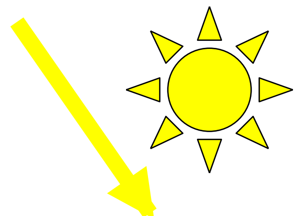
Photosynthesis

Modified by Georgia Agricultural Education Curriculum Office

July, 2002

Photosynthesis - Basics



3 carbon sugars produced

What is the transport sugar in plants?

O_2 is liberated from the H_2O

Photosynthesis - Light

Photosynthesis - Visible Spectrum

Violet

Blue

Green

Yellow

Red

Far-Red

Photosynthesis - PS Action Spectrum

Violet

Blue

Peak between 430 - 500 nm

Green

Yellow

Peak at about 680 nm

Red

Far-Red

Photosynthesis - Role of Pigments

1. **Fluorescence**
2. **Transfer energy**
3. **Transfer electrons**

Photosynthesis - Pigments

required pigment, “the hanger”

accessory pigment, “the tin foil”

anti-oxidants, protect the chlorophyll

yellow pigments are carotenoids

Photosynthesis - The Reactions

light dependent
harvesting energy from the sun

either light or dark
requires energy from 1st rxns
fixes CO_2 into sugars

Photosynthesis - Energy Transduction Rxns

2 photosystems, linkage pumps protons

“purpose”: to generate ATP & NADPH

note similarities to figure 6-16

Photosynthesis - Carbon Fixation Rxns

“purpose”: to fix carbon, storing energy in bonds

1st product contains 3 carbons

occurs in most plants

Photosynthesis - Photorespiration

binds with both O_2 and CO_2
when it binds with O_2, carbon is bound into other products
energy must be used to salvage the C
rubisco contains nitrogen which is commonly the limiting nutrient

Photosynthesis - C_4 Pathway

many native prairie grasses

1st product contains 4 carbons

use BOTH C_3 and C_4 pathways

C fixed by PEP carboxylase in mesophyll

prefers CO_2 over O_2

handles photorespiration problems

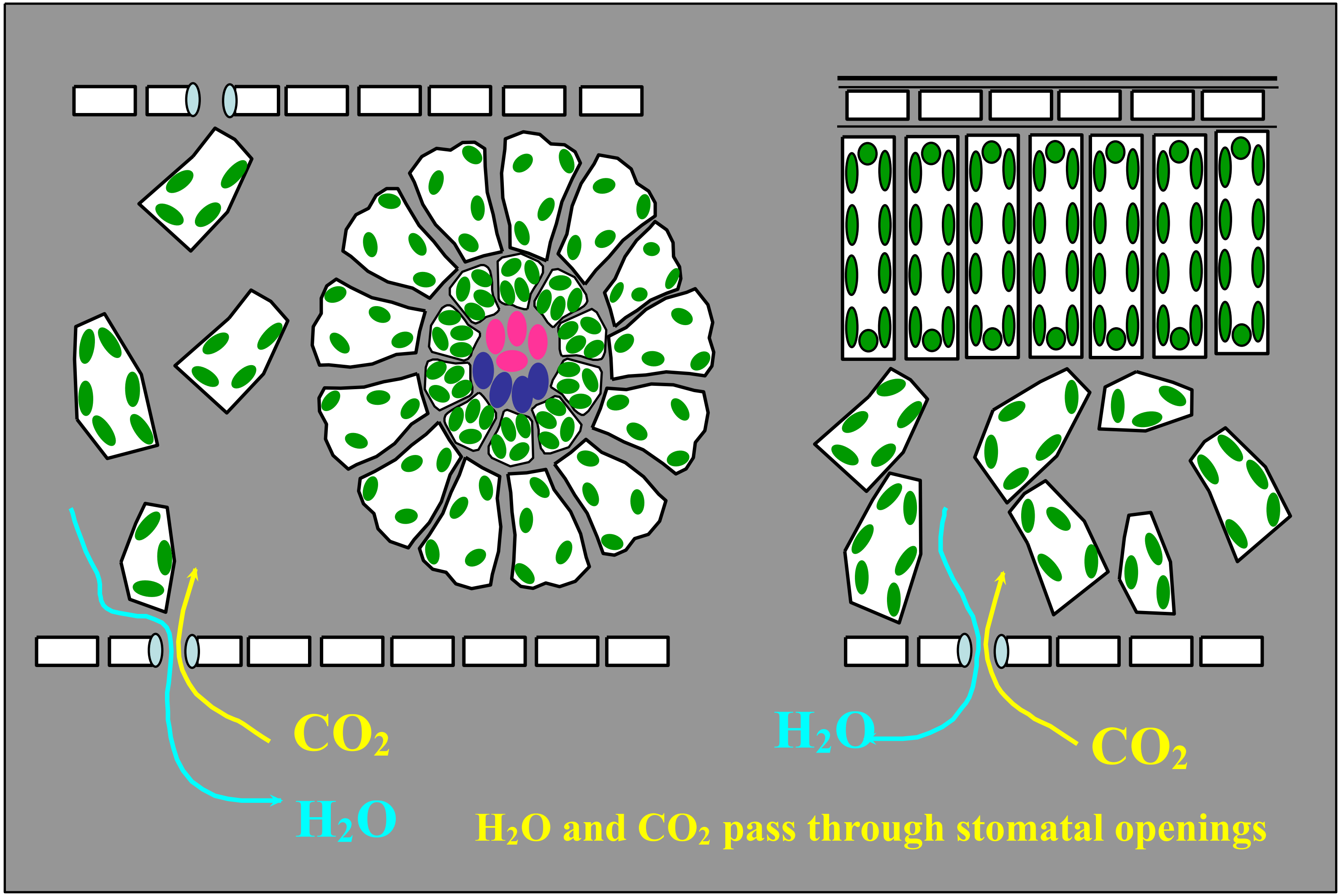
product is shipped to bundle sheath cells

