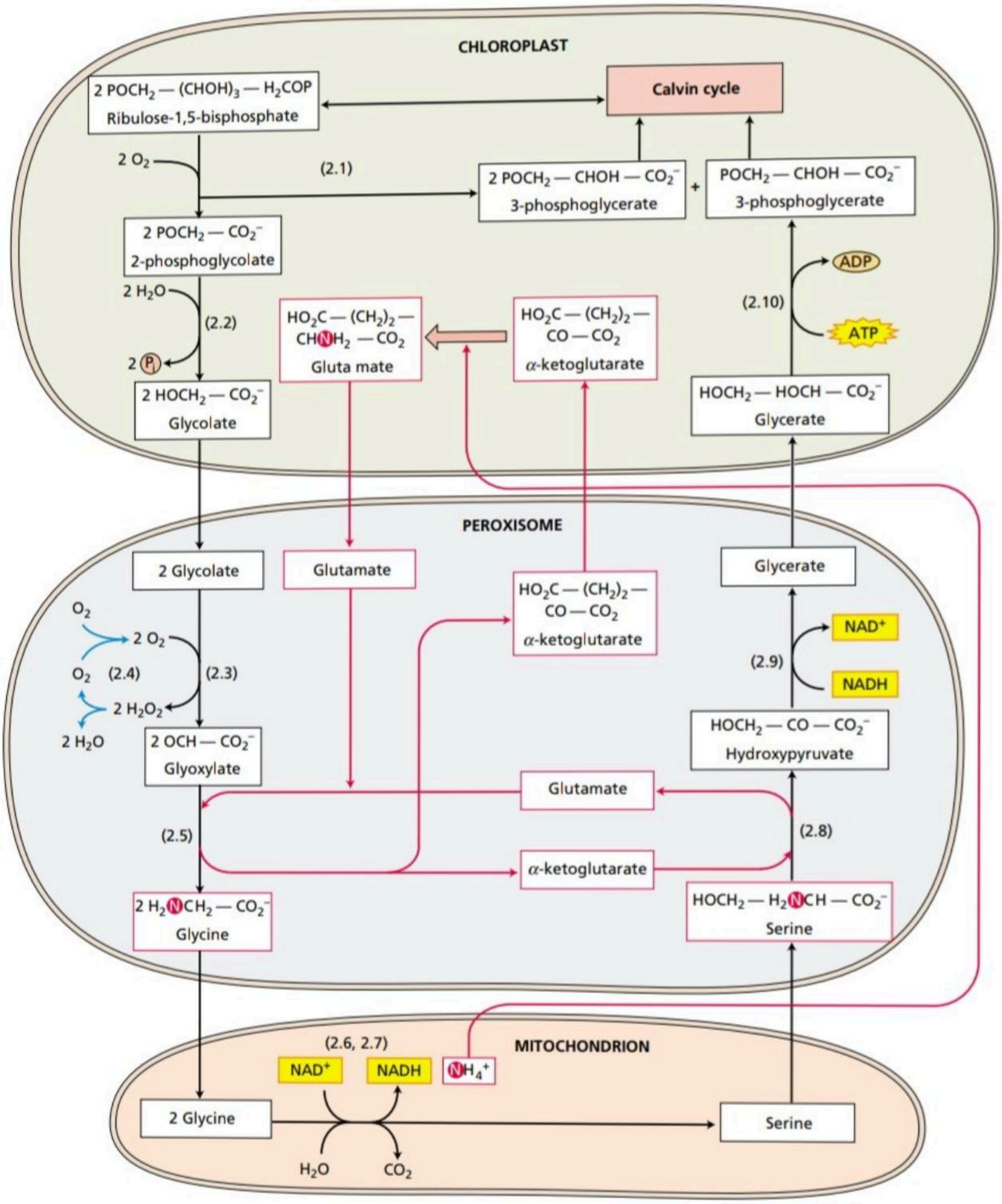


FIGURE 8.7 The main reactions of the photorespiratory cycle. Operation of the C_2 oxidative photosynthetic cycle involves the cooperative interaction among three organelles: chloroplasts, mitochondria, and peroxisomes. Two molecules of glycolate (four carbons) transported from the chloroplast into the peroxisome are converted to glycine, which in turn is exported to the mitochondrion and transformed to serine (three carbons) with the concurrent release of carbon dioxide (one carbon). Serine is transported to the peroxisome and transformed to glycerate. The latter flows to the chloroplast where it is phosphorylated to 3-phosphoglycerate and incorporated