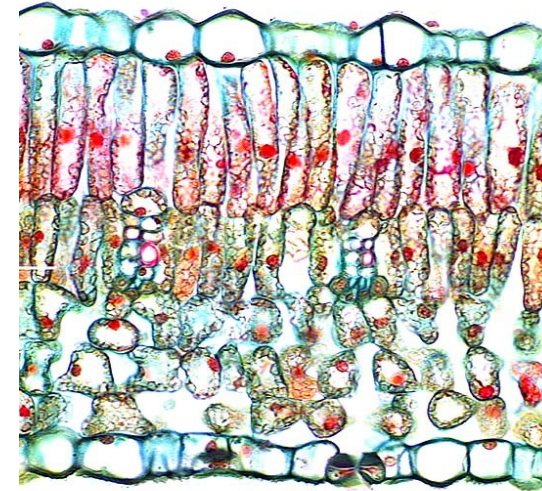
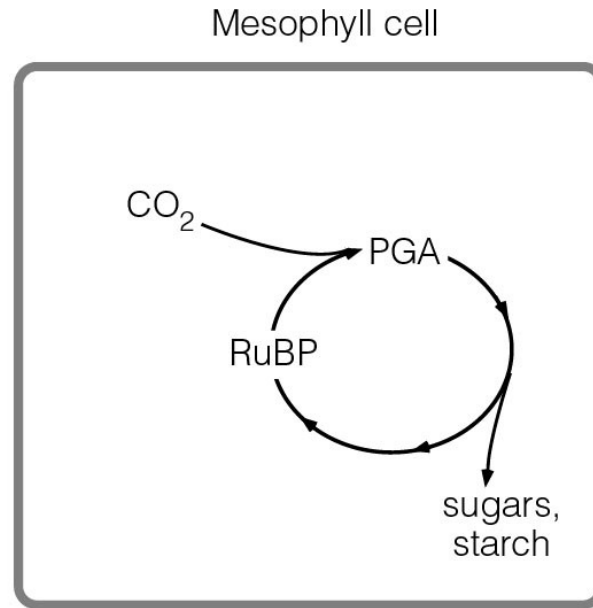