Kranz anatomy

the key to the C_4 pathway:

spatial separation

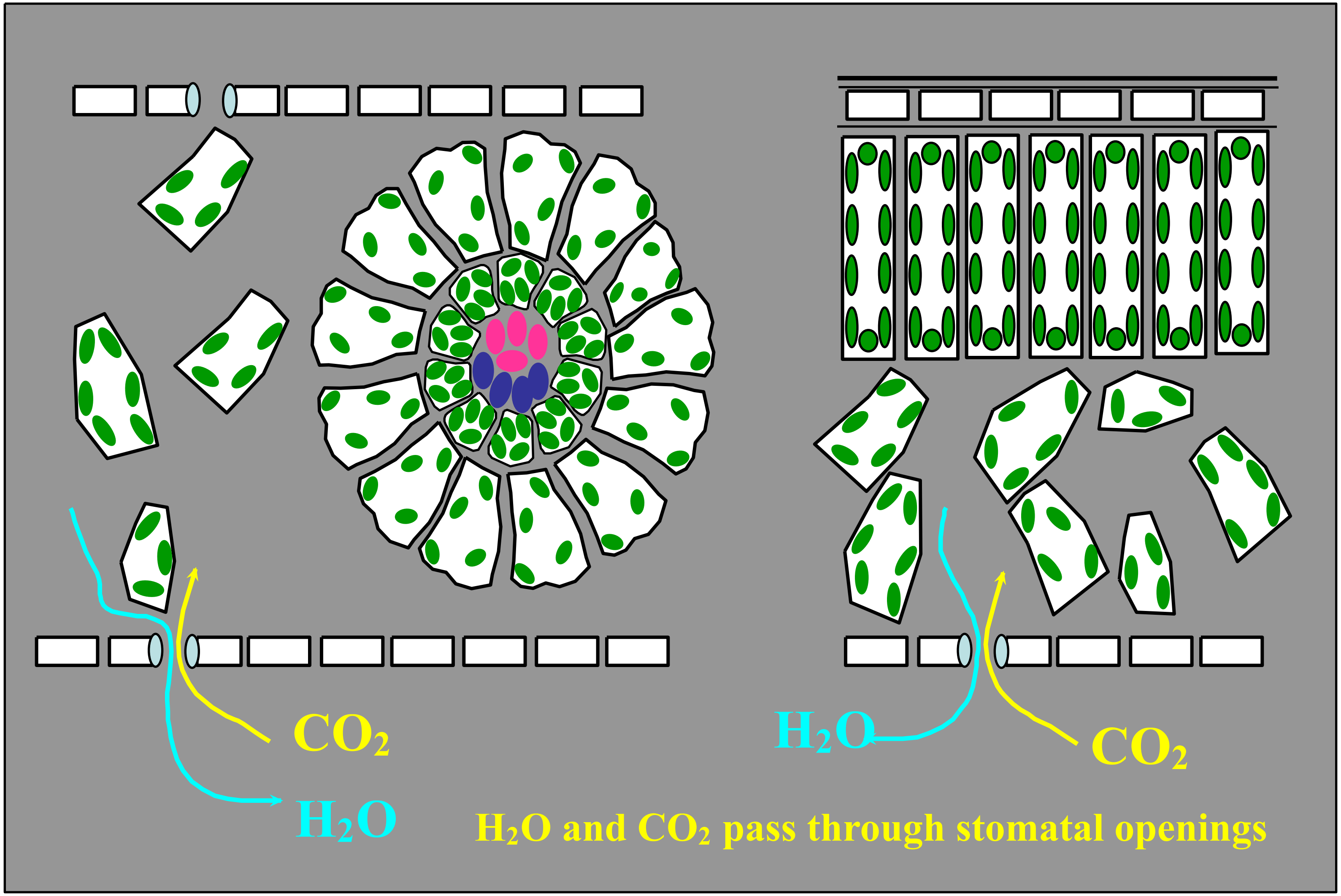
C_4 and C_3 Pathways - Differences in Anatomy



