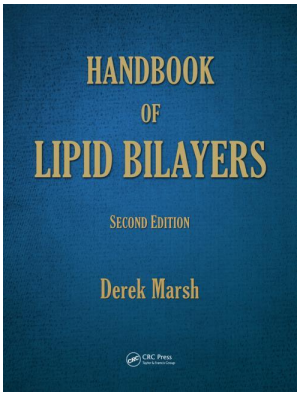

Handbook of Lipid Bilayers

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Fatty Acids

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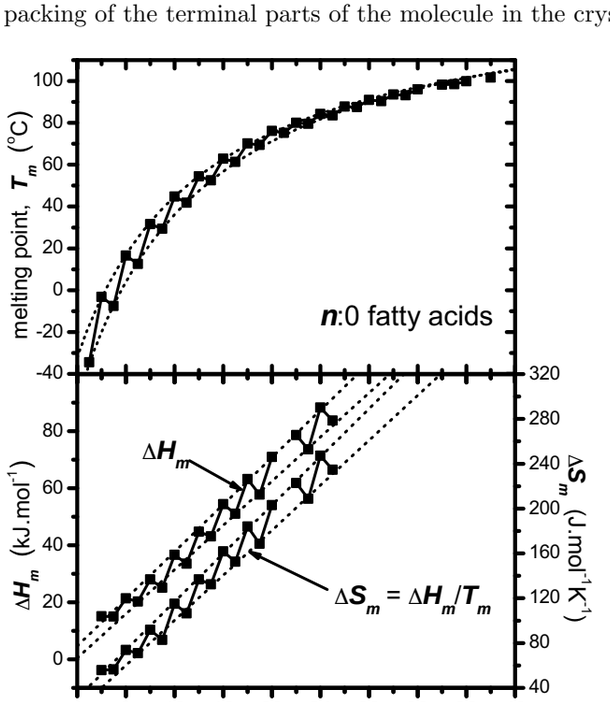
I.3 FATTY ACIDS

I.3.1 MELTING TEMPERATURES, ENTHALPIES, AND ENTROPIES

The melting points, T_m, and melting enthalpies, ΔH_m, of saturated fatty acids display an odd-even alternation that arises from differences in packing of the terminal parts of the molecule in the crystalline phase.



The melting enthalpies (and entropies, $\Delta S_m = \Delta H_m/T_m$) of normal saturated fatty acids increase linearly with chain length, n. The incremental values (ΔH_{inc} and ΔS_{inc}), per CH_2 group, are almost equal for odd and even chain lengths (4.1–4.3 kJ.mol^{-1}/CH_2), but the overall intercept, ΔH_o, is approximately 5 kJ.mol^{-1} greater for the even chain lengths than for the odd chain lengths.