C<sub>3</sub> plants

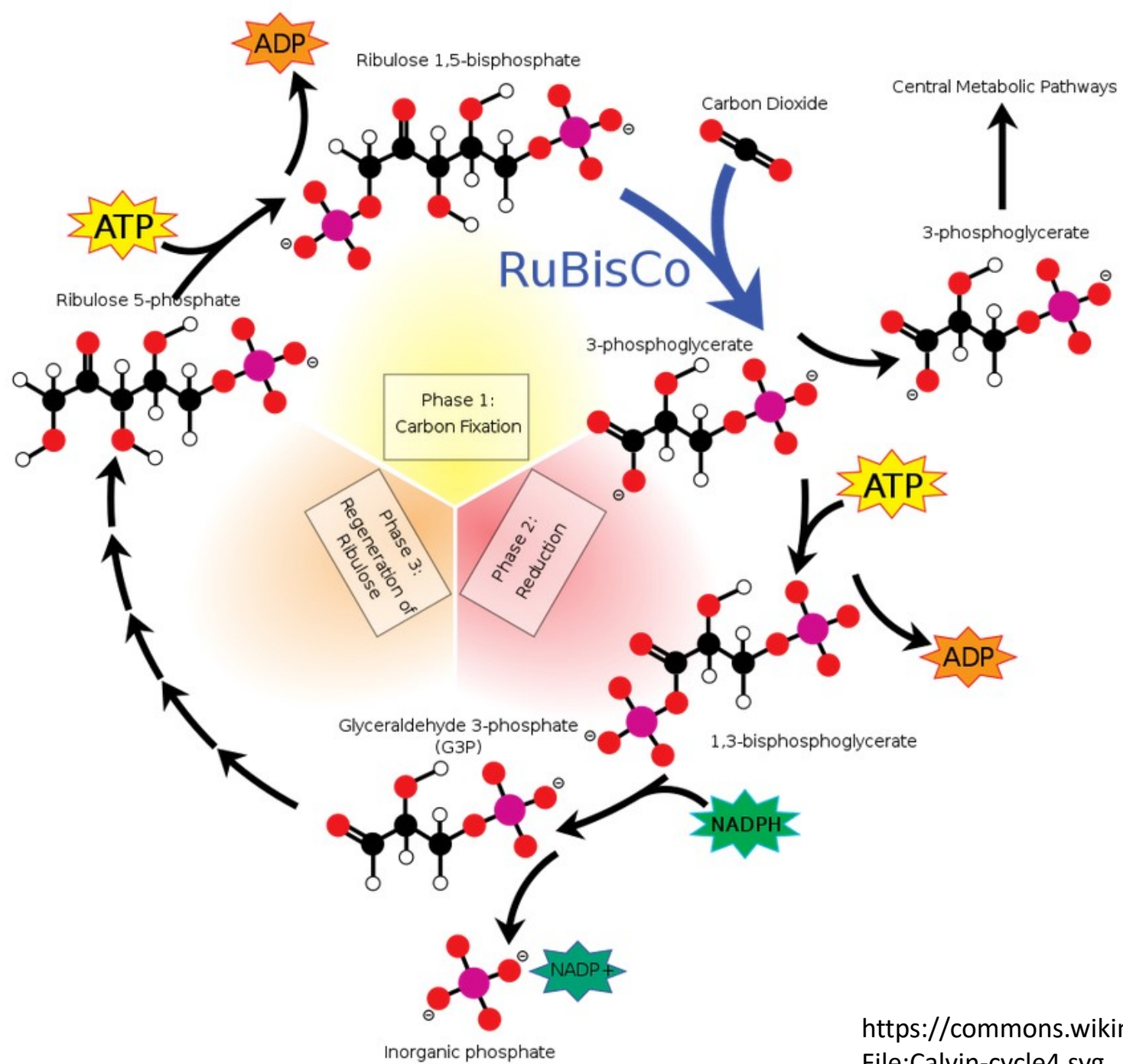


## C<sub>3</sub>-Photosynthese

PGA – 3-Phosphoglycerate (namensgebender C<sub>3</sub>-Körper)

RuBP – Ribulose-1,5-bisphosphat

RuBisCO - Ribulose-1,5-Bisphosphat Carboxylase Oxygenase



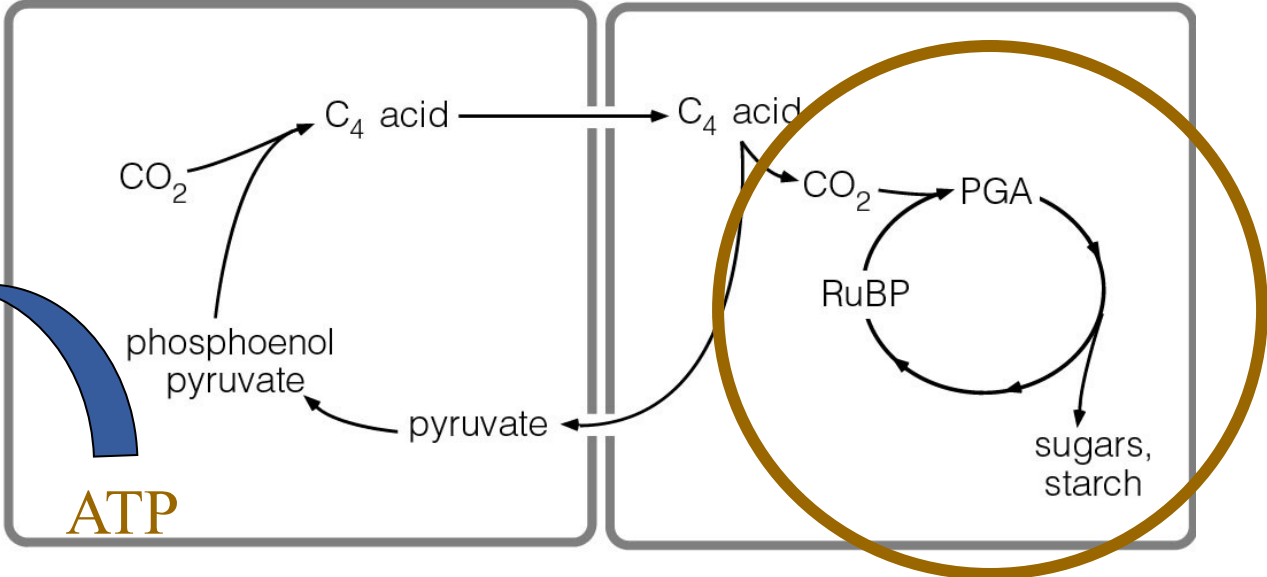
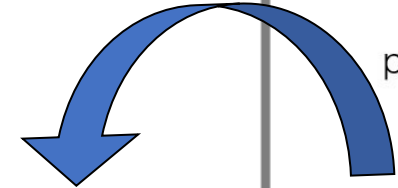
# C<sub>4</sub>-Photosynthese