Photosynthesis - CAM Pathway

Crassulacean acid metabolism (CAM)
use BOTH C_3 and C_4 pathways
C fixed by PEP carboxylase in DARK
allows plants to close stomata
product is used in same cells
must have HUGE vacuoles to store C
the key to the CAM pathway:
temporal separation
allows internal cycling during drought
pineapple is CAM

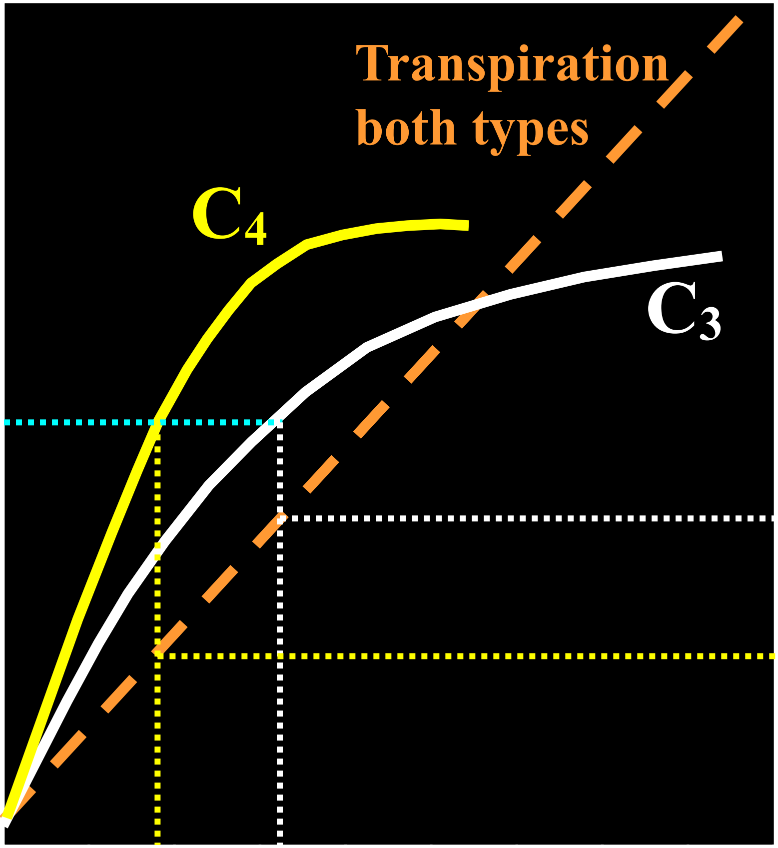
C_4 and C_3 Pathways - Differences in Anatomy



Photosynthesis - C_4 and C_3 Pathways

For a given growth rate, C_3 species use almost twice as much water as C_4 species.

