lecture 21: amino acid and lipids

N-transport amino acid:

Glutamate
Glutamine → donate nitrogen in the biosynthesis of amino acid nucleic acid and other N-containing compound
OR
introduced into aspartate and asparagine

Aspartate → nitrogen donor in numerous aminotransferase reactions

asparagine → nitrogen storage and transport compound

They are the major amino acid transported in phloem

Enzymes responsible for the N-transport amino acid synthesis

glutamine synthase (GS)
glutamate snthase (GOGAT)
glutamate dehydrogenase (GDH)
aspartate aminotransferase (AspAT)
asparagine synthase (AS)

These enzymes are involved in
.primary assimilation of inorganic nitrogen
.secondary assimilation of free ammonium within plants
because plants have to recycle its ammonium

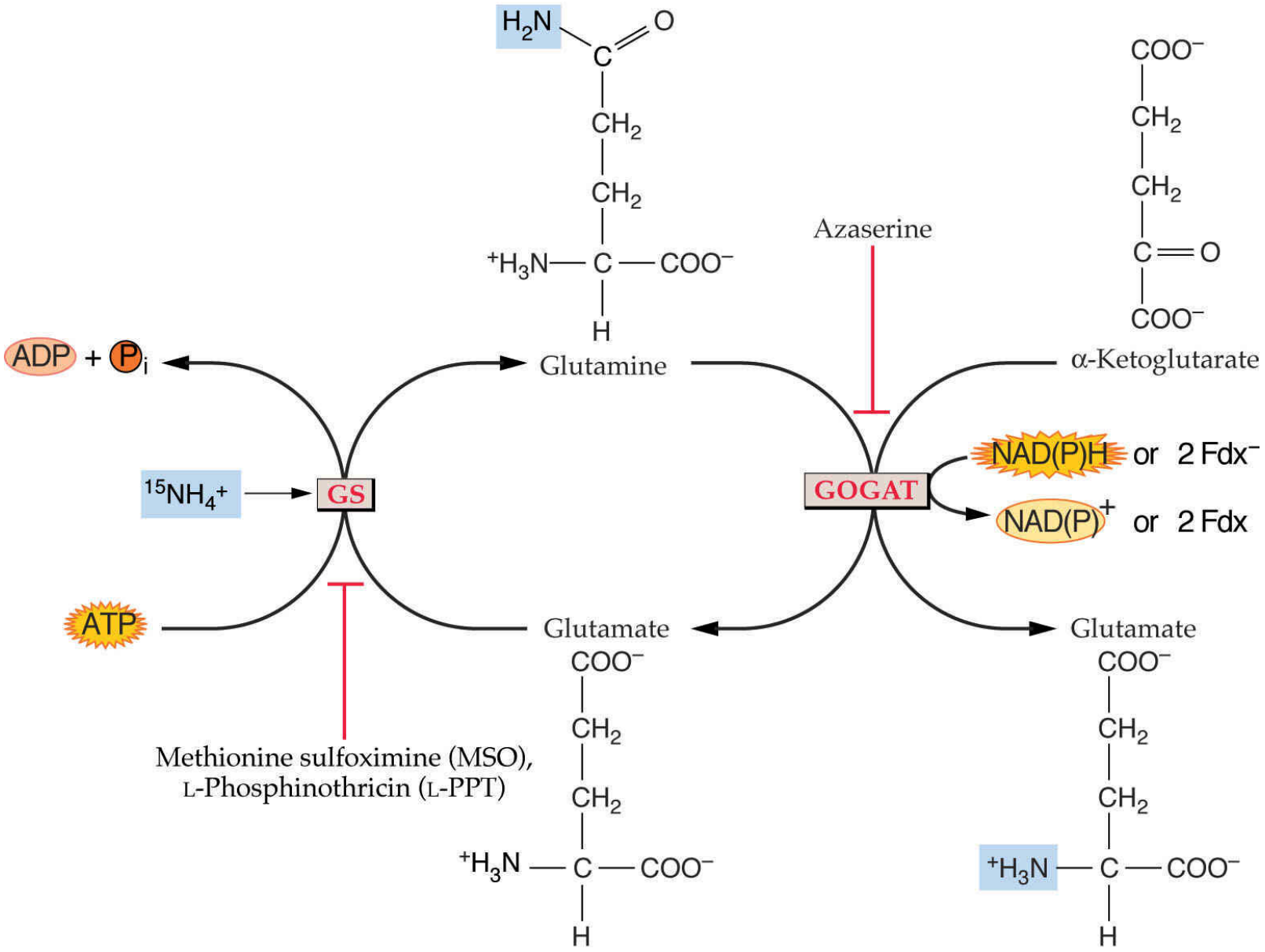


Fig.8.5 the major inorganic nitrogen assimilation pathway in plants

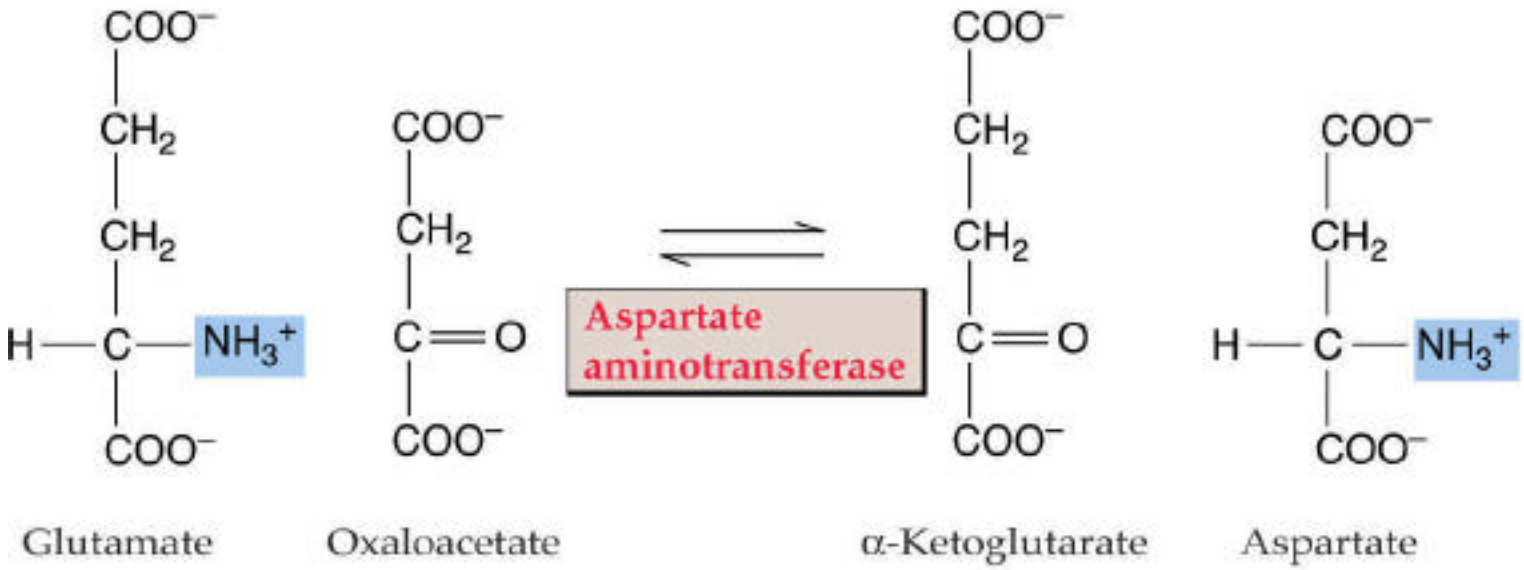

Aspartate aminotransferase
Glutamate
Oxaloacetate
α-Ketoglutarate
Aspartate

Fig. 8.16

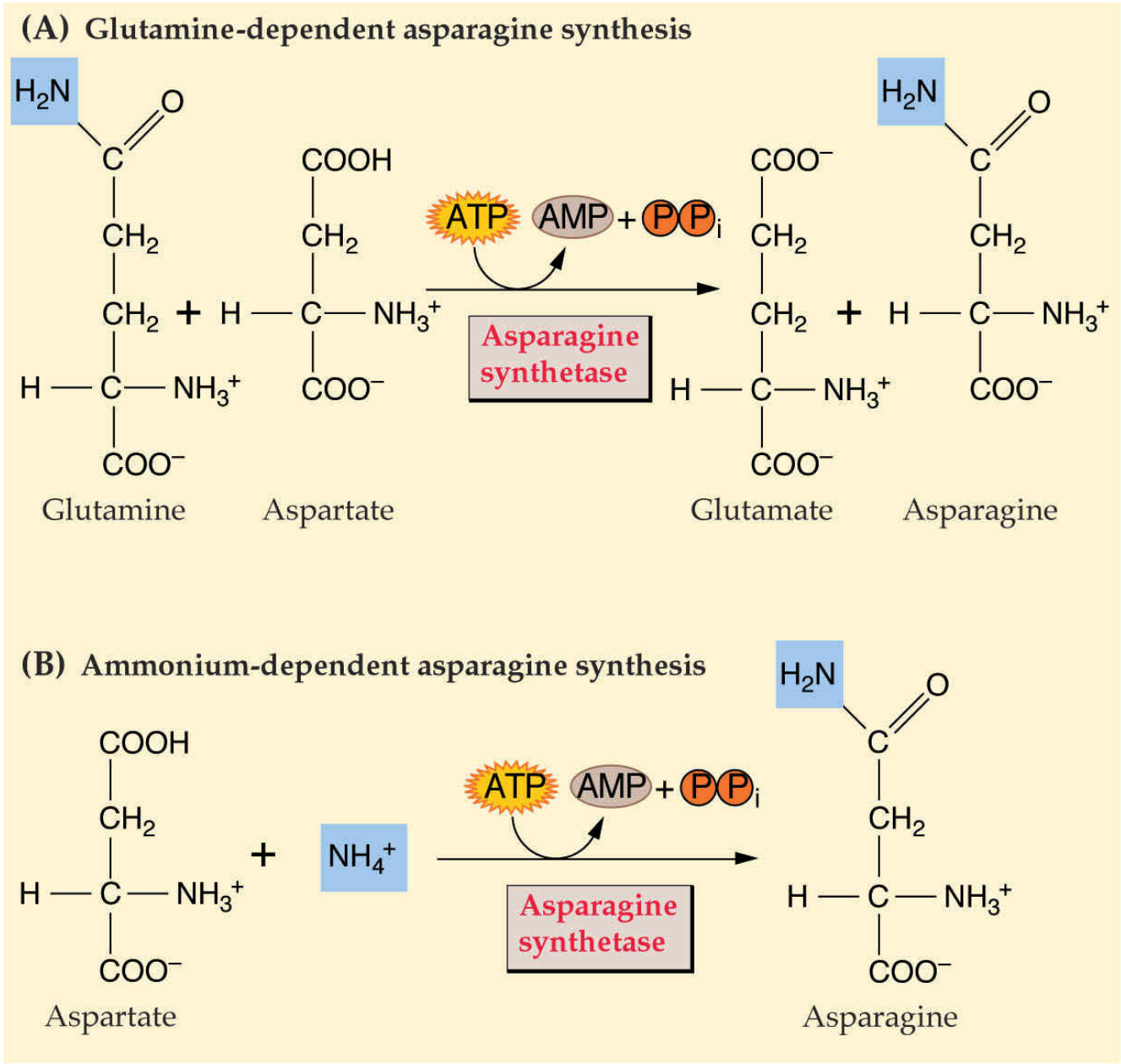

(A) Glutamine-dependent asparagine synthesis
ATP
AMP + PPi
Asparagine synthetase
Glutamine
Aspartate
Glutamate
Asparagine
(B) Ammonium-dependent asparagine synthesis
ATP
AMP + PPi
Asparagine synthetase
Aspartate
Asparagine