Mesophyll cell

Bundle sheath cell

C<sub>4</sub> plants



CO<sub>2</sub>

C<sub>4</sub> acid

C<sub>4</sub> acid

CO<sub>2</sub>

PGA

RuBP

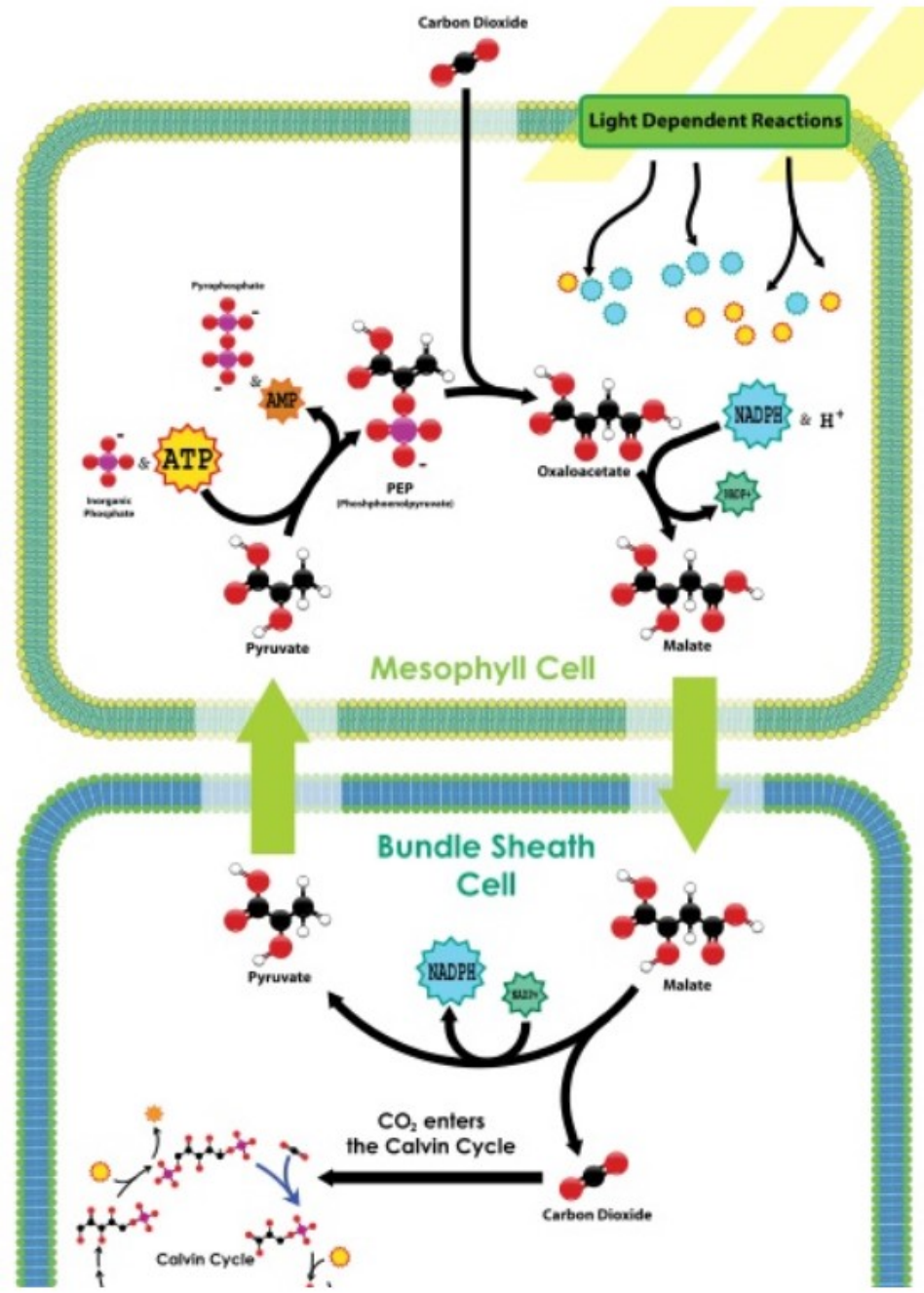
sugars,  
starch

phosphoenol  
pyruvate

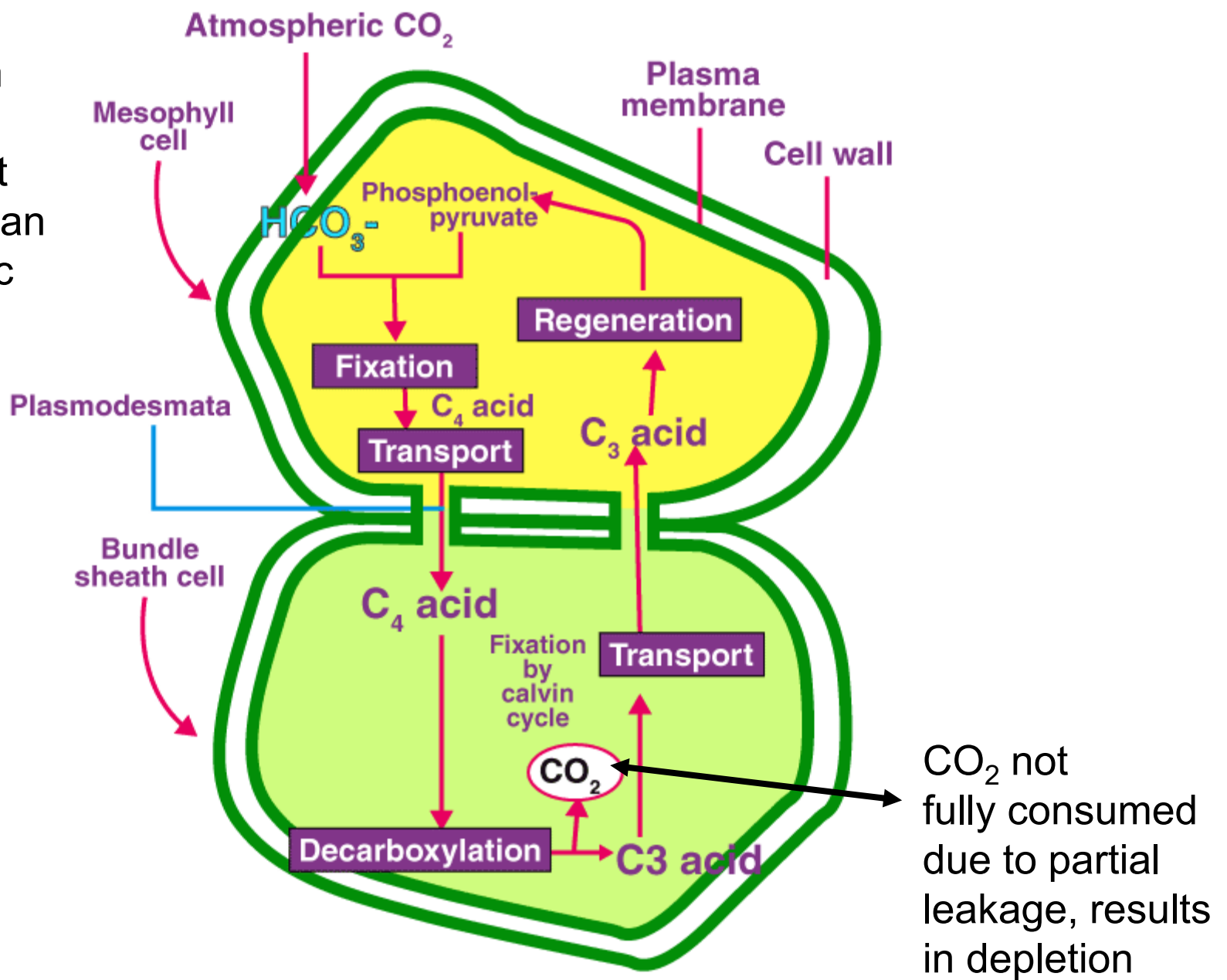
pyruvate

ADP

ATP



HCO<sub>3</sub><sup>-</sup>  
equilibrium  
isotopic  
enrichment  
stronger than  
PEP kinetic  
depletion

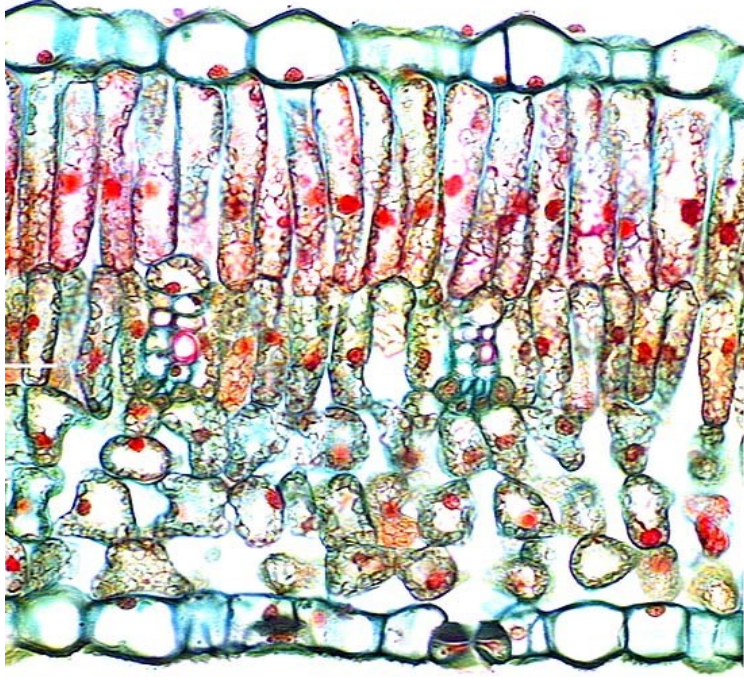


# Isotope effects in steps leading to CO<sub>2</sub> fixation in plants

Process	Isotope Effect ( $\alpha$ )	Discrimination (‰)	Symbol	Reference