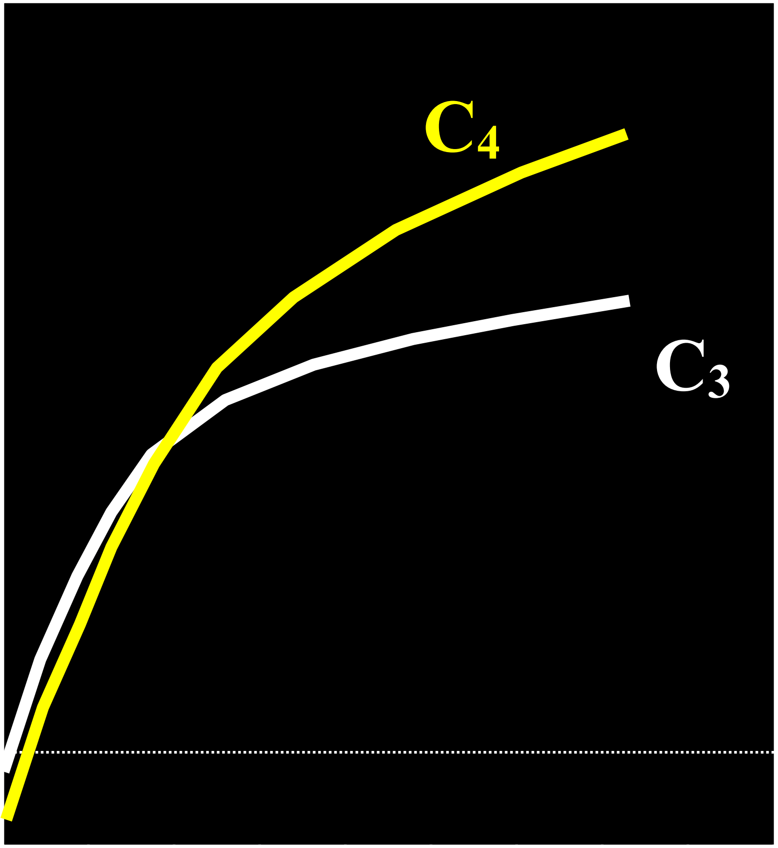
(i.e., they have lower water use efficiencies (WUE)



