4. SUMMARY OF ARABIDOPSIS LIPID COMPOSITION

This section summarizes the acyl lipid composition for various tissues and organs of wild type Arabidopsis. Data presented in this chapter were collected from Col-0 ecotype unless otherwise noted. The goal of this section is to provide a quick and easy access to summary on acyl lipid content and composition, which sometimes can be difficult to find. It is composed of 15 tables and 3 figures as outlined below:

Tables included: (*hyperlinked*)

Figures included:

Table 4. Fatty Acid Composition of Arabidopsis Tissues

Fatty Acids	Tissue Types				
	Seed	Leaf	Stem	Flower	Root
	Mature	5-Week-Old		Open Flower	15-Day-Old
16:0	8.7±0.1	15.0±0.13	26.3±0.6	28.0±0.1	20.7±0.8
16:1(d3 + d9)	—	3.8±0.04	2.3±0.02	—	1.2±0.6
16:2	—	1.1±0.03	—	—	0.4±0.1
16:3	—	13.8±0.19	11.7±1.6	3.3±0.4	1.5±0.1
18:0	3.6± 0.1	1.0±0.04	2.3±0.01	1.9±0.03	1.9±0.1
18:1 (d9 + d11)	15.0±0.2	3.5±0.14	1.0±0.01	—	7.5±0.01
18:2	29.0±0.3	15.7±0.17	19.9±2.4	36.9±0.4	36.5±1.8
18:3	19.2±0.1	46.0±0.2	36.4±3.3	28.3±0.1	24.6±2.3
20:0	2.2±0.1	—	—	0.6±0.1	1.4±0.02
20:1	20.2±0.1	—	—	—	—
20:2	2.0±0.1	—	—	—	—
22:0	—	—	—	0.5±0.02	2.5±0.1
22:1	1.7±0.1	—	—	—	—
24:0	—	—	—	0.4±0.03	1.7±0.1
Reference	Y.H. Li et al., 2006	Miquel and Browse, 1992	Y.H. Li et al., 2007a	Li-Beisson et al., 2009	Beaudoin et al., 2009

Data are mean expressed as mol% ± SD (SE for leaves). Seeds n = 6, leaves n = 24, stems n = 4, flowers n = 3, roots n = 4). — = not detected. (Prepared by Yonghua Li-Beisson)

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Table 5. Molecular Species Composition for 52 TAGs From Dry Seeds

TAG Molecular Species	Weight %	TAG Molecular Species	Weight %
20:1-18:2-18:3	11.5 ± 0.9	18:0-18:2-20:1	1.3 ± 0.1
18:2-20:1-18:2	7.7 ± 0.4	16:0-18:2-16:0	1.3 ± 0.1
18:3-20:1-18:3	6.9 ± 0.5	18:2-20:0-18:2	1.3 ± 0.1
16:0-18:2-20:1	5.1 ± 0.3	16:0-18:1-20:1	1.2 ± 0.1
18:1-18:2-18:3	4.4 ± 0.2	18:0-18:3-20:1	1.0 ± 0.1
20:1-18:3-18:1	4.2 ± 0.3	16:0-18:2-18:0	1.0 ± 0.0
16:0-18:2-18:3	3.6 ± 0.2	18:0-18:2-18:1	0.9 ± 0.1
18:2-16:0-18:2	3.4 ± 0.2	18:3-20:0-18:3	0.9 ± 0.1
16:0-18:3-20:1	3.4 ± 0.1	16:0-20:0-18:2	0.8 ± 0.0
20:1-20:1-18:2	2.8 ± 0.7	16:0-16:0-18:3	0.6 ± 0.1
20:1-20:1-18:3	2.8 ± 0.3	20:0-18:2-18:1	0.6 ± 0.0
16:0-18:2-18:1	2.8 ± 0.1	18:3-18:3-18:3	0.6 ± 0.1
18:2-18:2-18:1	2.6 ± 0.1	20:0-18:2-20:1	0.6 ± 0.1
18:1-20:1-18:1	2.5 ± 0.1	16:0-20:0-18:3	0.5 ± 0.0
18:2-18:3-18:2	2.3 ± 0.2	20:0-18:3-18:1	0.5 ± 0.0
18:3-18:1-18:3	2.2 ± 0.1	16:0-18:3-18:0	0.5 ± 0.0
18:3-18:2-18:3	1.8 ± 0.1	20:0-18:3-20:1	0.4 ± 0.0
18:1-18:2-18:1	1.7 ± 0.3	18:0-18:1-20:1	0.4 ± 0.1
20:0-18:2-18:3	1.7 ± 0.1	18:1-20:0-18:1	0.3 ± 0.0
16:0-18:3-18:1	1.6 ± 0.1	16:0-16:0-18:1	0.3 ± 0.1
18:0-18:2-18:3	1.6 ± 0.1	22:0-18:2-18:3	0.2 ± 0.0
18:2-18:2-18:0	1.5 ± 0.2	16:0-18:1-18:0	0.2 ± 0.0
18:3-18:2-22:1	1.4 ± 0.2	18:2-20:0-18:0	0.2 ± 0.0
20:1-18:1-20:1	1.4 ± 0.1	18:2-22:0-18:2	0.2 ± 0.0
18:2-18:2-18:2	1.3 ± 0.1	18:3-18:3-20:3	0.2 ± 0.0
18:1-18:3-18:1	1.3 ± 0.1	16:0-18:1-20:0	0.2 ± 0.1