Fig. 8.19

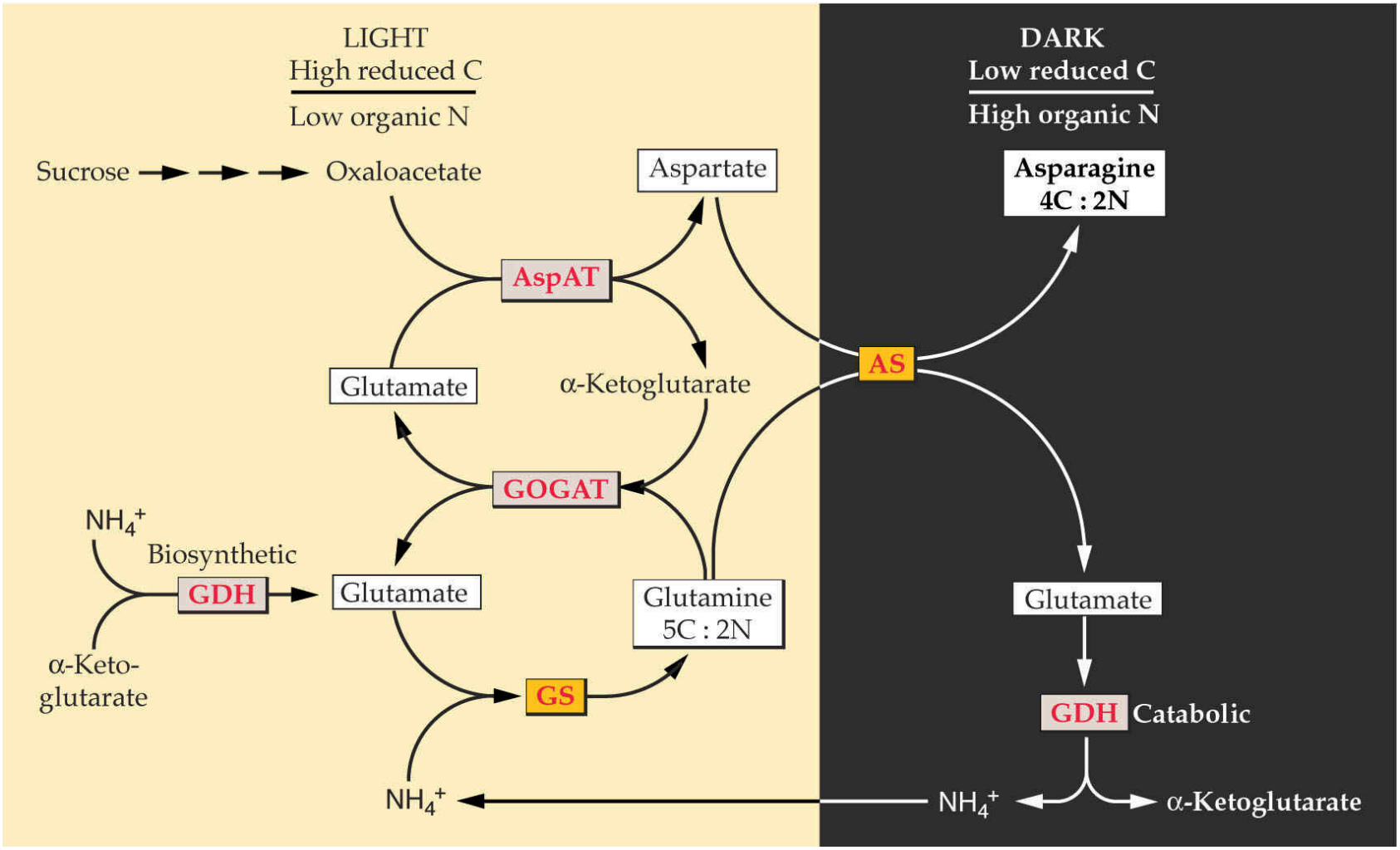

LIGHT
High reduced C
Low organic N
DARK
Low reduced C
High organic N
Sucrose
Oxaloacetate
Aspartate
Asparagine
4C : 2N
AspAT
AS
Glutamate
α-Ketoglutarate
GOGAT
NH4+
Biosynthetic
GDH
Glutamate
Glutamine
5C : 2N
Glutamate
α-Keto-
glutarate
GS
GDH Catabolic
NH4+
NH4+
α-Ketoglutarate

Fig. 8.20

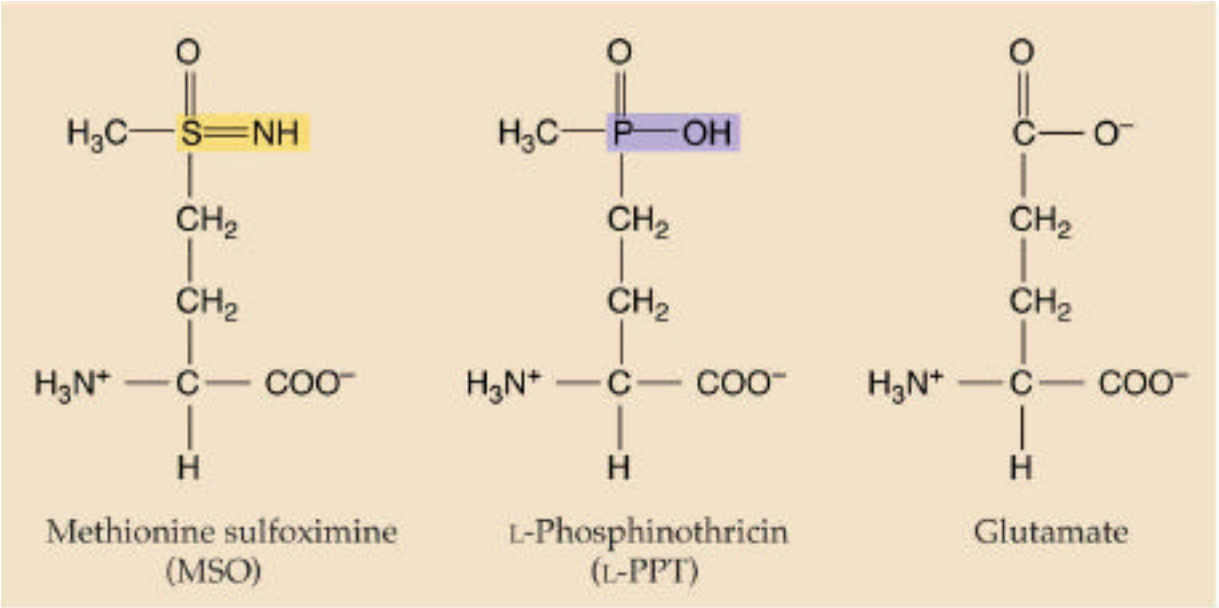


Fig. 8.7 structure of competitive inhibitor of GS

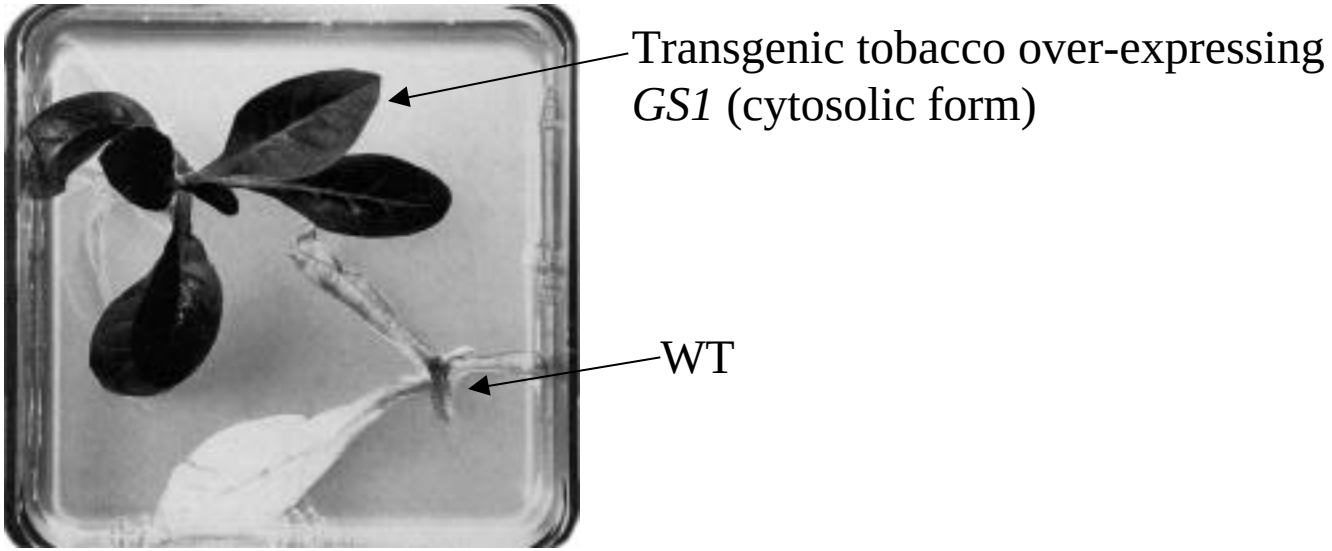


Fig. 8.22 (20 μM L-PPT)