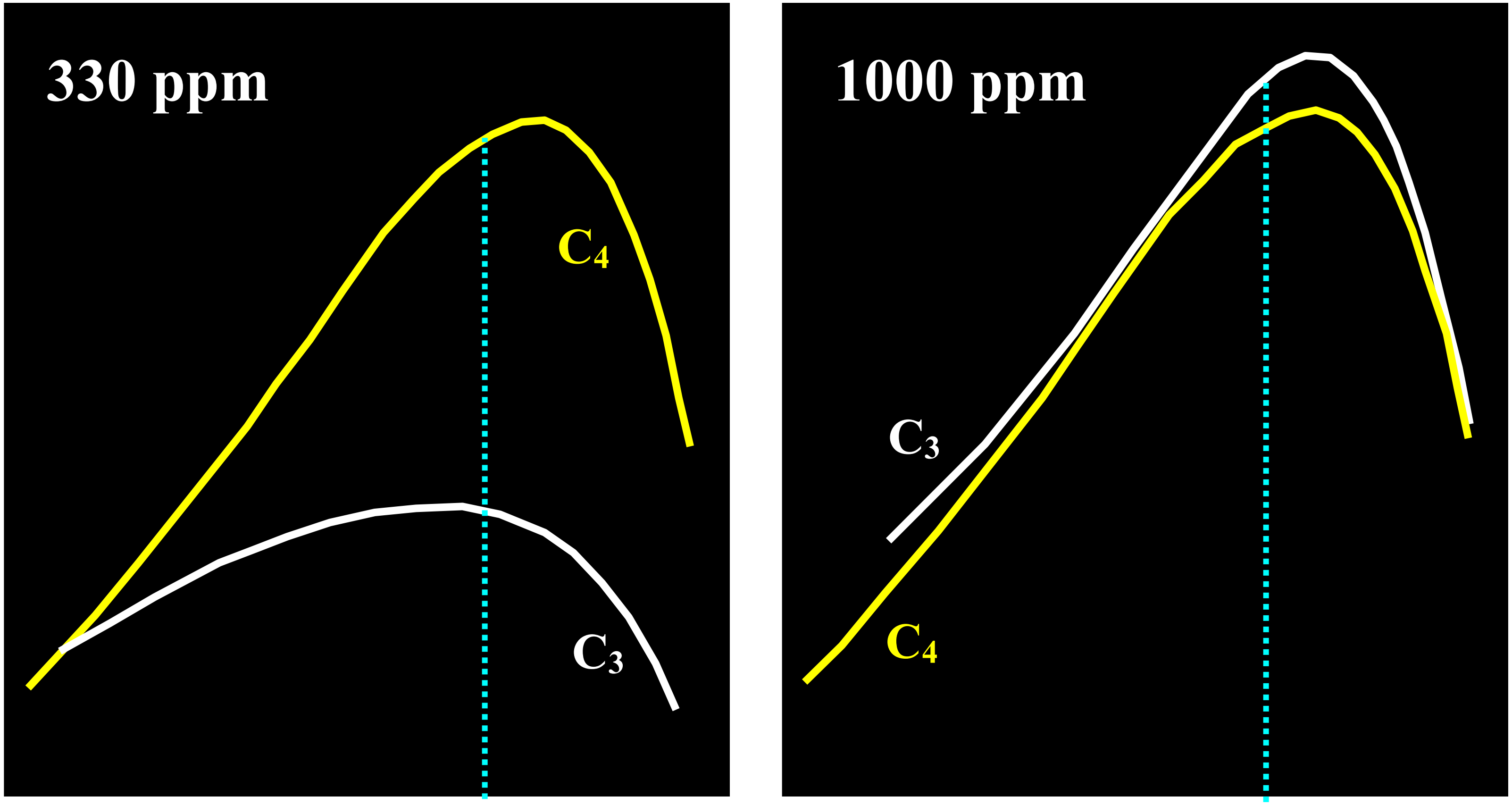
C_4 and C_3 Pathways - Light Saturation

C_3 species become light saturated more quickly

provides advantage in low light environments



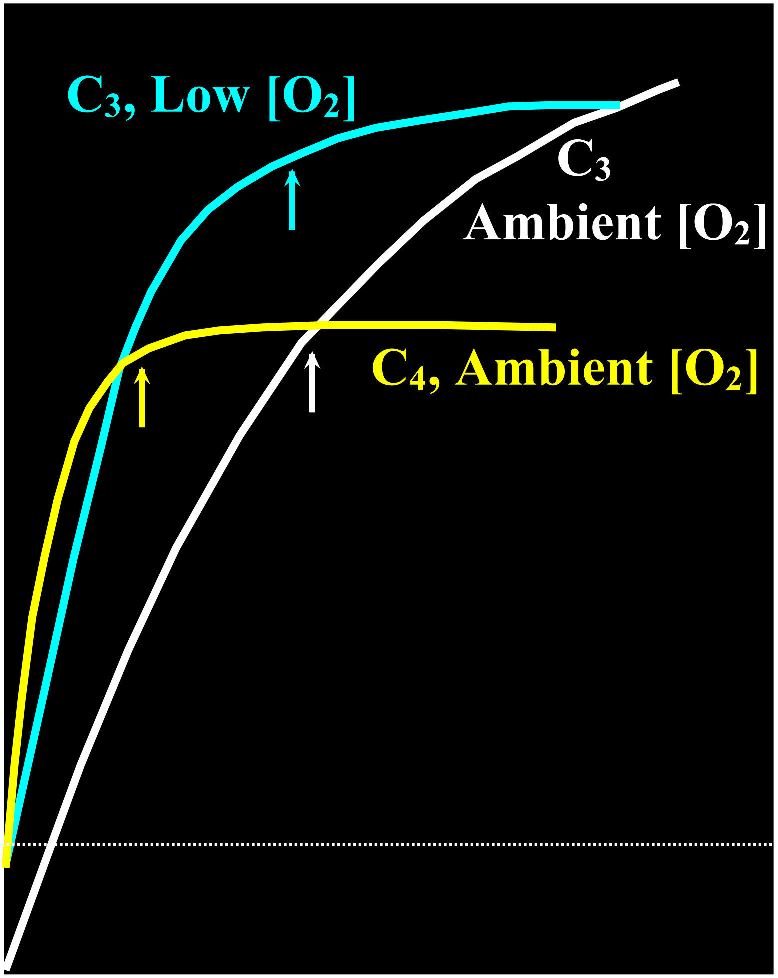
C_4 and C_3 Pathways - Effect of Temperature