INCREMENTAL MELTING ENTHALPIES AND ENTROPIES

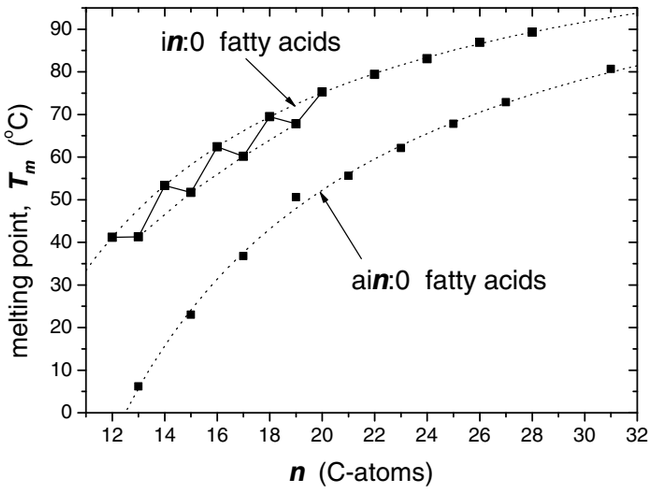
***n*:0 normal fatty acids**

chains	***n***	ΔH_{inc}/ **kJ.mol^{-1}/CH_2** **(kcal.mol^{-1}/CH_2)**	ΔH_o/ **kJ.mol^{-1}** **(kcal.mol^{-1})**	ΔS_{inc}/ **J.mol^{-1}.K^{-1}/CH_2** **(cal.mol^{-1}.K^{-1}/CH_2)**	ΔS_o/ **J.mol^{-1}.K^{-1}** **(cal.mol^{-1}.K^{-1})**
even	10–24	4.28±0.04 (1.02 ± 0.01)	−14.7±0.8 (−3.5 ± 0.2)	11.0±0.2 (2.63±0.04)	−16.5 ± 2.7 (−3.9 ± 0.6)
odd	11–25	4.09±0.08 (0.98±0.02)	−19.4±1.4 (−4.6 ± 0.3)	10.5±0.3 (2.51±0.006)	−29.5 ± 4.9 (−7.1 ± 1.2)

Note: $\Delta H_m = \Delta H_{inc} \times n + \Delta H_o$
$\Delta S_m = \Delta S_{inc} \times n + \Delta S_o$

Interestingly, the fatty acids of odd chain lengths undergo a crystalline polymorphic transition below the melting point with an enthalpy that is approximately equal to the difference in melting enthalpies of the odd and even chain lengths (6.0±1.2 kJ.mol^{-1}, n = 9 – 25, see, e.g., ref. [1]).

The melting temperatures of the normal saturated (n:0) fatty acids increase with increasing chain length for both odd and even n. This is seen also for the methylisobranched (in:0) and anteisobranched (ai$n$:0) fatty acids.



At long chain lengths, the melting points tend to a limiting value, when the end contributions to the melting enthalpy and entropy become a negligible fraction of the whole. The chain-length dependence, assuming a linear n-dependence of ΔH_m and ΔS_m is given by (see Section II.12.1 and ref. [2]):

$$T_m = T_m^{\infty}\left(1 - \frac{\Delta n}{n - n_s}\right)$$

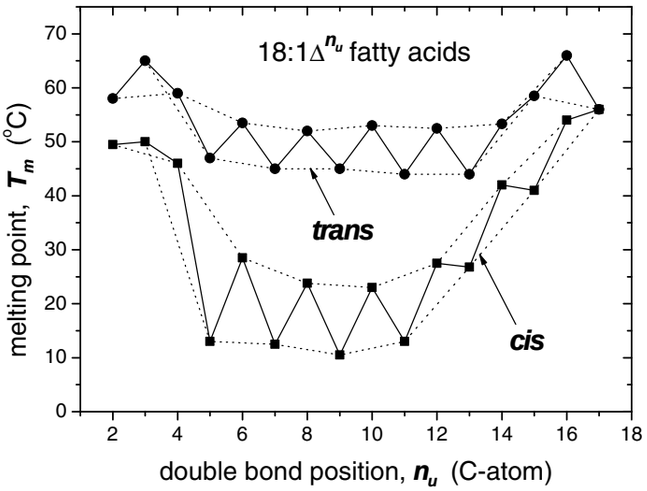
where T_m^{∞} is the melting temperature extrapolated to infinite chain length, n_s is the chain length at which the melting entropy extrapolates to zero and Δn is the increase in this quantity for the melting enthalpy.

CHAIN-LENGTH DEPENDENCE OF MELTING TEMPERATURES

n:0 normal, i*n*:0 isobranched and ai*n*:0 anteisobranched fatty acids

chains	n	T_m^{∞} (K)	Δn	n_s
n:0 even	6–38	418.6±2.0	4.45±0.17	−6.48±0.40
n:0 odd	5–35	424.4±2.2	4.97±0.18	−6.31±0.36
in:0 even	12–28	397.7±1.1	2.45±0.09	0.31±0.34
ai$n$:0 odd	13–31	398.3±8.2	3.29±0.60	2.03±1.55

The melting points of unsaturated fatty acids are lower than those of the saturated counterparts of equal chain length. The decrease is greater for *cis*-unsaturated than for *trans*-unsaturated fatty acids and depends on the position of the double bond:



Both this and the *odd-even* alternation with double-bond position, as well as the *cis-trans* differences, are again related to differences in packing of the unsaturated fatty acids in the crystalline state.