diffusion of CO <sub>2</sub> in air through the stomatal pore	1.0044	4.4	$a$	Craig
diffusion of CO <sub>2</sub> in air through the boundary layer to the stomatal	1.0029	2.9	$a_b$	Farquhar
diffusion of dissolved CO <sub>2</sub> through H <sub>2</sub> O	1.0007	0.7	$a_l$	O'Leary
net C3 fixation with respect to ci/ca	1.027	27	$b$	Farquhar and Richards
fixation of gaseous CO <sub>2</sub> by Rubisco from higher plants	1.030 (pH=8) 1.029 (pH=8.5)	30 29	$b_3$ $b_3$	Roeske and O'Leary Guy et al
fixation of HCO <sub>3</sub> <sup>-</sup> by PEP carboxylase	1.0020 1.0020	2.0 2.0	$b_4^*$	O'Leary et al Reibach and Benedict
fixation of gaseous CO <sub>2</sub> (in equilibrium with HCO <sub>3</sub> <sup>-</sup> at 25 °C) by PEP carboxylase	0.9943	-5.7	$b_4$	Farquhar
equilibrium hydration of CO <sub>2</sub> at 25 °C	0.991 0.991	-9.0 -9.0	$e_b$	Emrich et al Mook et al
equilibrium dissolution of CO <sub>2</sub> into water	1.0011 1.0011	1.1 1.1	$e_s$	Mook et al O'Leary