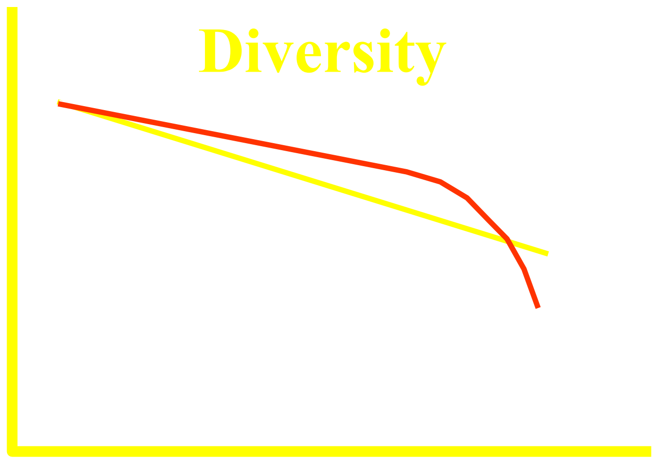
C_4 and C_3 Pathways - Photorespiration

Conflict between CO_2 and O_2 places C_3 species at a disadvantage

C_4 species are able to concentrate CO_2 providing an advantage under low CO_2 conditions



Global Change - CO_2, N and Diversity



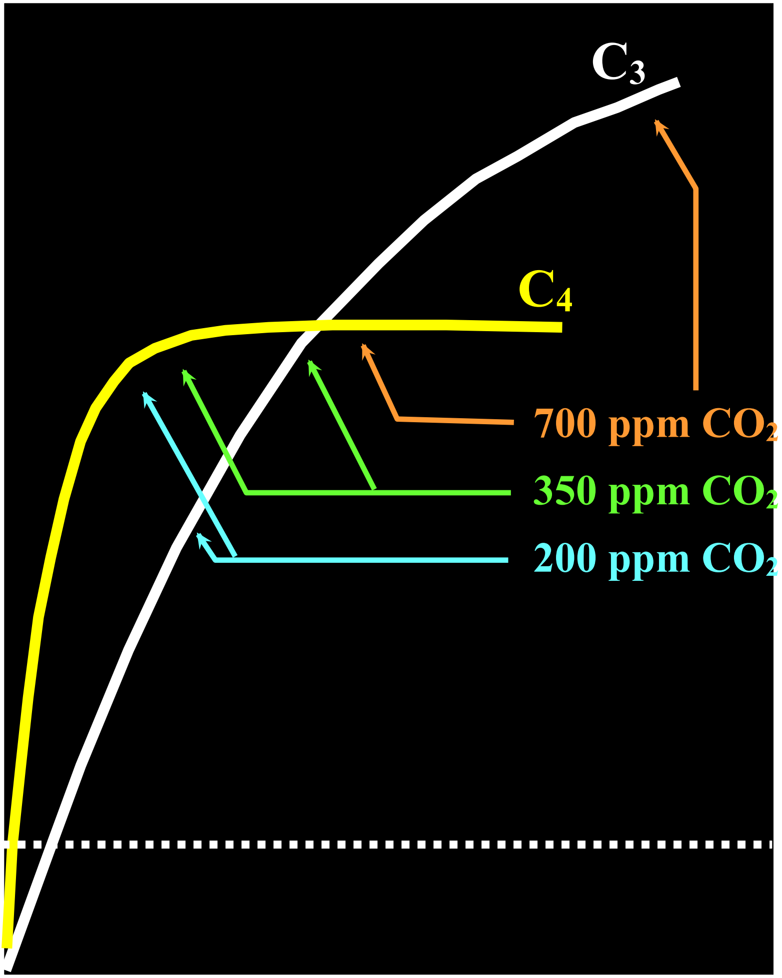
C_4 and C_3 Pathways - Effect of CO_2 concentration

Competitive advantage between C_3 and C_4 switches along CO_2 gradient

Low CO_2: C_4 advantage due to concentrating of CO_2

Ambient CO_2: net growth about equal but water use is greater in C_3

High CO_2: C_3 advantage due to C_4's low CO_2 saturation point and reduction of CO_2 / O_2 conflict in C_3



PS Pathways - Further Reading

Polley, H.W. 1997.

Journal of Range Management. 50:561-577.

Pearcy, R.W., and J Ehleringer. 1984.

Plant. Cell and Environment. 7:1-13.

Data presented in this slide set were adopted from these 2 sources. They are both excellent resources.