TAGs were extracted from 50 seeds/plant and subjected to LC-MS/MS analysis. Amounts were calculated as weight % of total TAGs detected. Only TAGs with an abundance >0.2% are shown. The putative *sn*-2 assignment of the fatty acid for each TAG annotation (*sn*-(1,3) – *sn*-2 – *sn*-(1,3) was deduced from the intensity of the MS2 daughter ions; *sn*-(1,3) positions are interchangeable. However, *sn*-2 assignments are not guaranteed without further analysis. Values are mean ± SD (n = 5). (Prepared by Tony Larson)

Table 6. Glycerolipid Composition of Arabidopsis Tissues

Glycerolipid Classes	Tissue Types				
	Seed	Root	Chloroplasts	Extrachloroplasts	Leaf (7-Week-Old)
PC	48.1	45.4	12.0	47.8	13.8
PE	22.1	27.5	—	36.5	7.1
PI + PS	18.9	12.9	—	10.9	3.1
PA	—	—	—	—	0.7
SQDG	—	—	3.9	—	—
DGDG	3.3	2.0	20.9	—	18.6
PG	4.6	3.8	9.5	4.4	13.5
MGDG	3.0	3.4	53.7	—	43.2
References	Browse and Somerville, 1994				Welti et al., 2002

Data are mean and expressed as mol%. — = not detected. (Prepared by Mats Andersson)

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Table 7. Fatty Acid Composition of Individual Leaf Glycerolipids From Arabidopsis

Fatty Acids	Leaf Glycerolipid Classes						
	PC	PE	PI	PG	MGDG	DGDG	SQDG
16:0	20.6	31.2	43.5	20.7	1.5	13.6	43.2
16:1	0.6	—	—	33.5	1.5	0.3	—
16:2	—	—	—	—	1.3	0.6	—
16:3	—	—	—	—	30.6	2.1	—
18:0	2.7	3.4	5.2	1.8	0.2	1.1	3.7
18:1	4.4	3.3	4.3	6	1.5	1.3	5.3
18:2	38.8	43	27	12.5	3.4	5.0	10.4
18:3	32.1	18.7	20	25.6	60.0	75.9	37.4
% of total polar lipids	17.2	10.3	3.5	10.1	42.3	14.2	2.5
Reference	Miquel and Browse, 1992						

Data are mean and expressed as mol%. 15-day-old rosette leaves were analyzed. — = not detected. (Prepared by Mats Andersson)

Table 8. Load of Cuticular Wax Compound Classes in Stems and Rosette Leaves of Arabidopsis

Compound Classes	Acyl Chain Length	Tissue Type	
		Stem	Leaf
Free fatty acids	C22	1.5 ± 0.3	—
	C24	2.7 ± 0.4	0.3 ± 0.2
	C26	5.7 ± 1.0	2.7 ± 0.5
	C28	23.5 ± 4.0	3.9 ± 0.5
	C30	15.5 ± 6.5	5.6 ± 1.0
Aldehydes	C26	8.4 ± 1.1	—
	C28	36.2 ± 4.5	2.5 ± 0.6
	C30	57.1 ± 6.9	2.7 ± 0.6
Primary alcohols	C24	3.5 ± 0.6	—
	C26	32.7 ± 4.6	3.6 ± 0.6
	C28	63.0 ± 8.8	6.3 ± 1.2
	C30	21.3 ± 1.9	1.5 ± 1.1
Alkanes	C25	4.5 ± 0.4	0.8 ± 0.6
	C26	0.6 ± 0.4	0.2 ± 0.3
	C27	27.3 ± 2.6	2.7 ± 0.5
	C28	8.0 ± 0.9	0.3 ± 0.2
	C29	1318.1 ± 57.6	30.3 ± 1.6
	C30	9.1 ± 0.6	1.1 ± 0.2
	C31	30.5 ± 6.0	60.5 ± 4.4
	C32	3.3 ± 0.4	1.2 ± 0.1
	C33	4.4 ± 0.4	16.7 ± 1.3
Secondary alcohols	C29	55.5 ± 8.5	—
	C31	8.1 ± 0.7	—
Ketone	C29	534.7 ± 12.4	0.9 ± 0.6
Wax esters	C38	3.8 ± 0.4	—
	C40	8.6 ± 0.3	—
	C42	28.5 ± 2.6	—
	C44	22.0 ± 1.9	—
	C46	9.8 ± 0.9	—
	C48	3.9 ± 0.6	—
Unidentified		43.0 ± 14.7	3.1 ± 2.1
Total		2399.1 ± 71.5	150.1 ± 8.2
Reference		Lü et al., 2009	

Total wax loads and coverage of individual compound classes (μg/dm^2) are given as mean values ±SD (n = 3). Stem and leaf tissue were taken from 6-week-old Arabidopsis plants. — = not detected. (Prepared by Owen Rowland)