into the Calvin cycle. Inorganic nitrogen (ammonia) released by the mitochondrion is captured by the chloroplast for the incorporation into amino acids by using appropiate skeletons (α-ketoglutarate). The heavy arrow in red marks the assimilation of ammonia into glutamate catalyzed by glutamine synthetase. In addition, the uptake of oxygen in the peroxisome supports a short oxygen cycle coupled to oxidative reactions. The flow of carbon, nitrogen and oxygen are indicated in black, red and blue, respectively. See Table 8.2 for a description of each numbered reaction.

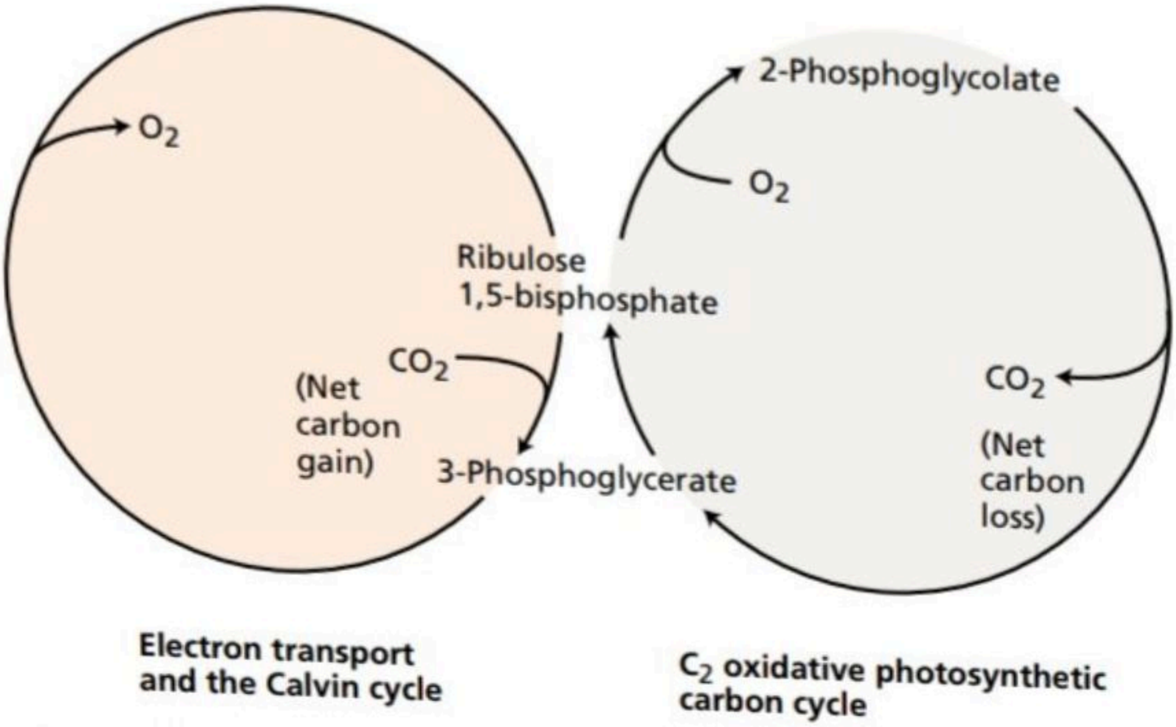
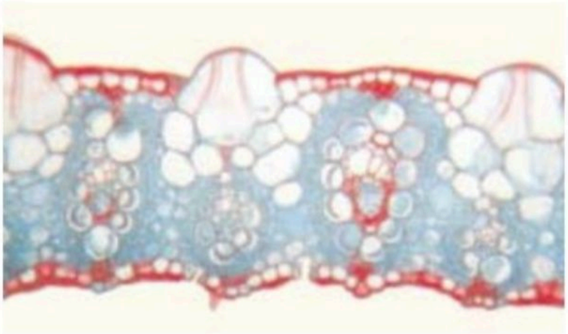
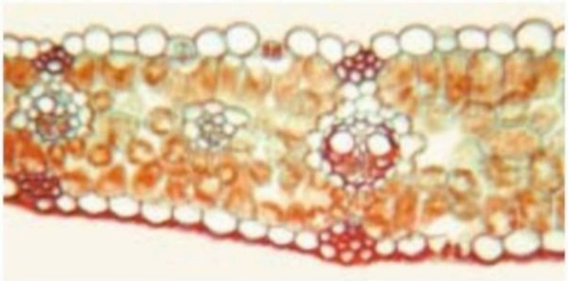