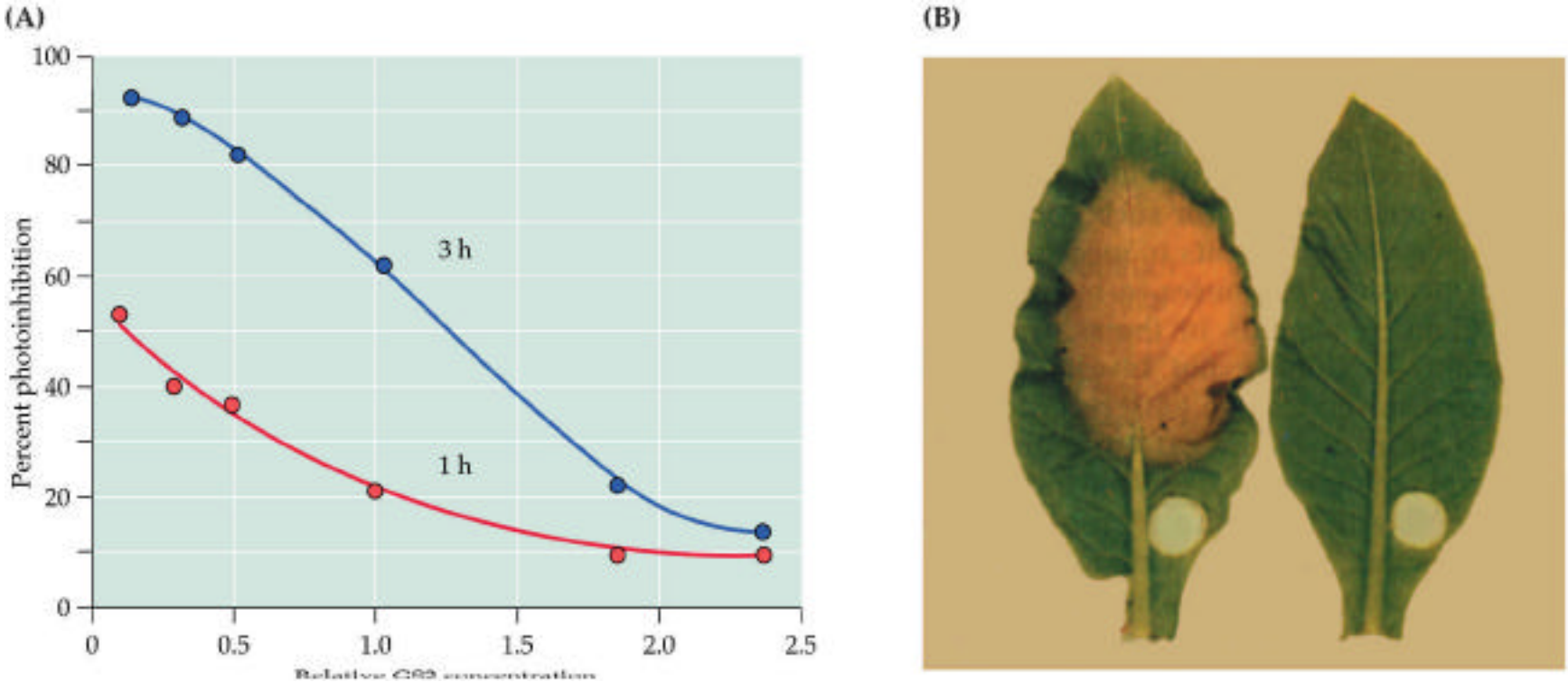

(A)
100
80
60
40
20
0
Percent photoinhibition
3 h
1 h
0
0.5
1.0
1.5
2.0
2.5
(B)

Fig. 8.23

Strategies making herbicide tolerant plants (box 8.4)

1. over-expressing the target enzyme such as the GS

2. express enzymes that detoxify or degrade the inhibitors
   i.e. express phosphinothricin acetyltransferase (bar) gene isolated from *streptomyces hygroscopicus* which confers resistance to L-PPT (basta).

3. introduce mutant target enzymes that are less sensitive to the inhibitors
   I.e. an naturally occurring form of EPSP synthase from agrobacteria is tolerant to high concentration of glyphosate (Roundup).

Fatty acid desaturase

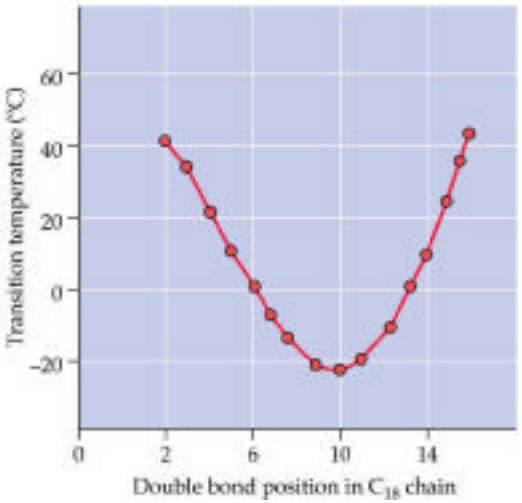


Fig. 10.17

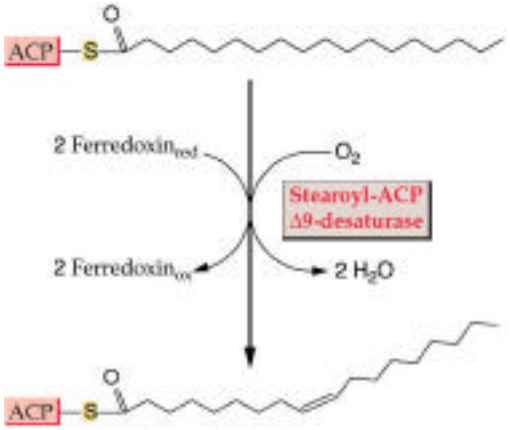


Fig. 10.18

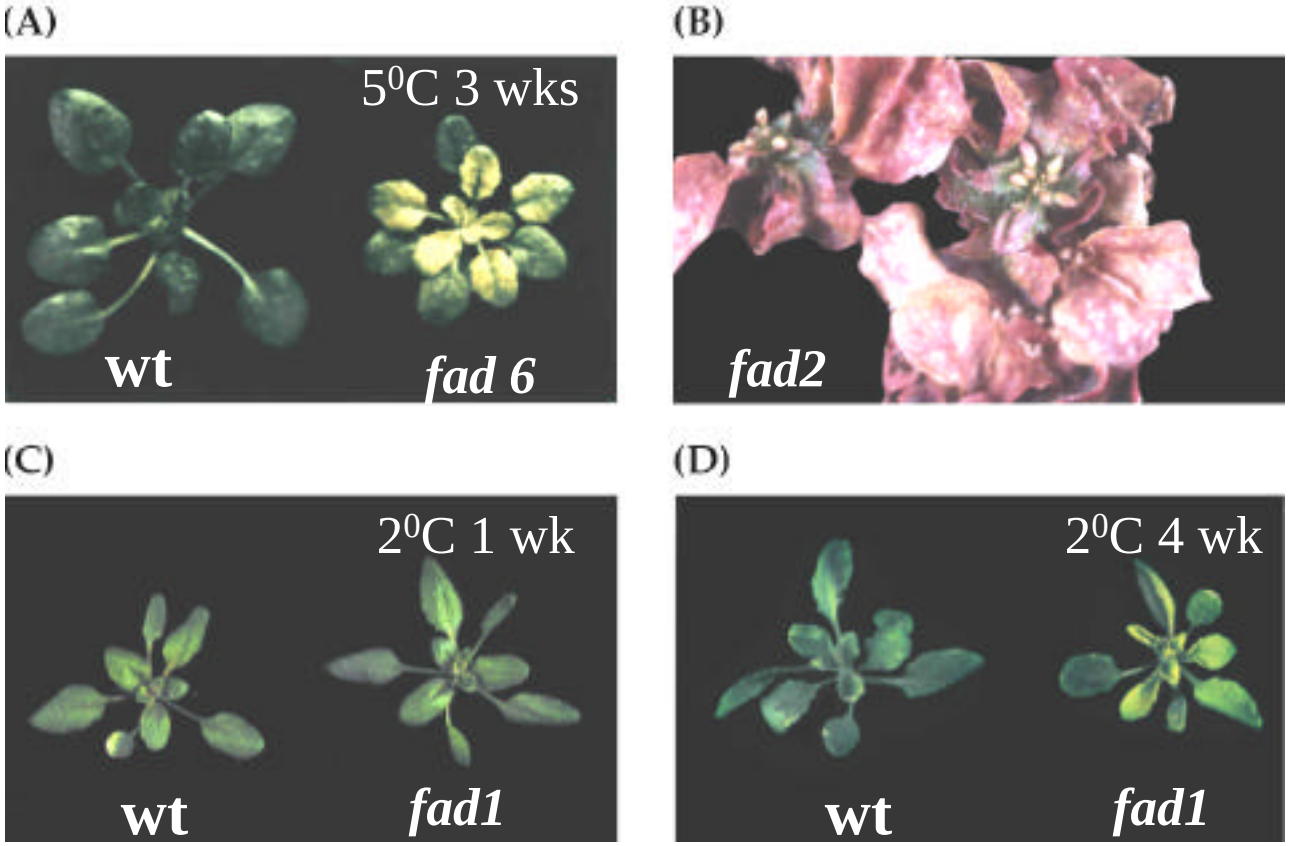
501-504, table 10.4

Does lipid composition affect chilling sensitivity?