I.3.2 FORMULAE, MOLECULAR WEIGHTS, MELTING POINTS, AND CALORIMETRIC PROPERTIES

This list was originally adapted from a compilation in the CRC *Handbook of Biochemistry and Molecular Biology, Lipids, Carbohydrates, and Steroids*, 3rd ed. (Fasman, G. D., Ed.) and in Markley, K.S. (1964) *Biology Data Book*, pp. 370-380, which should be consulted for data on other physical and chemical characteristics of fatty acids. Data are now modified and extended from other sources.

I.3.2.1 SATURATED FATTY ACIDS

acid			chemical formula	molecular weight	(exact mass)	melting point (°C)	enthalpy, $\Delta H_m{}^a$		entropy, $\Delta S_m{}^a$	
symbol	systematic name	common name					(kJ.mol^{-1})	(kcal. mol^{-1})	(J.mol^{-1} K^{-1})	(cal.mol^{-1} K^{-1})
1:0	methanoic	formic	HCOOH	46.03	(46.005)	8.4	10.54	2.52	37.45	8.95
2:0	ethanoic	acetic	CH_3COOH	60.05	(60.021)	16.7	11.59	2.77	39.99	9.56
3:0	propanoic	propionic	C_2H_5COOH	74.08	(74.037)	−22	9.46	2.26	37.65	9.00
4:0	butanoic	butyric	C_3H_7COOH	88.11	(88.052)	−7.9	11.05	2.64	41.64	9.95
5:0	pentanoic	valeric	C_4H_9COOH	102.13	(102.068)	−34.5				
6:0	hexanoic	caproic	$C_5H_{11}COOH$	116.16	(116.084)	−3.4	15.06	3.60	55.84	13.35
7:0	heptanoic	heptylic	$C_6H_{13}COOH$	130.18	(130.099)	−10.5	14.98	3.58	57.03	13.63
8:0	octanoic	caprylic	$C_7H_{15}COOH$	144.21	(144.115)	16.7	21.38	5.11	73.76	17.63
9:0	nonanoic	pelargonic	$C_8H_{17}COOH$	158.24	(158.131)	12.5	20.29	4.85	71.04	16.98
10:0	decanoic	capric	$C_9H_{19}COOH$	172.26	(172.146)	31.6	28.03	6.70	91.99	21.99
11:0	undecanoic	undecylic	$C_{10}H_{21}COOH$	186.29	(186.162)	29.3	25.06	5.99	82.86	19.80
12:0	dodecanoic	lauric	$C_{11}H_{23}COOH$	200.32	(200.178)	44.2	36.61	8.75	115.36	27.57
13:0	tridecanoic	tridecylic	$C_{12}H_{25}COOH$	214.34	(214.193)	41.5	33.56	8.02	106.64	25.49
14:0	tetradecanoic	myristic	$C_{13}H_{27}COOH$	228.37	(228.209)	53.9	44.77	10.70	136.89	32.72
15:0	pentadecanoic	pentadecylic	$C_{14}H_{29}COOH$	242.40	(242.225)	52.3	43.10	10.30	132.42	31.65
16:0	hexadecanoic	palmitic	$C_{15}H_{31}COOH$	256.42	(256.240)	63.1	54.39	13.0	161.76	38.66
17:0	heptadecanoic	margaric	$C_{16}H_{33}COOH$	270.45	(270.256)	61.3	51.04	12.2	152.62	36.48
18:0	octadecanoic	stearic	$C_{17}H_{35}COOH$	284.48	(284.272)	69.6	63.18	15.1	184.33	44.06
19:0	nonadecanoic	nonadecylic	$C_{18}H_{37}COOH$	298.50	(298.287)	68.6	57.74	13.8	168.95	40.38
20:0	icosanoic	arachidic	$C_{19}H_{39}COOH$	312.53	(312.303)	75.4	70.92	16.95	203.47	48.63
21:0	henicosanoic	-	$C_{20}H_{41}COOH$	326.56	(326.318)	74.3				
22:0	docosanoic	behenic	$C_{21}H_{43}COOH$	340.58	(340.334)	80.0	78.66	18.8	222.74	53.24
23:0	tricosanoic	-	$C_{22}H_{45}COOH$	354.61	(354.350)	79.1	73.64	17.60	209.05	49.96
24:0	tetracosanoic	lignoceric	$C_{23}H_{47}COOH$	368.64	(368.365)	84.2	88.28	21.1	247.05	59.05
25:0	pentacosanoic		$C_{24}H_{49}COOH$	382.66	(382.381)	83.5	83.68	20.00	234.63	56.08
26:0	hexacosanoic	cerotic	$C_{25}H_{51}COOH$	396.69	(396.397)	88.5				
27:0	heptacosanoic	carboceric	$C_{26}H_{53}COOH$	410.72	(410.412)	87.7				
28:0	octacosanoic	montanic	$C_{27}H_{55}COOH$	424.74	(424.428)	90.9				
29:0	nonacosanoic	-	$C_{28}H_{57}COOH$	438.77	(438.444)	90.3				
30:0	triacontanoic	melissic	$C_{29}H_{59}COOH$	452.80	(452.459)	93.6				
31:0	hentriacontanoic	-	$C_{30}H_{61}COOH$	466.82	(466.475)	93.1				
32:0	dotriacontanoic	lacceric	$C_{31}H_{63}COOH$	480.85	(480.491)	96.2				
33:0	tritriacontanoic		$C_{32}H_{65}COOH$	494.88	(494.506)					
34:0	tetratriacontanoic	gheddic	$C_{33}H_{67}COOH$	508.90	(508.522)	98.4				
35:0	pentatriacontanoic	ceroplastic	$C_{34}H_{69}COOH$	522.93	(522.538)	98.4				
36:0	hexatriacontanoic	-	$C_{35}H_{71}COOH$	536.96	(536.553)	99.9				