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Table 9. Total Load of Suberin and Suberin-Associated Waxes in Arabidopsis Seeds and Roots

Tissue Type	Suberin Polyester Monomers		Chloroform-Extracted Waxes	
	Monomer Load	**References**	**Wax Load**	**References**
Seed	[a]2.56 μg/g seeds 46 ng/seed 12 μg/cm^2	Molina et al., 2006	170 μg/g seeds 1.3 ng/seed	Y.H. Li et al., 2007b Beisson et al., 2007
Root	[b]62.7 mg/g residue [b]50.5 μg/cm^2 [c]7.2 mg/g cell wall [d]17 mg/g cell wall	Franke et al., 2005 Franke et al., 2005 Beisson et al., 2007 Y.H. Li et al., 2007b	360 μg/gfw	Y.H. Li et al., 2007b

(Prepared by Isabel Molina)
[a]Suberin monomers are mostly deposited on the seed coat, but determinations were performed on solvent-extracted residues of whole mature seed samples. Thus, the reported total lipid polyester monomer load includes a contribution of cutin-like monomers from the embryo (about 11% in *B. napus* seeds).
[b]Lipid polyester monomers determined on solvent-extracted and enzyme-digested (cellulases + pectinases) roots of 5-week-old plants grown on soil.
[c]Lipid polyester monomers determined on solvent-extracted primary roots of 1-week-old seedlings grown on plates.
[d]Lipid polyester monomers determined on solvent-extracted secondary roots of 7-week-old plants grown on soil.

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Table 10. Suberin Monomer Composition in Seed Coats and Roots

Polyester Monomers	Tissue Type	
	Seed[a] (mol %)	Root[b] (Weight %)
Octadecan-1-ol (C18)	1.50 ± 0.10	2.11 ± 1.46
Eicosan-1-ol (C20)	1.50 ± 0.10	2.49 ± 0.13
Docosan-1-ol (C22)	2.80 ± 0.25	1.83 ± 0.53
Nonadecan-1-ol, branched (C19)	0.30 ± 0.05	—
Tricosan-1-ol, branched (C23)	0.35 ± 0.05	—
Total alkan-1-ols	**6.50 ± 0.45**	**6.43 ± 1.06**
16-Hydroxyhexadecanoic acid (C16)	1.75 ± 0.10	5.77 ± 1.2
18-Hydroxyoctadecadienoic acid (C18:2)	4.55 ± 0.60	—
18-Hydroxyoctadecenoic acid (C18:1)	3.45 ± 0.25	23.11 ± 2.26
18-Hydroxyoctadecanoic acid (C18)	0.25 ± 0.05	2.73 ± 0.88
20-Hydroxyeicosanoic acid (C20)	0.65 ± 0.10	3.07 ± 0.44
22-Hydroxydocosanoic acid (C22)	4.20 ± 0.25	7.79 ± 0.76
22-Hydroxydocosanoic acid, branched (C22)	0.70 ± 0.05	—
23-Hydroxytricosanoic acid (C23)	0.55 ± 0.05	—
24-Hydroxytetracosanoic acid (C24)	12.60 ± 0.45	0.71 ± 0.24
24-Hydroxytetracosanoic acid, branched (C24)	0.40 ± 0.05	—
25-Hydroxypentacosanoic acid (C25)	0.30 ± 0.05	—
26-Hydroxyhexacosanoic acid (C26)	0.20 ± 0.05	—
Total ω-hydroxy fatty acids	**29.6 ± 1.95**	**43.19 ± 4.14**
1,16-Hexadecane dioic acid (C16)	1.80 ± 0.10	4.91 ± 1.3
1,18-Octadecadiene dioic acid (C18:2)	8.90 ± 0.75	—
1,18-Octadecene dioic acid (C18:1)	3.40 ± 0.20	10.68 ± 0.76
1,18-Octadecane dioic acid (C18)	0.50 ± 0.05	5.87 ± 4.79
1,20-Eicosane dioic acid (C20)	—	1.01 ± 0.2
1,22-Docosane dioic acid (C22)	1.65 ± 0.10	1.39 ± 0.15
1,24-Tetracosane dioic acid (C24)	8.50 ± 0.40	0.35 ± 0.26
Total 1, ω-dicarboxylic acids	**24.75 ± 1.60**	**24.21 ± 4.69**
1,20-Eicosane diol (C20)	0.30 ± 0.05	—
1,22-Docosane diol (C22)	2.40 ± 0.02	—
Total 1, ω-alkane diols	**2.70 ± 0.25**	**—**
Hexadecanoic acid (C16)	2.00 ± 0.25	—
Octadecanoic acid (C18)	0.35 ± 0.10	0.12 ±0 .03
C18:1, C18:2, C18:3 acids	5.50 ± 1.50	—
Eicosanoic acid (C20)	0.50 ± 0.05	2.23 ± 0.82
Eicosenoic acid (C20:1)	1.40 ± 0.40	—
Docosanoic acid (C22)	0.50 ± 0.05	6.18 ± 0.7
Tetracosanoic acid (C24)	1.50±0.10	1.11 ± 0.52
Hexacosanoic acid (C26)	0.55 ± 0.05	—
Hexacosenoic acid (C26:1)	0.45 ± 0.10	—