FIGURE 8.8 The flow of carbon in the leaf is determined by the balance between two mutually opposing cycles. Whereas the Calvin cycle is capable of independent operation in the presence of adequate substrates generated by photosynthetic electron transport, the C_2 oxidative photosynthetic carbon cycle requires continued operation of the Calvin cycle to regenerate its starting material, ribulose-1,5-bisphosphate.

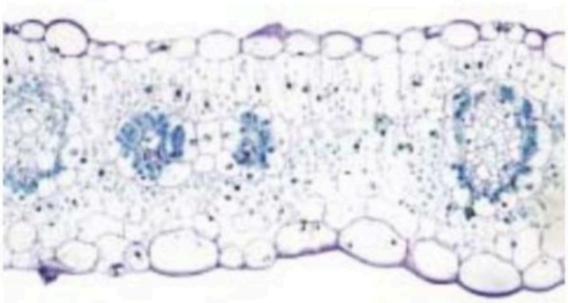
(A)



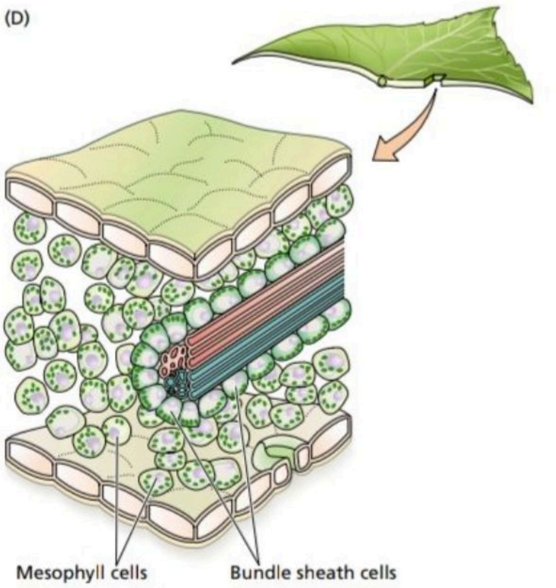
(B)



(C)



(D)



(E)

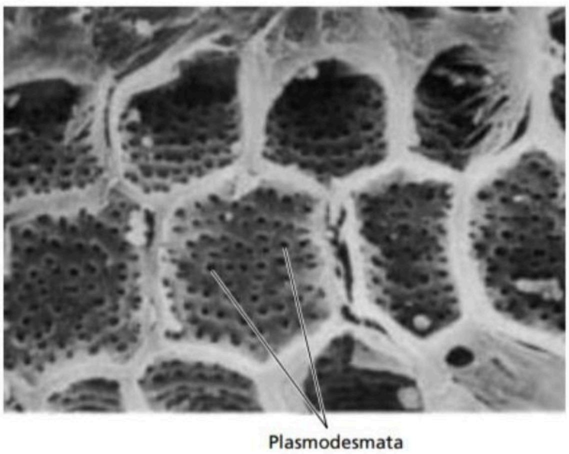


FIGURE 8.9 Cross-sections of leaves, showing the anatomic differences between C_3 and C_4 plants. (A) A C_4 monocot, *saccharum officinarum* (sugarcane). (135×) (B) A C_3 monocot, Poa sp. (a grass). (240×) (C) A C_4 dicot, *Flaveria australasica* (Asteraceae). (740×) The bundle sheath cells are large in C_4 leaves (A and C), and no mesophyll cell is more than two or three cells away from the nearest bundle sheath cell. These anatomic features are absent in the C_3 leaf (B). (D) Three-dimensional model of a C_4 leaf. (A and B © David Webb; C courtesy of Athena McKown; D after Lüttge and Higinbotham; E from Craig and Goodchild 1977.)
(E) Scanning electon micrograph of a C_4 leaf from *Triodia irritans,* showing the plasmodesmata pits in the bundle sheath heath cell walls through which metabolites of the C_4 carbon cycle are thought to be transported.