[a] ΔH_m = melting enthalpy, ΔS_m = melting entropy. For sources of enthalpies, see refs. [3; 4].

I.3.2.2 MONOENOIC UNSATURATED FATTY ACIDS

acid			chemical formula	molecular weight	(exact mass)	melting point (°C)
symbol	**systematic name**	**common name**				
4:1tΔ^2	2*E*-butenoic	crotonic	$C_4H_6O_2$	86.09	(86.037)	72.0
4:1cΔ^2	2*Z*-butenoic	isocrotonic	$C_4H_6O_2$	86.09	(86.037)	14.5
5:1cΔ^2	2*Z*-pentenoic	β-ethylacrylic	$C_5H_8O_2$	100.12	(100.052)	8
5:1Δ^4	4*Z*-pentenoic	allylacetic	$C_5H_8O_2$	100.12	(100.052)	−18
6:1cΔ^2	2*Z*-hexenoic	isohydrosorbic	$C_6H_{10}O_2$	114.14	(114.068)	32
6:1cΔ^3	3*Z*-hexenoic	hydrosorbic	$C_6H_{10}O_2$	114.14	(114.068)	12
6:1cΔ^4	4*Z*-hexenoic	γ-hexenoic	$C_6H_{10}O_2$	114.14	(114.068)	10
7:1cΔ^3	3*Z*-heptenoic	β-heptenoic	$C_7H_{12}O_2$	128.17	(128.084)	−12
7:1Δ^6	6*Z*-heptenoic	ε-heptenoic	$C_7H_{12}O_2$	128.17	(128.084)	−6.5
8:1cΔ^3	3Z-octenoic	*cis*-β-octenoic	$C_8H_{14}O_2$	142.20	(142.099)	−25
8:1tΔ^3	3*E*-octenoic	*trans*-β-octenoic	$C_8H_{14}O_2$	142.20	(142.099)	1
8:1cΔ^4	4*Z*-octenoic	γ-octenoic	$C_8H_{14}O_2$	142.20	(142.099)	−35
8:1cΔ^6	6*Z*-octenoic	*cis*-ε-octenoic	$C_8H_{14}O_2$	142.20	(142.099)	−17
8:1tΔ^6	6*E*-octenoic	*trans*-ε-octenoic	$C_8H_{14}O_2$	142.20	(142.099)	6
9:1cΔ^2	2*Z*-nonenoic	α-nonylenic	$C_9H_{16}O_2$	156.22	(156.115)	4
9:1cΔ^8	8*Z*-nonenoic	8-nonylenic	$C_9H_{16}O_2$	156.22	(156.115)	5
10:1cΔ^2	2*Z*-decenoic	2-decylenic	$C_{10}H_{18}O_2$	170.25	(170.131)	12
10:1cΔ^3	3*Z*-decenoic	3-decylenic	$C_{10}H_{18}O_2$	170.25	(170.131)	18
10:1cΔ^4	4*Z*-decenoic	obtusilic	$C_{10}H_{18}O_2$	170.25	(170.131)	-
10:1Δ^9	9*Z*-decenoic	caproleic	$C_{10}H_{18}O_2$	170.25	(170.131)	26.5
11:1cΔ^9	9*Z*-undecenoic	9-undecylenic	$C_{11}H_{20}O_2$	184.28	(184.146)	11.4
11:1Δ^{10}	10*Z*-undecenoic	10-undecylenic	$C_{11}H_{20}O_2$	184.28	(184.146)	24.5