Octacosenoic acid (C28)	0.15	—
Octacosenoic acid (C28:1)	0.30 ± 0.05	—
Dotriacontanoic acid (C32)	0.10	—
Dotriacontenoic acid (C32:1)	0.15	—
Tetratriacontenoic acid (C34)	0.15	—
Total fatty acids	**13.6 ± 2.9**	**9.64 ± 0.77**
2-Hydroxytetracosanoic acid (C24)	0.4 ± 0.15	0.12 ± 0.1
10,16-Dihydroxyhexadecanoic acid (C16)	0.55 ± 0.25	—
9,10,18-Trihydroxyoctadecenoic acid (C18:1)	4.8 ± 0.85	—
Secondary hydroxy-containing species	**5.75 ± 1.25**	**0.12 ± 0.1**
Ferulate	15.2 ± 1.3	3.65 ± 3.15
Coumarate	—	1.51 ± 0.69
Sinapate	1.4 ± 0.5	—
β-sitosterol (C29:1)	0.5 ± 0.05	—
Other	**17.1 ± 1.9**	**11.26 ± 3.89**
References	Molina et al., 2006	Franke et al., 2005

Composition and relative amounts of monomers released from solvent-extracted seed residues by NaOMe-catalyzed transmethylation and from root cell walls by BF3/MeOH transesterification. — = not detected. (Prepared by Isabel Molina)
[a]*For seed analysis,* three extractions of bulked mature *Arabidopsis thaliana* seed batches were performed and each seed residue was analyzed in triplicate to give 9 determinations, reported as the average ±SD. GC analyses were undertaken on acetyl derivatives. Peaks that were identified and that are at least 1% of the peak area of the greatest peak, 24-hydroxytetracosanoate, were summed to give 100 mole %. Unidentified peaks represented 18% of the identified peak by peak area.
[b]*For root analysis*, root cell walls were prepared from 5-week-old *Arabidopsis thaliana* plants. Mean and SD were determined from 10 replicates each representing the roots of 5 to 7 plants. Acids were analyzed as methyl esters, hydroxyl groups as trimethylsilyl ethers.

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Table 11. Composition of Arabidopsis Root Waxes

Compound classes	Acyl chain length	Waxes (weight %)
Primary alcohols	**18:0**	0.97
	20:0	2.18
	22:0	6.13
Free fatty acids	**16:0**	3.75
	18:0	4.93
	20:0	0.89
	22:0	3.06
	24:0	2.38
	26:0	0.43
	28:0	0.23
	30:0	0.09
Stem-type waxes	**29 Alkane**	2.93
	29 15-OH	2.02
	29 ketone	0.57
Monoacylglycerols	**β-22:0**	2.29
	a-22:0	0.99
	β-24:0	1.26
	a-24:0	0.72
	β-26:0	0.30
	a-26:0	0.17
	β-28:0	—
	a-28:0	0.16
	β-30:0	—
	a-30:0	0.23
Sterols	**28:1**	3.67
	29:1	12.16
Coumarates	**18:0**	6.90
	20:0	7.72
	22:0	9.86
Ferulates	**18:0**	1.23
	20:0	2.28
	22:0	4.31
Caffeates	**18:0**	2.67
	20:0	3.45
	22:0	9.06
Reference	Y.H. Li et al., 2007b	

Data are average of 3 replicates. — = not detected. (Prepared by Isabel Molina)

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Table 12. Composition of Arabidopsis Seed Waxes

Compound Classes	Acyl Chain Length	Mass%
Fatty acids	26:0	3.09 ± 0.42
Primary alcohols	26:0	4.33 ± 0.03
	28:0	4.91 ± 0.03
	30:0	0.95 ± 0.22
Alkanes	27:0	1.46 ± 0.05
	29:0	54.41 ± 0.42
	31:0	2.80 ± 0.06
Secondary alcohols	29 15-OH	9.34 ± 0.05
Ketones	29	18.70 ± 0.28
References	Molina et al., 2008	

Values are average ±SE (n = 3). (Prepared by Isabel Molina)