# Variations in $^{13}\text{C}$ are associated with photosynthetic pathway



$\text{C}_3$

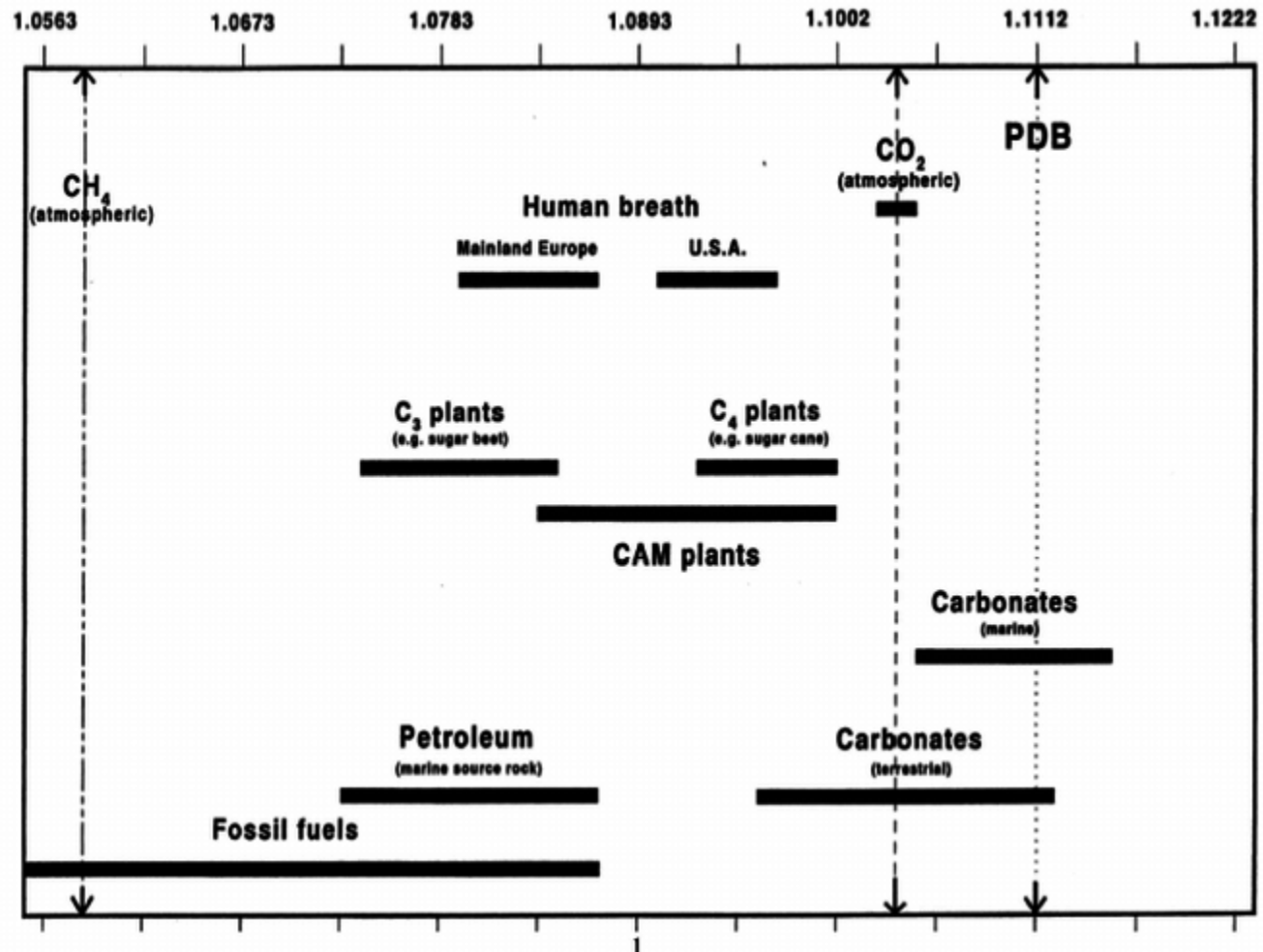
> 95 % of all plant species  
70-75 % of all productivity (today)  
~ 50 % of all productivity (ice age)