12:1cΔ^2	2*Z*-dodecenoic	2-lauroleic	$C_{12}H_{22}O_2$	198.30	(198.162)	17
12:1cΔ^4	4*Z*-dodecenoic	linderic	$C_{12}H_{22}O_2$	198.30	(198.162)	1.0–1.3
12:1cΔ^5	5*Z*-dodecenoic	denticetic	$C_{12}H_{22}O_2$	198.30	(198.162)	-
12:1cΔ^9	9*Z*-dodecenoic	lauroleic	$C_{12}H_{22}O_2$	198.30	(198.162)	-
12:1cΔ^{10}	10*Z*-dodecenoic	-	$C_{12}H_{22}O_2$	198.30	(198.162)	18
12:1Δ^{11}	11*Z*-dodecenoic	-	$C_{12}H_{22}O_2$	198.30	(198.162)	20
13:1cΔ^2	2*Z*-tridecenoic	-	$C_{13}H_{24}O_2$	212.33	(212.178)	38–39
13:1cΔ^{11}	11*Z*-tridecenoic	-	$C_{13}H_{24}O_2$	212.33	(212.178)	28–29
13:1Δ^{12}	12*Z*-tridecenoic	-	$C_{13}H_{24}O_2$	212.33	(212.178)	38–39
14:1cΔ^2	2*Z*-tetradecenoic		$C_{14}H_{26}O_2$	226.36	(226.193)	33; 50–53
14:1cΔ^4	4*Z*-tetradecenoic	tsuzuic	$C_{14}H_{26}O_2$	226.36	(226.193)	18.0–18.5
14:1cΔ^5	5*Z*-tetradecenoic	physeteric	$C_{14}H_{26}O_2$	226.36	(226.193)	20
14:1cΔ^9	9*Z*-tetradecenoic	myristoleic	$C_{14}H_{26}O_2$	226.36	(226.193)	−4.5
15:1cΔ^2	2*Z*-pentadecenoic	-	$C_{15}H_{28}O_2$	240.38	(240.209)	4.5
16:1cΔ^2	2*Z*-hexadecenoic	gaidic	$C_{16}H_{30}O_2$	254.41	(254.225)	40.5–41.7
16:1tΔ^2	2*E*-hexadecenoic	-	$C_{16}H_{30}O_2$	254.41	(254.225)	46.5–47.6
16:1tΔ^3	3*E*-hexadecenoic	-	$C_{16}H_{30}O_2$	254.41	(254.225)	53–54
16:1cΔ^7	7*Z*-hexadecenoic	-	$C_{16}H_{30}O_2$	254.41	(254.225)	32–33(α); 40–41(β)
16:1cΔ^9	9*Z*-hexadecenoic	palmitoleic	$C_{16}H_{30}O_2$	254.41	(254.225)	−0.5 to +0.5
16:1tΔ^9	9*E*-hexadecenoic	palmitelaidic	$C_{16}H_{30}O_2$	254.41	(254.225)	32–33
16:1cΔ^{10}	10*Z*-hexadecenoic		$C_{16}H_{30}O_2$	254.41	(254.225)	15–16
17:1cΔ^2	2*Z*-heptadecenoic		$C_{17}H_{32}O_2$	268.43	(268.240)	51.8–53.7
17:1tΔ^2	2*E*-heptadecenoic		$C_{17}H_{32}O_2$	268.43	(268.240)	56.6–58.5
17:1cΔ^7	7*Z*-heptadecenoic		$C_{17}H_{32}O_2$	268.43	(268.240)	3.5–4.5
17:1cΔ^8	8*Z*-heptadecenoic		$C_{17}H_{32}O_2$	268.43	(268.240)	5.5–7