Table 13. Cutin Monomer Composition in Arabidopsis Tissues

Compound Classes	Acyl Chain Length	Tissue Type		
		Stem	Leaf	Flower
		(µg/dm^2)		(µg/g FW)
Fatty acids	16:0	4.5 ± 0.2	2.8 ± 0.2	10 ± 1
	18:0	1.2 ± 0.1	1.4 ± 0.1	2.9 ± 0.3
	18:1, 18:2	2.5 ± 0.6	1.5 ± 0.2	3.6 ± 0.9
	20:0	2.8 ± 1.1	1.4 ± 0.1	10 ± 1
	22:0	3.4 ± 0.3	2.2 ± 0.2	24 ± 1
	24:0	7.1 ± 1.4	4.4 ± 0.3	6 ± 1
ω-hydroxy fatty acids	16:0	12.3 ± 1.1	1.3 ± 0.1	44 ± 6
	18:2	7 ± 0.3	6.4 ± 0.5	45 ± 2
	18:1	7.9 ± 0.8	4.7 ± 0.1	23 ± 9
α,ω-Dicarboxylic acids	16:0	15.8 ± 1.8	9.9 ± 0.4	102 ± 14
	18:2	127.2 ± 26.6	57.7 ± 2.2	126 ± 22
	18:1	10.4 ± 1.6	9.7 ± 0.3	74 ± 14
	18:0	4.3 ± 0.7	5 ± 0.2	14 ± 8
10(9),16-dihydroxy 16:0		3.6 ± 0.2	4 ± 0.1	620 ± 120
Total		210 ± 18.2	110.7 ± 9.8	1104 ± 81
References		Y.H. Li et al., 2007a; Li-Beisson et al., 2009		

Data are mean with SD (n = 4). For leaf and cutin analysis, samples were prepared from 5-week-old plants; for flowers, open flower (stage 15) were used. — = not detected. (Prepared by Fred Beisson)

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Table 14. Fatty Acid Composition of Glycerophospholipids in Mitochondrial Membranes of Arabidopsis

Fatty Acids	Lipid Species				
	PC	PE	CL	PI	PG
16:0	20.3	19.9	7.0	58.8	64.3
18:0	12.0	5.5	2.7	16.0	16.6
18:1	12.4	9.4	5.8	4.2	6.0
18:2	28.9	39.9	36.8	11.9	7.8
18:3	26.4	25.3	47.7	9.1	5.3
Reference	Caiveau et al., 2001				

Data are expressed on a mol% basis. Cell suspension culture of *A. thaliana* L. (Heynh) was used. (Prepared by Hajime Wada and Kenta Katayama)

Table 15. Lipid Composition of Mitochondria Isolated from Arabidopsis

Cell Suspension Culture	Lipid Species								Reference
	PC	PE	PG	PI	CL	DGDG	MGDG	SQDG	
Cultured with 1 mM Pi	39.4	41.2	3	3.3	10.2	1.5	1.4	0	Jouhet et al., 2004
Cultured without Pi for 3 d	32.6	29	0.3	2.3	14.7	18.2	2.3	0.6	
Cultured with 1 mM Pi	49	33	2	5	11	—	—	—	Caiveau et al., 2001

— = not detected. (Prepared by Hajime Wada and Kenta Katayama)

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Table 16. Acyl-CoA Composition of Arabidopsis Leaf Tissues

Acyl-CoAs	Content (fmol/mgFW)
2:0	488.31 ± 30.10
14:0	34.66 ± 1.94
16:0	292.72 ± 9.18
16:1	14.48 ± 1.08
18:0	45.79 ± 2.15
18:1	10.99 ± 3.17
18:2	119.97 ± 7.72
18:3	85.06 ± 3.71
20:0	54.15 ± 1.97
Reference	Kannangara et al., 2007

Data are represented as mean ± SE (n = 3). (Prepared by Yonghua Li-Beisson)

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Table 17. Sphingolipid Composition of Arabidopsis Tissues

The sphingolipid content of Arabidopsis varies based on the method used to determine composition and the tissue from which the sphingolipids are extracted. Data are provided for the two main methods of analysis, hydrolysis and measurement of the long-chain base (LCB) component and liquid chromatography tandem mass spectrometry (LC-MS/MS) of the intact sphingolipids. All data are from Arabidopsis leaf tissue at 5–6 weeks of age. (Prepared by Jonathan E. Markham)

Table 17.1. Sphingolipid Composition Determined by LCB Analysis

	t18:1(8*Z*)	t18:1(8*E*)	t18:0	d18:1(8*Z*)	d18:1(8*E*)	d18:0	TOTAL
Total tissue	59.8 ± 2.9 22.8%	170.5 ± 9.0 65.1%	13.5 ± 0.9 5.2%	2.1 ± 0.3 0.8%	14.7 ± 1.9 5.6%	1.4 ± 0.2 0.5%	262.0 ± 14.3 100%
Neutral sphingolipids	13.0 ± 2.2 39.9%	8.2 ± 1.3 25%	0.8 ± 0.2 0.1%	1.5 ± 0.2 4.5%	8.6 ± 1.2 26.6%	0.3 ± 0.0 0.9%	32.6 ± 4.5 12.4%
Anionic sphingolipids	7.3 ± 2.1 8.7%	67.0 ± 19.3 80.4%	4.8 ± 0.9 5.9%	0.1 ± 0.0 0.1%	2.9 ± 0.4 3.6%	1.1 ± 0.4 1.3%	83.2 ± 23.0 31.8%
Ceramide	0.04 2.9%	0.68 49.3%	0.66 47.7%	0 0%	0 0%	0 0%	1.37 0.5%
Glucosylceramide	10.9 40.9%	8.8 32.9%	0.3 1.1%	0.5 2.0%	6.1 22.7%	0.1 0.4%	26.7 10.2%
GIPC	3.6 7.3%	36.5 72.8%	7.4 14.7%	0 0%	1.3 2.5%	1.3 2.7%	50.1 19.1%
Reference	Markham et al., 2006						

Sphingolipid composition of Arabidopsis determined by hydrolysis and analysis of LCBs as *o*-phthaldialdehyde derivatives as described in **Section I** (Markham et al., 2006). Table is given for Total tissue, the relative proportion of neutral and anioic sphingolipid, and individually purified compounds. Quantities are in nmol g fw^{-1} (n = 5; ±SD). GIPC = glycosylinositolphosphoryl-ceramide.

