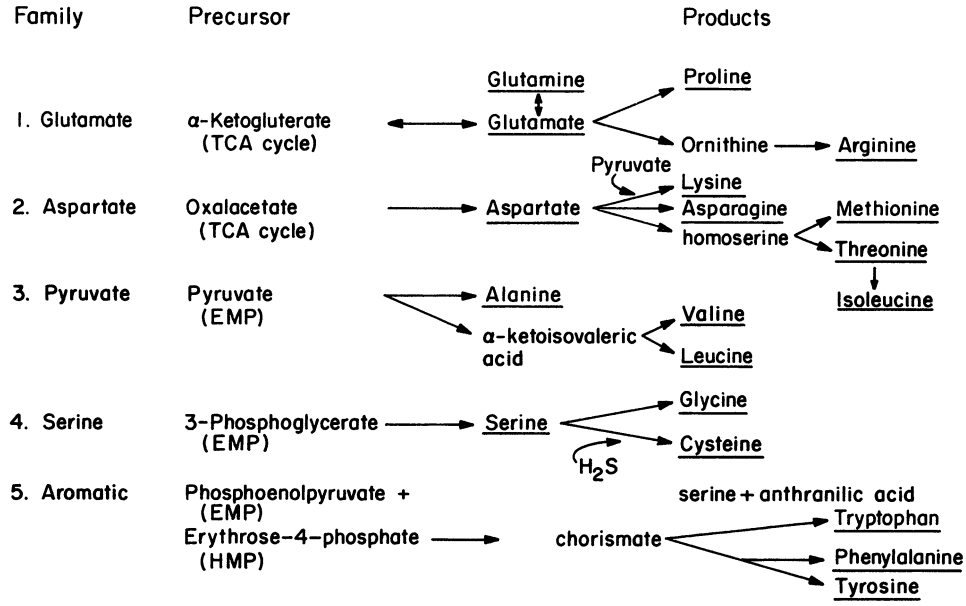

Figure 5.8. Summary of the amino acid families and their synthesis from intermediates in the EMP, TCA, and HMP pathways. The amino acids are underlined.

cumvent these irreversible reactions with energy-consuming reactions. Since pyruvate can be synthesized from a wide variety of pathways, it is the starting point. However, in glycolysis the final step to convert phosphoenolpyruvate (PEP) into pyruvate is irreversible. In gluconeogenesis, PEP is produced from pyruvate from

$$\text{pyruvate} + CO_2 + \text{ATP} + H_2O \longrightarrow \text{oxalacetate} + \text{ADP} + \text{Pi} + 2H^+ \qquad (5.16)$$

and

$$\text{oxalacetate} + \text{ATP} \longrightarrow \text{PEP} + \text{ADP} + CO_2 \qquad (5.17)$$

or a net reaction of

$$\text{pyruvate} + 2\ \text{ATP} + H_2O \longrightarrow \text{PEP} + 2\ \text{ADP} + 2\ H^+ \qquad (5.18)$$

The reactions in glycolysis are reversible (under appropriate conditions) up to the formation of fructose-1,6-diphosphate. To complete glucogenesis, two enzymes (fructose-1, 6-diphosphatase and glucose-6-phosphatase) not in the EMP pathway are required. Thus, an organism with these two enzymes and the ability to complete reaction 5.19 should be able to grow a wide variety of nonhexose carbon–energy sources.

So far we have concentrated on aerobic metabolism. Many of the reactions we have described would be operable under anaerobic conditions. The primary feature of anaerobic metabolism is energy production in the absence of oxygen and in most cases the absence of other external electron acceptors. The cell must also balance its generation and consumption of reducing power. In the next section we show how the pathways we have discussed can be adapted to the constraints of anaerobic metabolism.