acid			chemical formula	molecular weight	(exact mass)	melting point (°C)
symbol	**systematic name**	**common name**				
17:1cΔ^{9}	9*Z*-heptadecenoic		$C_{17}H_{32}O_2$	268.43	(268.240)	11.4–12.2
17:1tΔ^{9}	9*E*-heptadecenoic		$C_{17}H_{32}O_2$	268.43	(268.240)	38
17:1Δ^{16}	16*Z*-heptadecenoic		$C_{17}H_{32}O_2$	268.43	(268.240)	52–54
18:1cΔ^{2}	2*Z*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	50.5
18:1tΔ^{2}	2*E*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	58.5
18:1cΔ^{3}	3*Z*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	49.5–50.5
18:1tΔ^{3}	3*E*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	64.5–65.5
18:1cΔ^{4}	4*Z*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	45.5–46.5
18:1tΔ^{4}	4*E*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	58.5–59.5
18:1cΔ^{5}	5*Z*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	12.5–13.5
18:1tΔ^{5}	5*E*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	(43–44); 47.5
18:1cΔ^{6}	6*Z*-octadecenoic	petroselinic	$C_{18}H_{34}O_2$	282.46	(282.256)	32–33
18:1tΔ^{6}	6*E*-octadecenoic	petroselaidic	$C_{18}H_{34}O_2$	282.46	(282.256)	52.7–53.4; 54–59
18:1cΔ^{7}	7*Z*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	12.5–13.1
18:1tΔ^{7}	7*E*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	44.2–44.5
18:1cΔ^{9}	9*Z*-octadecenoic	oleic	$C_{18}H_{34}O_2$	282.46	(282.256)	13.4(α), 16.3(β)
18:1tΔ^{9}	9*E*-octadecenoic	elaidic	$C_{18}H_{34}O_2$	282.46	(282.256)	44.5–46.5
18:1cΔ^{10}	10*Z*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	22.2–22.8
18:1tΔ^{10}	10*E*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	52–52.6
18:1cΔ^{11}	11*Z*-octadecenoic	asclepic	$C_{18}H_{34}O_2$	282.46	(282.256)	14.5–15.5
18:1tΔ^{11}	11*E*-octadecenoic	vaccenic	$C_{18}H_{34}O_2$	282.46	(282.256)	44
18:1cΔ^{12}	12*Z*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	26.5–27.5
18:1tΔ^{12}	12*E*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	39.7–40.1
18:1cΔ^{13}	13*Z*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	26.5–27
18:1tΔ^{13}	13*E*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	43.5–44.5
18:1cΔ^{15}	15*Z*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	41–42
18:1tΔ^{15}	15*E*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	59; 61–65
18:1cΔ^{16}	16*Z*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	54
18:1tΔ^{16}	16*E*-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	65.6–66.2
18:1Δ^{17}	17-octadecenoic		$C_{18}H_{34}O_2$	282.46	(282.256)	55–55.5
19:1Δ^{2}	2-nonadecenoic		$C_{19}H_{36}O_2$	296.49	(296.272)	66.5
20:1cΔ^{5}	5*Z*-icosenoic		$C_{20}H_{38}O_2$	310.51	(310.287)	26–27
20:1tΔ^{5}	5*E*-icosenoic		$C_{20}H_{38}O_2$	310.51	(310.287)	52.5–54
20:1cΔ^{9}	9*Z*-icosenoic	gadoleic	$C_{20}H_{38}O_2$	310.51	(310.287)	24–24.5
20:1tΔ^{9}	9*E*-icosenoic	gadelaidic	$C_{20}H_{38}O_2$	310.51	(310.287)	54
20:1cΔ^{11}	11*Z*-icosenoic	gondoic	$C_{20}H_{38}O_2$	310.51	(310.287)	23.5–24
20:1tΔ^{11}	11*E*-icosenoic		$C_{20}H_{38}O_2$	310.51	(310.287)	52–53
20:1cΔ^{14}	14*Z*-icosenoic		$C_{20}H_{38}O_2$	310.51	(310.287)	42.5
20:1cΔ^{17}	17*Z*-icosenoic		$C_{20}H_{38}O_2$	310.51	(310.287)	50–51
22:1cΔ^{11}	11*Z*-docosenoic	cetoleic	$C_{22}H_{42}O_2$	338.57	(338.318)	32.5–33
22:1cΔ^{13}	13*Z*-docosenoic	erucic	$C_{22}H_{42}O_2$	338.57	(338.318)	34.7
22:1tΔ^{13}	13*E*-docosenoic	brassidic	$C_{22}H_{42}O_2$	338.57	(338.318)	61.9
22:1cΔ^{19}	19*Z*-docosenoic		$C_{22}H_{42}O_2$	338.57	(338.318)	60–62
24:1cΔ^{15}	15*Z*-tetracosenoic	nervonic	$C_{24}H_{46}O_2$	366.62	(366.350)	42.5–43.0
24:1tΔ^{15}	15*E*-tetracosenoic		$C_{24}H_{46}O_2$	366.62	(366.350)	66–67; (65.5)
26:1cΔ^{17}	17*Z*-hexacosenoic	ximenic	$C_{26}H_{50}O_2$	394.67	(394.381)	50.5–50.9
28:1cΔ^{19}	19*Z*-octacosenoic		$C_{28}H_{54}O_2$	422.73	(422.412)	57.8–58.2
30:1cΔ^{21}	21*Z*-triacontenoic	lumequeic	$C_{30}H_{58}O_2$	450.78	(450.444)	60.8–61.2