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Table 17.2. Sphingolipid Composition Determined by LC-MS/MS

Cer	c16:0	c18:0	c20:0	c20:1	c22:0	c22:1	c24:0	c24:1	c26:0	c26:1	Total
d18:0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
d18:1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	**0.4**
t18:0	0.4	0.0	0.0	0.0	0.1	0.0	0.8	0.5	0.4	0.1	**2.2**
t18:1	0.6	0.0	0.1	0.0	0.5	0.1	2.6	1.1	1.8	0.4	**7.3**
Total	**1.1**	**0.1**	**0.2**	**0.0**	**0.7**	**0.1**	**3.5**	**1.6**	**2.2**	**0.5**	**13.6**

hCer	h16:0	h18:0	h20:0	h20:1	h22:0	h22:1	h24:0	h24:1	h26:0	h26:1	Total
d18:0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.4**
d18:1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**
t18:0	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.2	0.0	0.0	**0.6**
t18:1	0.7	0.1	0.1	0.0	0.9	0.0	2.3	3.5	0.7	0.3	**8.6**
Total	**1.3**	**0.1**	**0.1**	**0.0**	**1.0**	**0.0**	**2.6**	**3.8**	**0.8**	**0.3**	**9.9**

GlcCer	h16:0	h18:0	h20:0	h20:1	h22:0	h22:1	h24:0	h24:1	h26:0	h26:1	Total
d18:0	1.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.3**
d18:1	52.0	0.2	0.2	0.0	1.1	0.1	2.1	5.8	0.2	0.6	**62.2**
t18:0	0.1	0.0	0.0	0.0	0.2	0.0	0.6	0.8	0.2	0.0	**1.9**
t18:1	28.0	0.0	1.8	0.0	13.0	0.5	32.6	58.1	10.3	5.3	**149.6**
Total	**81.2**	**0.2**	**2.1**	**0.1**	**14.3**	**0.6**	**35.3**	**64.7**	**10.6**	**5.9**	**214.9**

GIPC	h16:0	h18:0	h20:0	h20:1	h22:0	h22:1	h24:0	h24:1	h26:0	h26:1	Total
d18:0	2.3	0.0	0.0	0.0	1.5	0.1	0.5	0.8	0.1	1.7	**7.1**
d18:1	9.6	0.1	1.6	0.0	1.1	0.0	3.3	1.9	0.6	0.7	**19.0**
t18:0	1.1	0.1	0.4	0.0	2.4	0.2	8.9	13.4	1.3	0.3	**28.1**
t18:1	16.6	0.6	2.6	0.0	38.7	0.8	85.2	99.9	24.5	8.9	**277.7**
Total	**29.6**	**0.8**	**4.6**	**0.1**	**43.8**	**1.1**	**97.9**	**116.0**	**26.4**	**11.6**	**331.9**

Total	16:0	18:0	20:0	20:1	22:0	22:1	24:0	24:1	26:0	26:1	Total
d18:0	3.9	0.0	0.1	0.0	1.5	0.1	0.6	0.8	0.1	1.7	**8.8**
d18:1	61.9	0.4	1.9	0.0	2.3	0.1	5.5	7.8	0.8	1.3	**81.9**
t18:0	1.6	0.1	0.4	0.0	2.8	0.2	10.5	14.9	1.8	0.4	**32.8**
t18:1	45.8	0.7	4.5	0.1	53.2	1.4	122.7	162.6	37.2	15.0	**443.1**
Total	**113.1**	**1.1**	**6.9**	**0.1**	**59.8**	**1.8**	**139.3**	**186.1**	**40.0**	**18.4**	**570.4**

Free LCBs and LCB-Ps

d18:0	d18:1	d18:2	t18:0	t18:1	3-KS	d18:0-P	d18:1-P	d18:2-P	t18:0-P	t18:1-P
0.63	**0.06**	**0.02**	**1.57**	**0.62**	**0.00**	**0.00**	**0.02**	**0.01**	**0.07**	**0.14**

LC-MS/MS provides much more data about the sphingolipid LCB–fatty acid pairings, but it provides a lower value for the total sphingolipid composition. The reasons for this are discussed in Markham & Jaworski, 2007. Figures are in nmol g dw^{-1} (Dry weight is about 1/10th of fresh weight). Data are arranged by sphingolipid; Cer = Ceramide, hCer = 2-hydroxyceramide, GlcCer= Glucosylceramide, GIPC = glycosylinositolphosphoylceramide. The Total table is a sum of all the classes of sphingolipids and represents the total composition. Numbers for the amount of free LCBs and long-chain base-1-phosphates (LCB-Ps) are also provided.