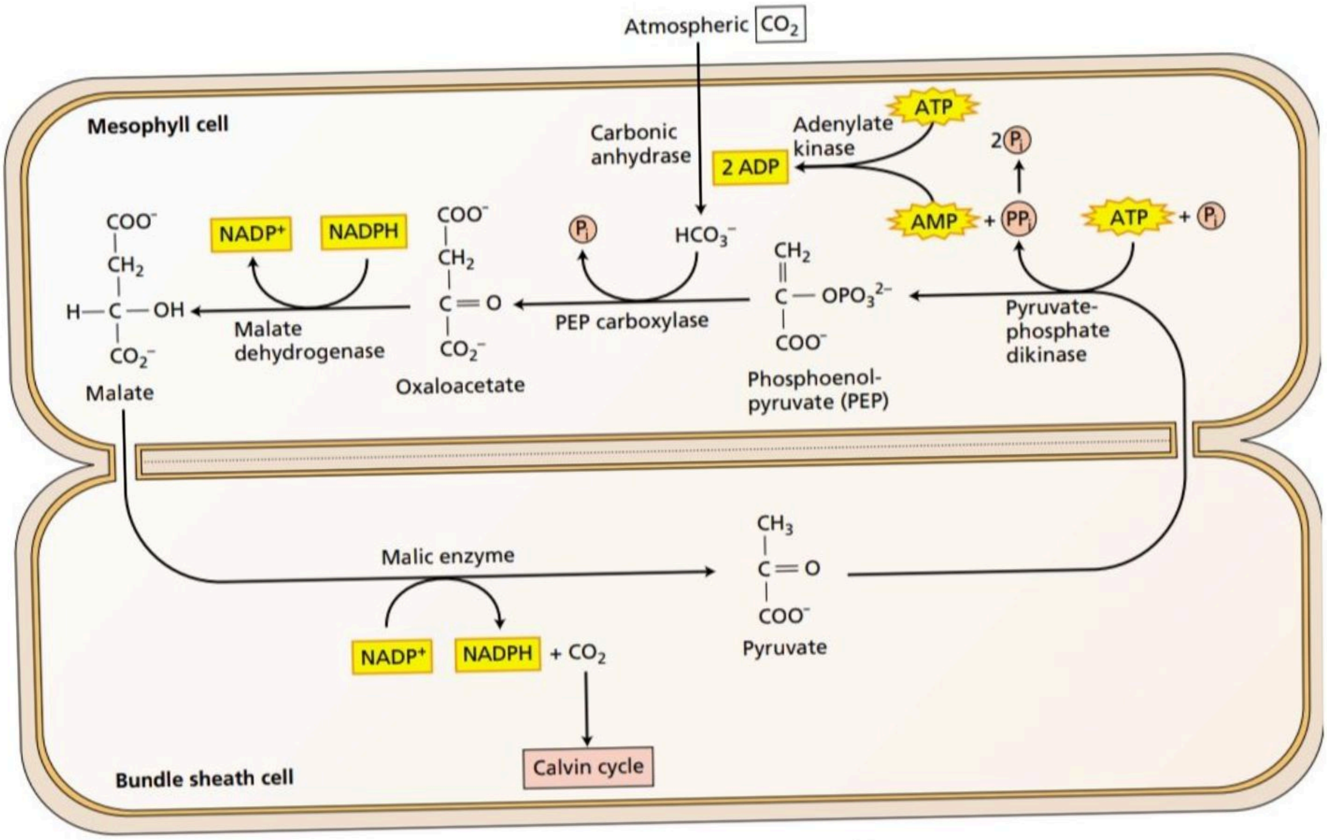


FIGURE 8.11 The C_4 photosynthetic pathway. The hydrolysis of two ATP drives the cycle in the direction of the arrows, thus pumping CO_2 from the atmosphere to the Calvin cycle of the chloroplasts from bundle sheath cells.