I.3.2.3 DIENOIC UNSATURATED FATTY ACIDS

acid			chemical formula	molecular weight	(exact mass)	melting point (°C)
symbol	systematic name	common name				
5:2cΔ^{2,4}	2*Z*,4*Z*-pentadienoic	*β*-vinylacrylic	$C_5H_6O_2$	98.10	(98.037)	80
6:2cΔ^{2,4}	2*Z*,4*Z*-hexadienoic	sorbic	$C_6H_8O_2$	112.13	(112.052)	134.5
10:2tcΔ^{2,4}	2*E*,4*Z*-decadienoic	stillingic	$C_{10}H_{16}O_2$	168.23	(168.115)	-
10:2ttΔ^{2,4}	2*E*,4*E*-decadienoic		$C_{10}H_{16}O_2$	168.23	(168.115)	49–50
10:2tΔ^{2,6}	2*E*,6*E*-decadienoic		$C_{10}H_{16}O_2$	168.23	(168.115)	42–43
10:2tΔ^{4,6}	4*E*,6*E*-decadienoic		$C_{10}H_{16}O_2$	168.23	(168.115)	39
12:2tΔ^{2,4}	2*E*,4*E*-dodecadienoic		$C_{12}H_{20}O_2$	196.29	(196.146)	49–51
12:2tΔ^{2,8}	2*E*,8*E*-dodecadienoic		$C_{12}H_{20}O_2$	196.29	(196.146)	35
16:2tΔ^{3,9}	3*E*,9*E*-hexadecadienoic		$C_{16}H_{28}O_2$	252.39	(252.209)	20–22
16:2cΔ^{9,12}	9*Z*,12*Z*-hexadecadienoic		$C_{16}H_{28}O_2$	252.39	(252.209)	-
18:2cΔ^{2,5}	2*Z*,5*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	34–36
18:2cΔ^{3,6}	3*Z*,6*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	22–23
18:2cΔ^{4,7}	4*Z*,7*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	11–12
18:2cΔ^{5,8}	5*Z*,8*Z*-octadecadienoic	sebaleic	$C_{18}H_{32}O_2$	280.45	(280.240)	−8
18:2cΔ^{5,12}	5*Z*,12*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	−30
18:2tΔ^{5,12}	5*E*,12*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	16–19; 26.5–27
18:2tcΔ^{5,12}	5*E*,12*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	−12
18:2ctΔ^{5,12}	5*Z*,12*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	−4
18:2tΔ^{6,8}	6*E*,8*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	52–52.5
18:2cΔ^{6,9}	6*Z*,9*Z*-octadecadienoic	petroslinoleic	$C_{18}H_{32}O_2$	280.45	(280.240)	−11.5
18:2tΔ^{6,9}	6*E*,9*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	14–16
18:2tΔ^{6,10}	6*E*,10*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	40.5–41
18:2tΔ^{6,11}	6*E*,11*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	27–27.5
18:2tΔ^{6,12}	6*E*,12*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	37–37.5
18:2cΔ^{7,10}	7*Z*,10*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	−15
18:2tΔ^{7,12}	7*E*,12*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	26.5–27
18:2tΔ^{8,10}	8*E*,10*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	56–56.5
18:2cΔ^{8,11}	8*Z*,11*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	−16(−12.5 to −19.5)
18:2tΔ^{8,12}	8*E*,12*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	38.5–39
18:2cΔ^{9,11}	9*Z*,11*Z*-octadecadienoic	ricinenic	$C_{18}H_{32}O_2$	280.45	(280.240)	42–43.2
18:2tΔ^{9,11}	9*E*,11*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	54
18:2ctΔ^{9,11}	9*Z*,11*E*-octadecadienoic	rumenic	$C_{18}H_{32}O_2$	280.45	(280.240)	20
18:2cΔ^{9,12}	9*Z*,12*Z*-octadecadienoic	*α*-linoleic	$C_{18}H_{32}O_2$	280.45	(280.240)	−5.2 to −5.0
18:2tΔ^{9,12}	9*E*,12*E*-octadecadienoic	linolelaidic	$C_{18}H_{32}O_2$	280.45	(280.240)	28–29
18:2ctΔ^{9,12}	9*Z*,12*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	1
18:2tcΔ^{9,12}	9*E*,12*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	1
18:2cΔ^{10,12}	10*Z*,12*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	38–39
18:2tΔ^{10,12}	10*E*,12*E*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	55.5–56
18:2tcΔ^{10,12}	10*E*,12*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	22–23
18:2cΔ^{10,13}	10*Z*,13*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	−10.5
18:2cΔ^{11,14}	11*Z*,14*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	4.5–5.5
18:2cΔ^{11,15}	11*Z*,15*Z*-octadecadienoic		$C_{18}H_{32}O_2$	280.45	(280.240)	11