2°C one day 25°C

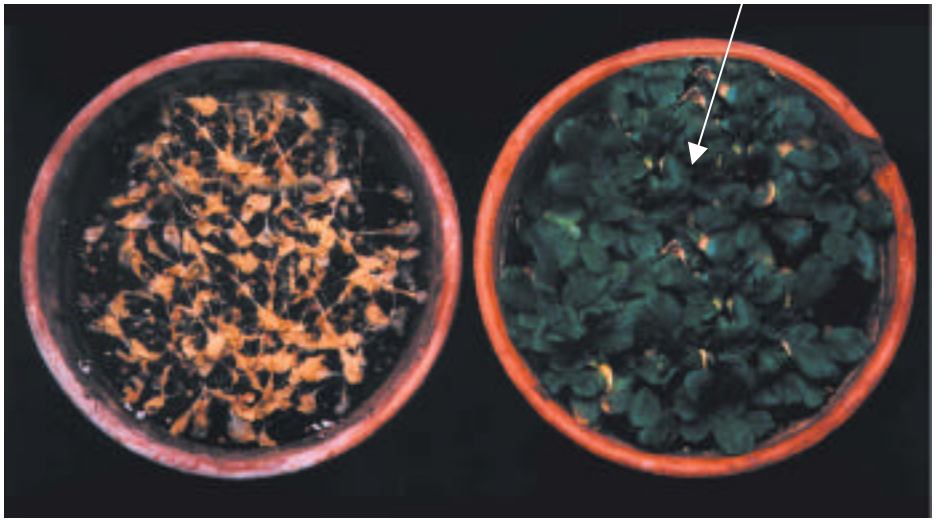
Fig. 10.45 cucumber is a chilling sensitive plant (also rice, soybean, cotton, maize tropical fruits)

Decreased unsaturation resulted in chilling sensitivity to *Arabidopsis* which is a cold-resistant plant



Name	Subcellular location	fatty acid substrate	double bond site
FAD2	ER	$18:1^{\triangle 9}$	$\triangle 12$
FAD6	chloroplast	$16:1^{\triangle 7}$ $18:1^{\triangle 9}$	$\omega 6$
FAD1			