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Table 18. Stereospecific Analysis of Arabidopsis Seed Triacylglycerols

Table 18.1. Occurrence of Fatty Acids at Each *sn*-Position

	16:0	18:0	18:1Δ9	18:1Δ11	18:2	18:3	20:0	20:1	20:2	22:0	22:1
TAG	8.3	3.4	15	1.2	28.6	18.5	2.1	19.8	1.2	0.3	1.6
sn-1	11.2	3.6	12.8	1.7	23.3	16.4	2.4	21.7	3.5	0.4	2.7
sn-2	6.4	3.6	17.4	0.9	44.3	22	0.9	3.3	0.5	0.4	0.4
sn-3	18.2	9.8	13.9	1	6	4.8	6.3	34.3	1.5	1.3	2.8

Table 18.2. Occurrence of Each Fatty Acid Across All Three *sn*-Positions

	16:0	18:0	18:1Δ9	18:1Δ11	18:2	18:3	20:0	20:1	20:2	22:0	22:1
sn-1	31.4	21.4	29.1	47.3	31.7	38.0	25.1	36.6	64.3	19.9	46.2
sn-2	17.8	20.9	39.4	24.4	60.1	50.8	9.4	5.6	8.3	19.4	7.0
sn-3	50.9	57.8	31.6	28.2	8.2	11.1	65.5	57.8	27.4	60.6	46.8

TAGs were isolated from mature *A. thaliana* (L.) Heynh. Columbia wild type seed and subjected to a Grignard-based stereospecific analysis. Table 18.1 shows the occurrence of all fatty acids at each *sn*-position. Table 18.2 shows the occurrence of each fatty acid across all three *sn*-positions. Values represent mol% of the total. (Prepared by Timothy P. Durrette; data from Taylor et al., 1995).

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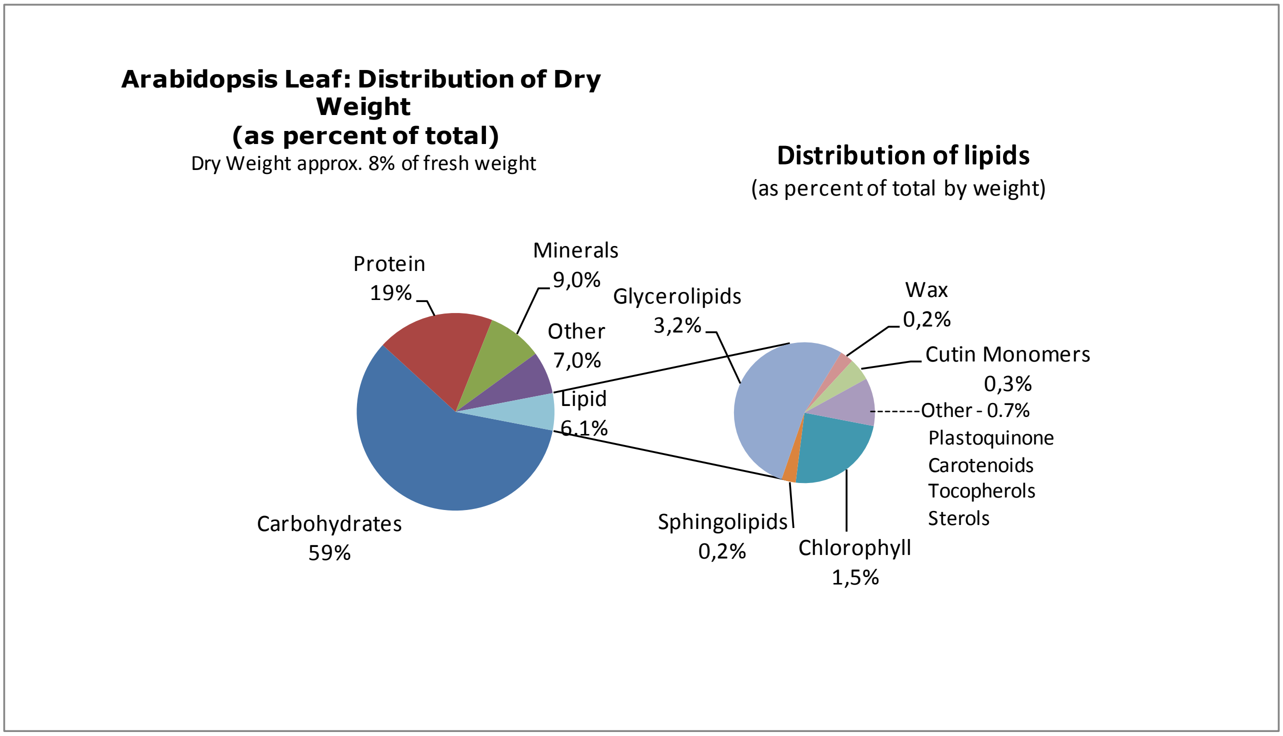

Figure 21. Relative Distribution of Lipids and Other Components of Arabidopsis Leaf.
Data adapted from Browse and Somerville (1994). (Prepared by John Ohlrogge)