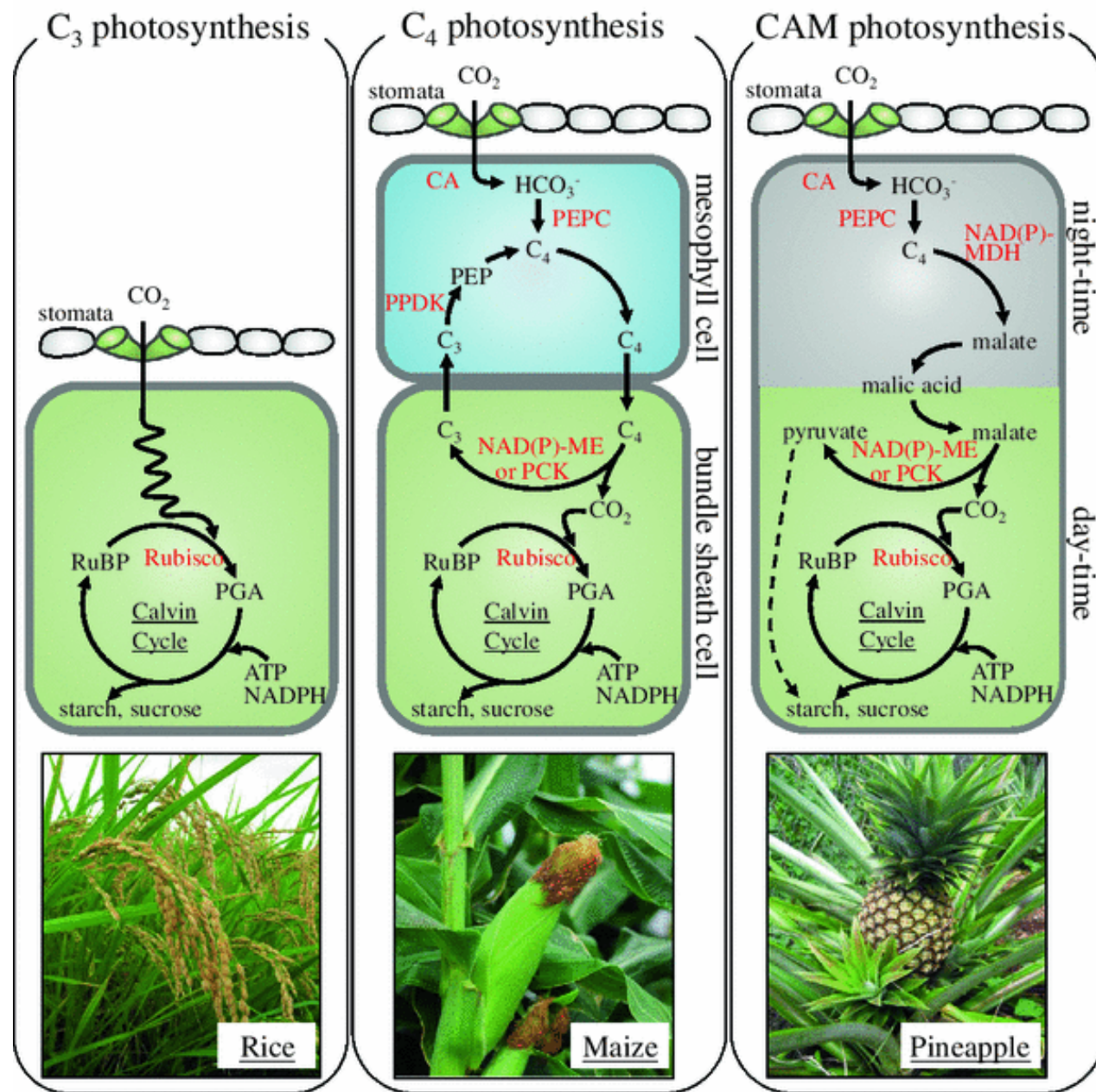
$\text{C}_4$

< 5 % of all plant species  
25-30 % of all productivity (today)  
~ 50 % of all productivity (ice age)

**$^{13}\text{C}$  atom %**







Yamori, W., Hikosaka, K. & Way, D.A. Temperature response of photosynthesis in C<sub>3</sub>, C<sub>4</sub>, and CAM plants: temperature acclimation and temperature adaptation. *Photosynth Res* 119, 101–117 (2014). <https://doi.org/10.1007/s11120-013-9874-6>