pretreated at 4°C for 4 days



Both pots were kept -5°C for 4 days, and then grow at 23oC for 10 days

Fig. 10.48 cold acclimation allowed plants to survive freezing

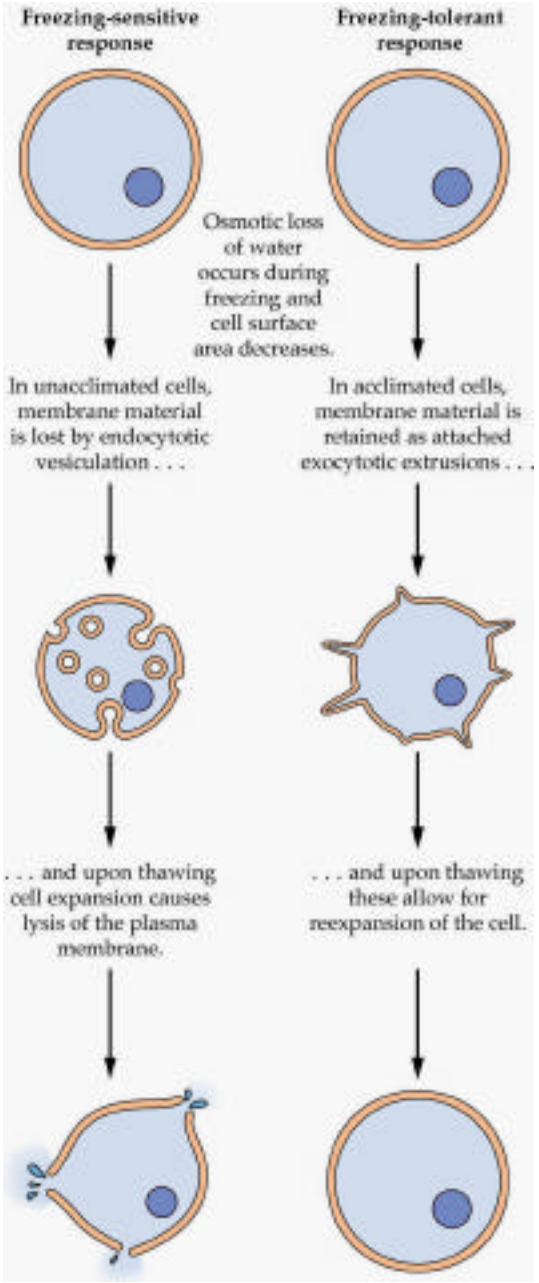


Fig. 10.49

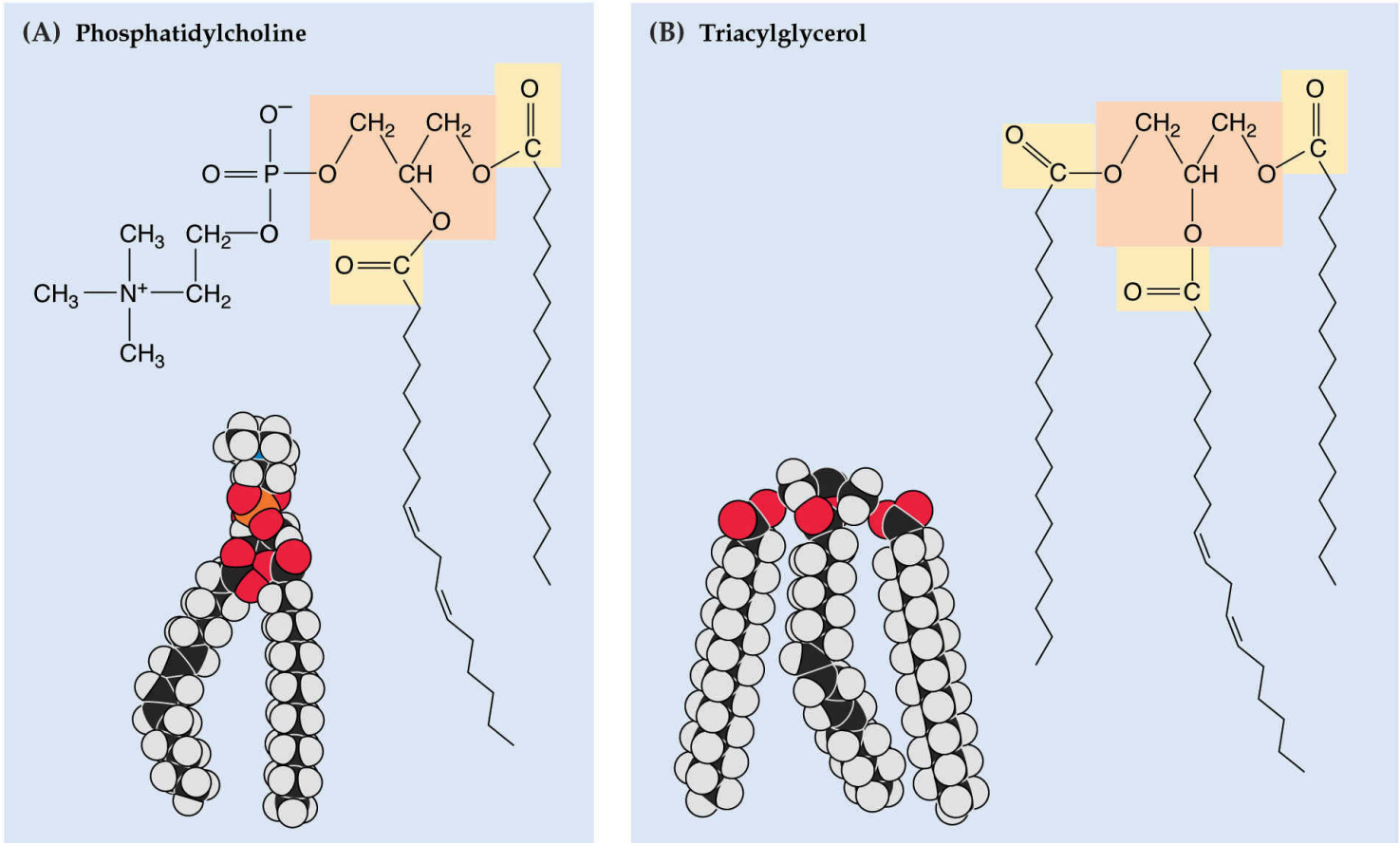


Fig. 10.5

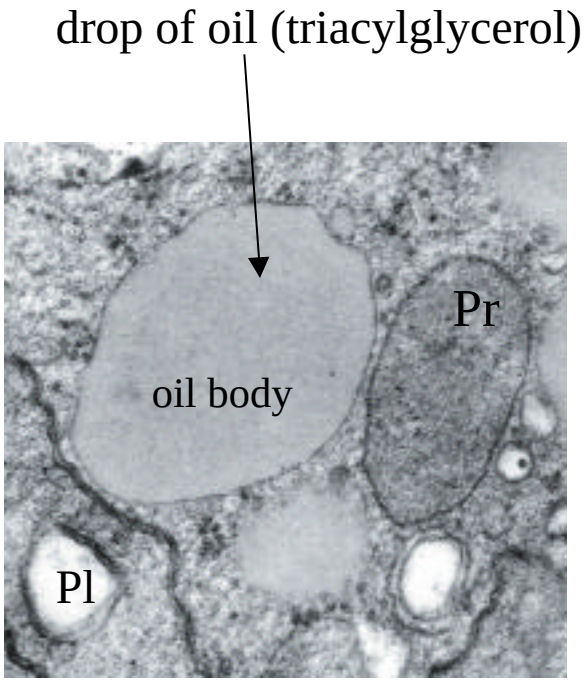


Fig. 10.63

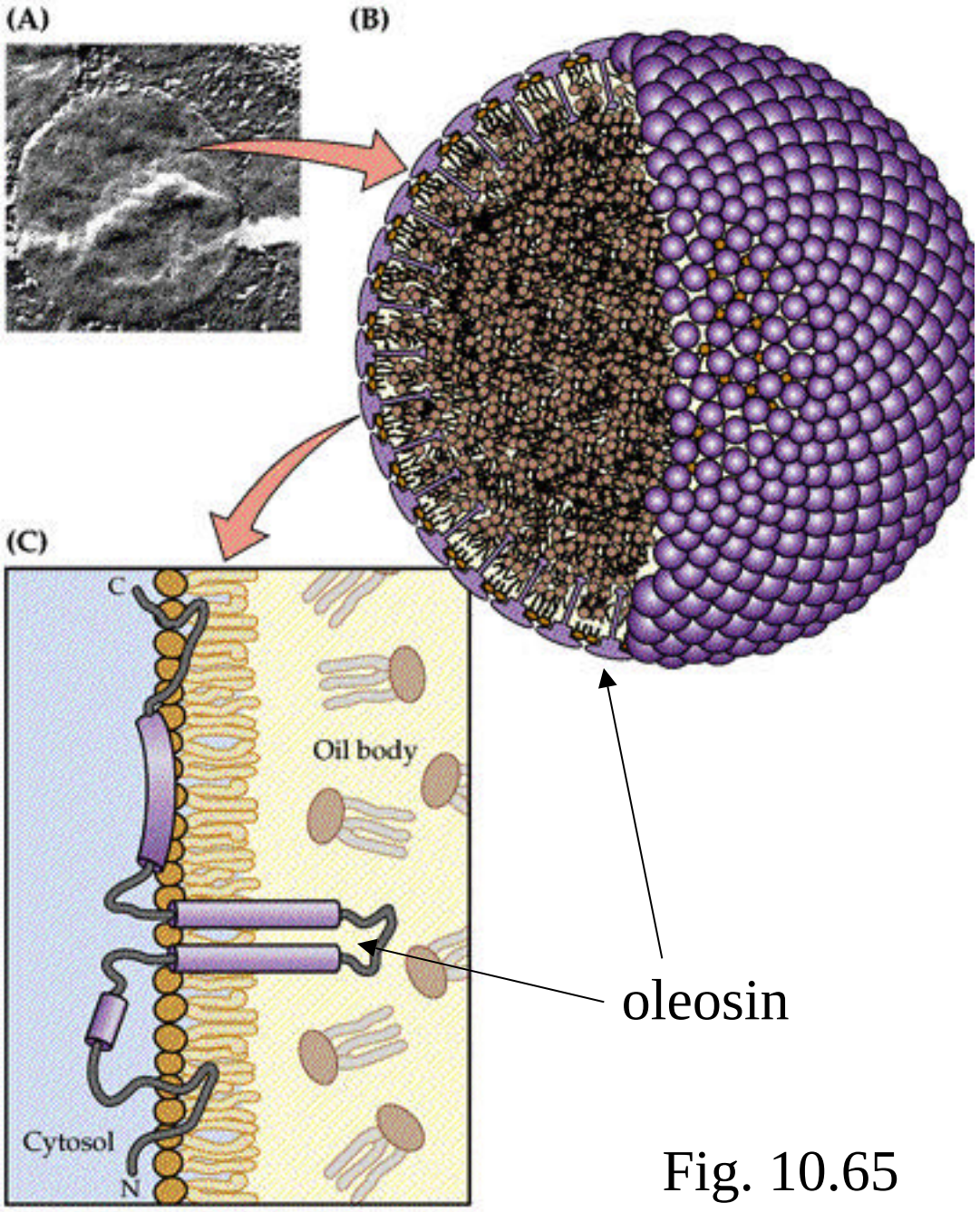


Fig. 10.65

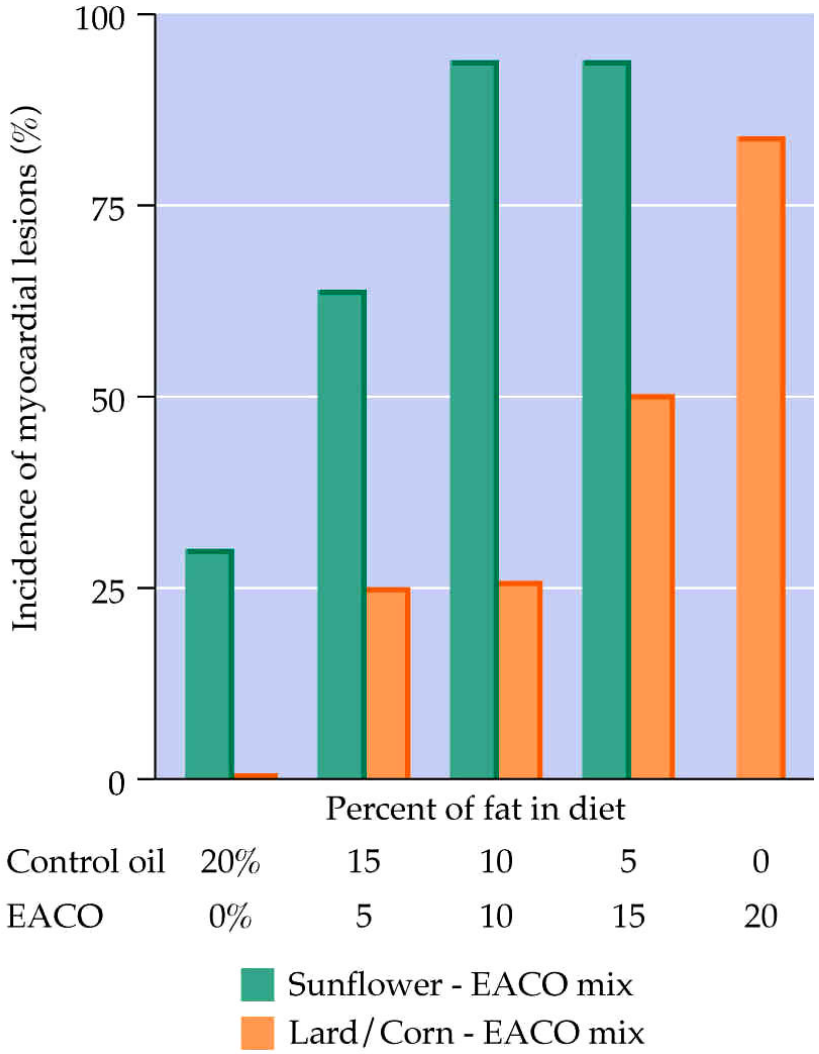


Fig. 10.28 EACO-high erucic acid containing oil

erucic acid: 22:1 $^{\Delta 13}$ is present 50% in rapeseed oil (*brassica napus*)

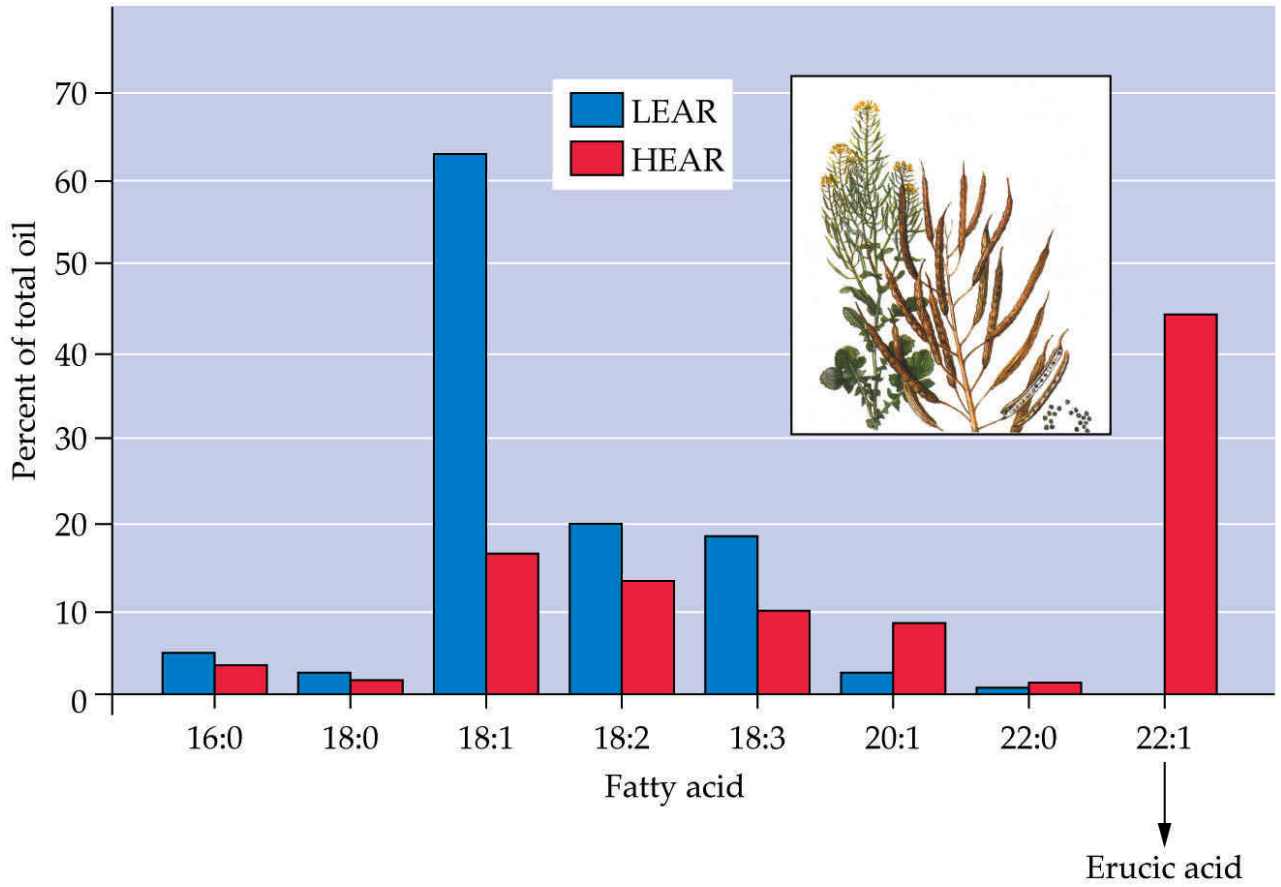


Fig. 10.69 Canola is the world third largest source of vegetable oil

Genetic engineering of lipids

1. inhibit β-ketoacyl-CoA synthase gene to reduce erucici acid (Canola)
2. co-suppression of oleoyl desaturase in soybean

    oleic acid increases from 10% to >85% of the total fatty acids

    satuated fatty acis reduced from >15% to <5%

The oil from these soybeans will have improved health benefits and improved stability

3. In coriander, acyl-ACP-ACP desaturase has been cloned, which is responsible for petroselinic acid ($18:1^{\delta 6)}$ biosynthesis. petroselinic acid is a cis-unsaturated fatty acid with a melting temperature above room temperature, suitable for margarine manufacture but without the high saturated fatty acid content associated with health problems.

At least two other genes for its biosynthesis have to be cloned and introduced into the same plant.