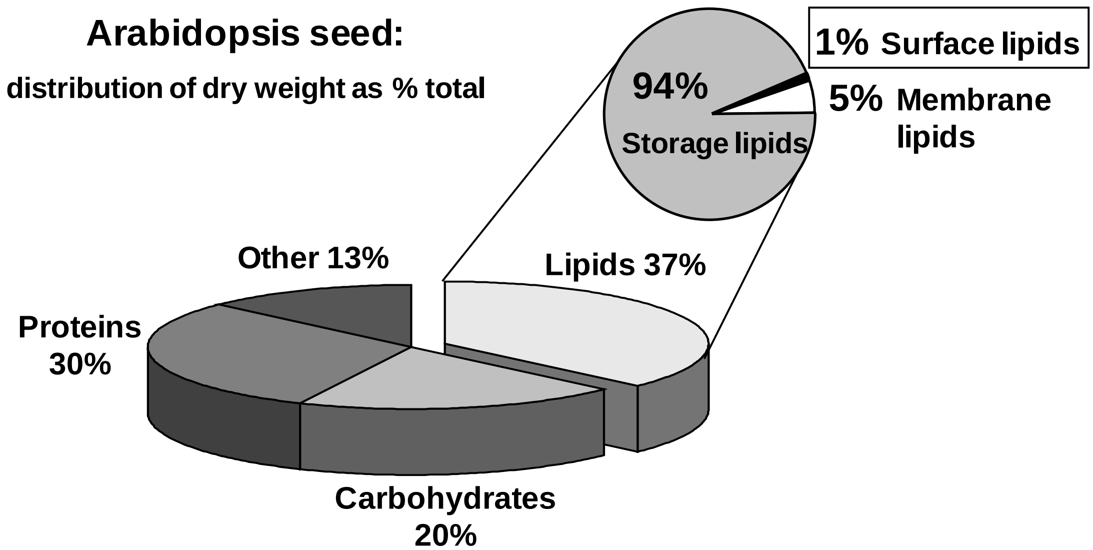

Figure 22. Relative Distribution of Lipids and Other Components of Arabidopsis Seeds.
Relative contribution of storage lipids and proteins were obtained from Y.H. Li et al., 2006. Percentage of membrane glycerolipids relative to total lipids is from Ohlrogge and Browse, 1995. Content of surface lipids is from Molina et al. (2006) and Beisson et al. (2007). (Prepared by Isabel Molina)

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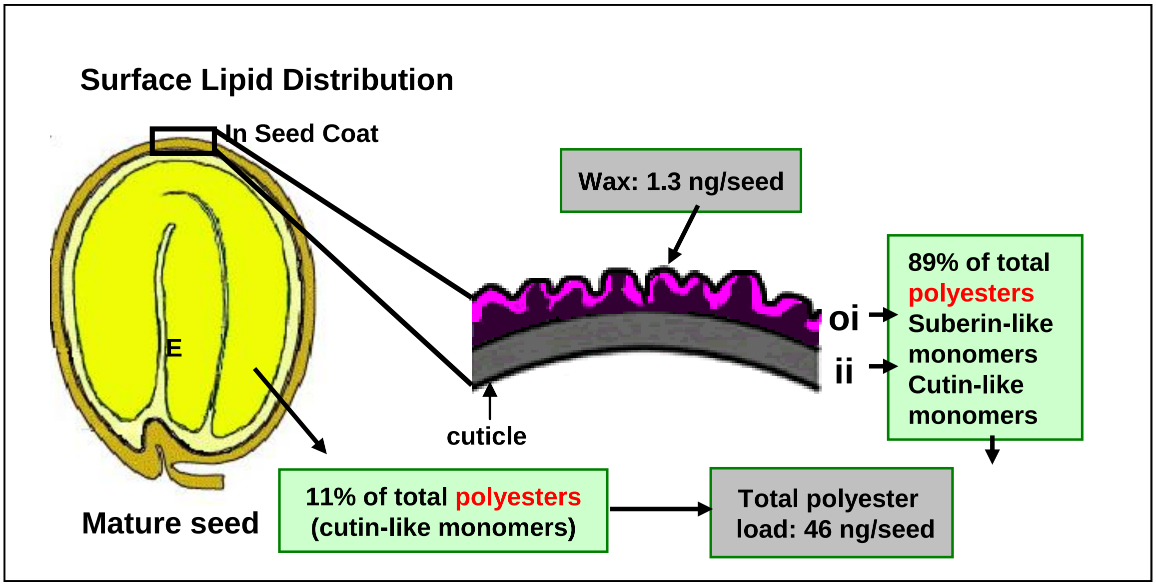

Figure 23. Distribution of Extracellular Lipids in Mature Seeds.
Values of total polyester monomers and distribution between seed coat and embryo (inferred from *B. napus* data) are from Molina et al. (2006). Distribution of polyester monomers in inner integument (ii) and outer integument (oi) summarize results from Molina et al. (2008). Surface wax load was reported by Beisson et al. (2007). (Prepared by Isabel Molina)