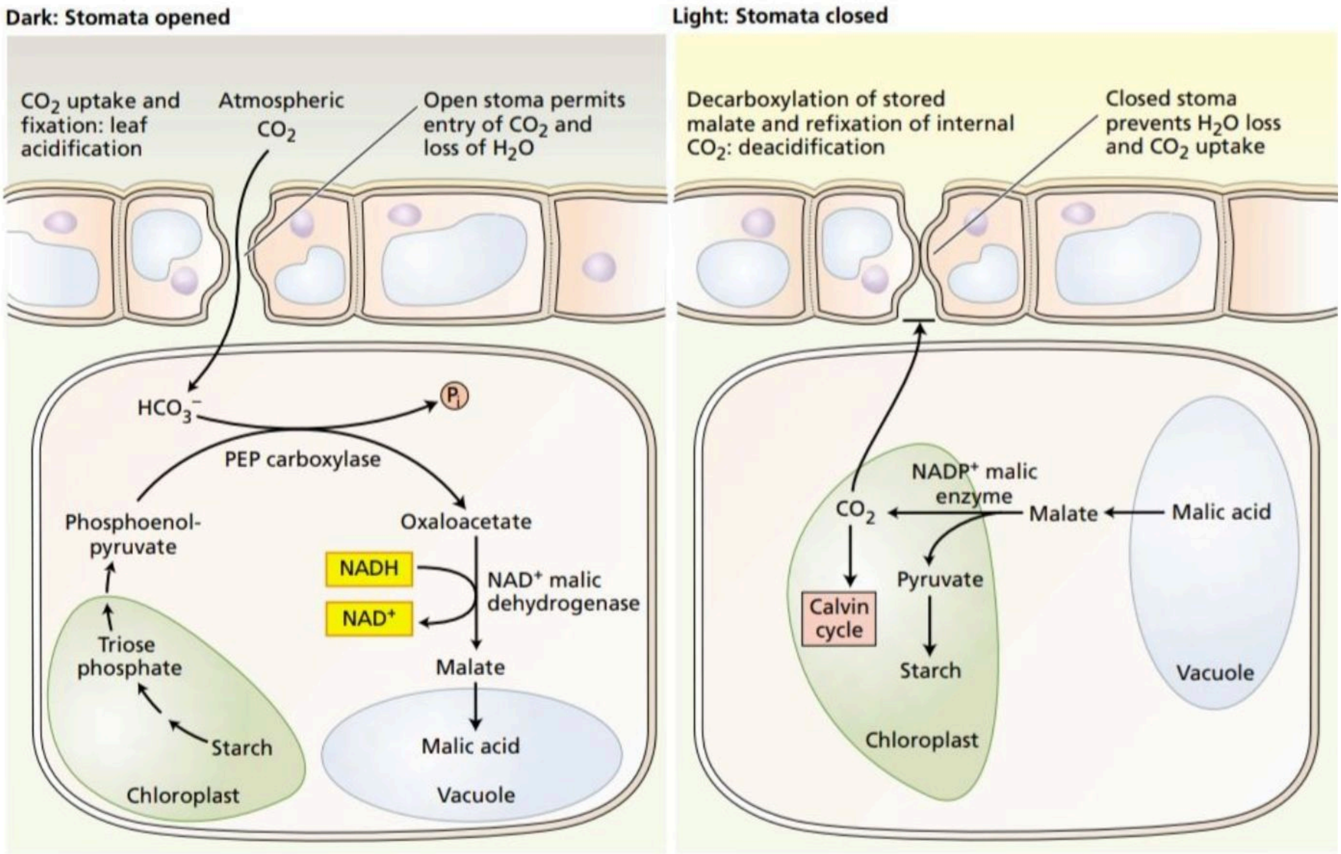


FIGURE 8.12 Crassulacean acid metabolism (CAM). Temporal separation of CO_2 uptake from photosynthetic reactions: CO_2 uptake and fixation take place at night, and decarboxylation and refixation of the internally released CO_2 occur during the day. The adaptive advantage of CAM is the reduction of water loss by transpiration, achieved by the stomatal opening during the night.