4. increase the yield: over express ACCase and acyltransferase

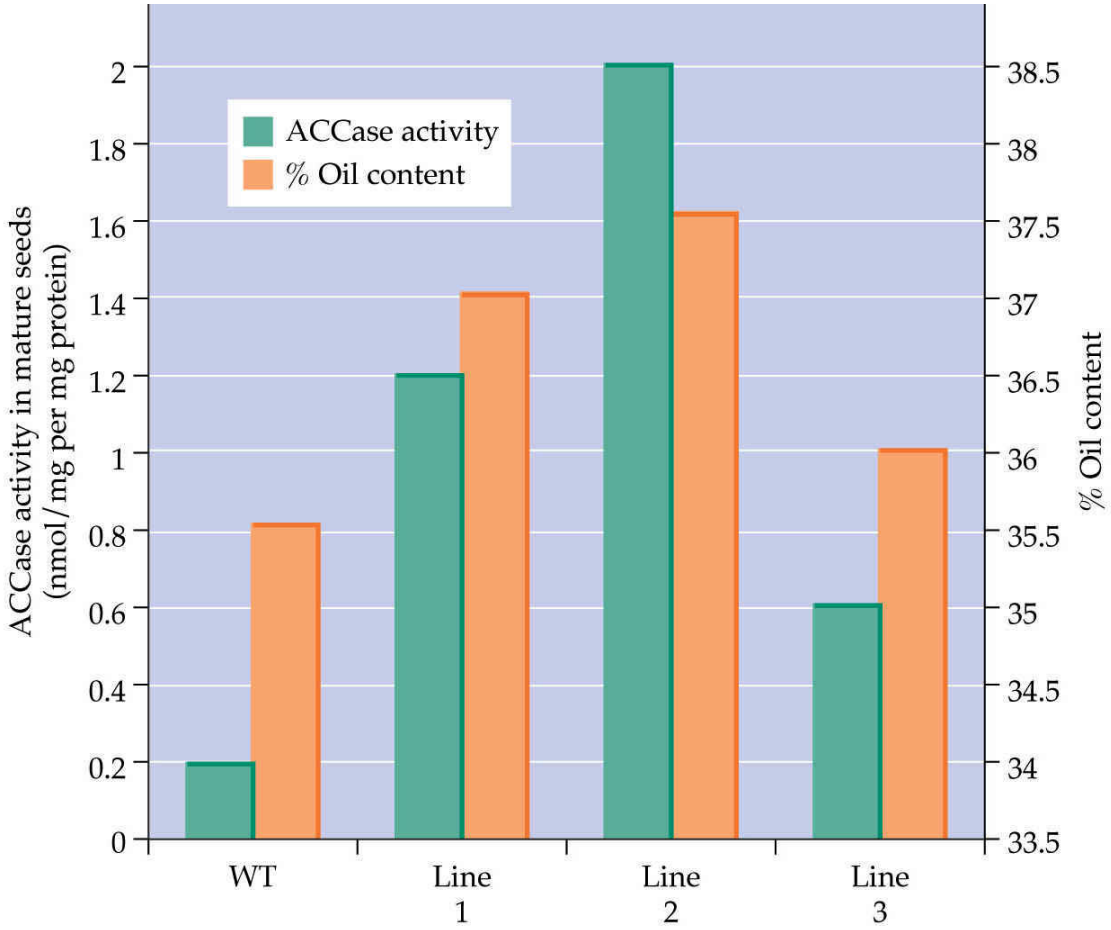

ACCase activity
% Oil content
ACCase activity in mature seeds (nmol/mg per mg protein)
% Oil content
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
38.5
38
37.5
37
36.5
36
35.5
35
34.5
34
33.5
WT
Line 1
Line 2
Line 3

Fig. 10.70

Industrial applications of vegetable oils:

Current:
soaps, detergent, paint, varnishes, lubricant, adhesives and plastics

Future:
biodiesels,
expand the range of fatty acids produced from crop,
so their usage can be expanded.

Production of biodegradable plastics

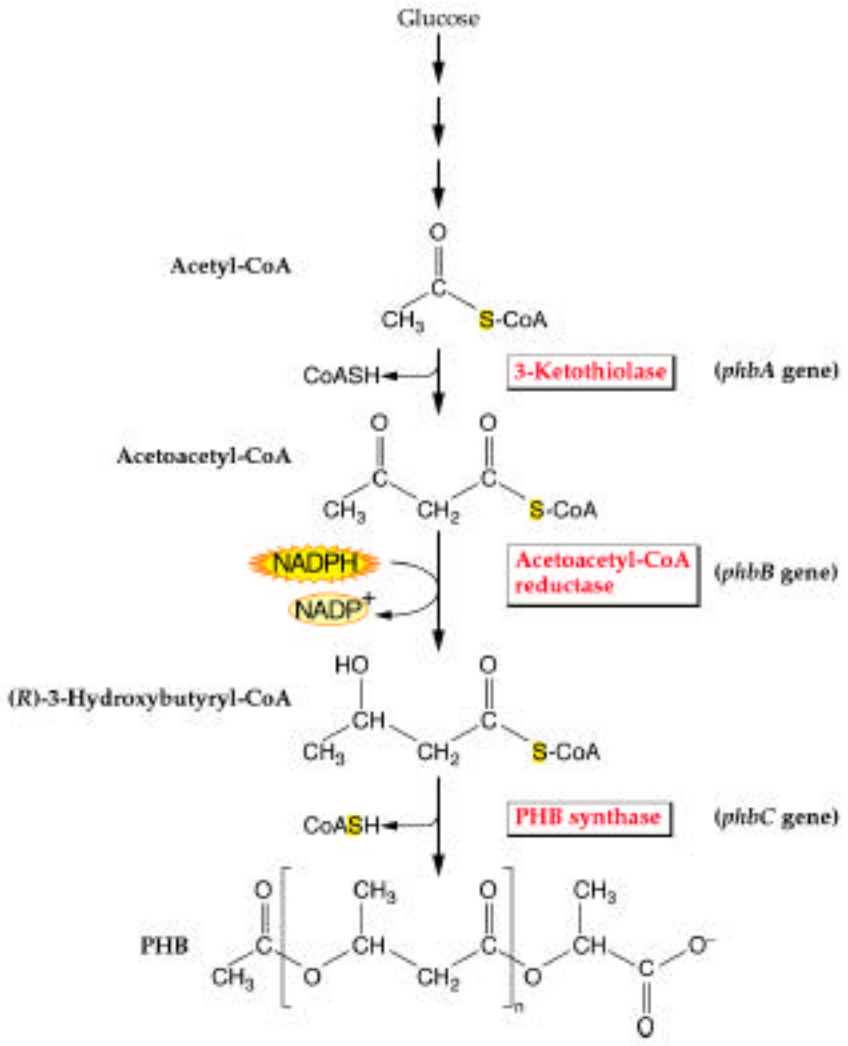


Fig. 10. 74

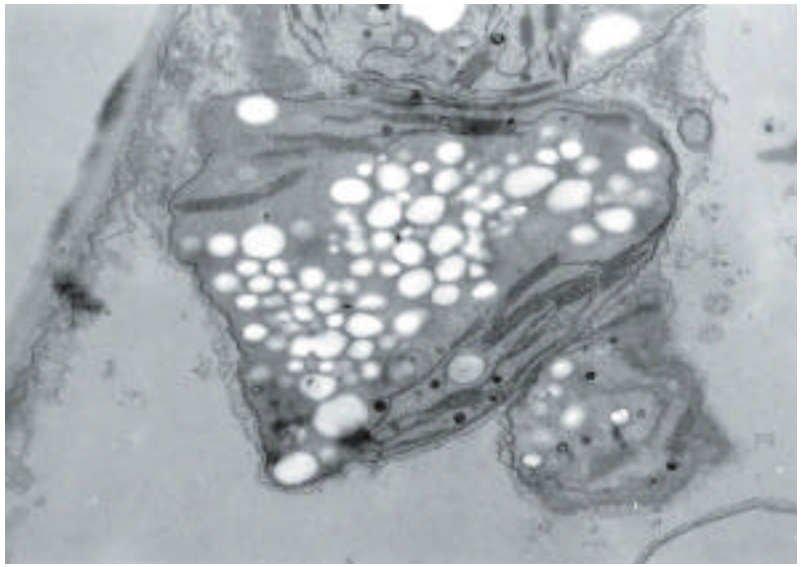


Fig. 10.75

518-525