acid			chemical formula	molecular weight	(exact mass)	melting point (°C)
symbol	systematic name	common name				
18:2c$\Delta^{12,15}$	12Z,15Z-octadecadienoic	-	$C_{18}H_{32}O_2$	280.45	(280.240)	18–18.5
18:2c$\Delta^{13,16}$	13Z,16Z-octadecadienoic	-	$C_{18}H_{32}O_2$	280.45	(280.240)	20.5–21.5
18:2c$\Delta^{14,17}$	14Z,17Z-octadecadienoic	-	$C_{18}H_{32}O_2$	280.45	(280.240)	37–37.5
20:2c$\Delta^{11,14}$	11Z,14Z-icosadienoic	-	$C_{20}H_{36}O_2$	308.50	(308.272)	-
22:2c$\Delta^{5,13}$	5Z,13Z-docosadienoic	-	$C_{22}H_{40}O_2$	336.55	(336.303)	−4
22:2c$\Delta^{13,16}$	13Z,16Z-docosadienoic	-	$C_{22}H_{40}O_2$	336.55	(336.303)	-
26:2c$\Delta^{17,20}$	17Z,20Z-hexacosadienoic	-	$C_{26}H_{48}O_2$	392.66	(392.365)	61

I.3.2.4 TRIENOIC UNSATURATED FATTY ACIDS

acid			chemical formula	molecular weight	(exact mass)	melting point (°C)
symbol	systematic name	common name				
16:3c$\Delta^{6,10,14}$	6Z,10Z,14Z-hexadecatrienoic	hiragonic	$C_{16}H_{26}O_2$	250.38	(250.193)	-
18:3tcc$\Delta^{3,9,12}$	3E,9Z,12Z-octadecatrienoic		$C_{18}H_{30}O_2$	278.43	(278.225)	61–61.5
18:3c$\Delta^{6,9,12}$	6Z,9Z,12Z-octadecatrienoic	γ-linolenic	$C_{18}H_{30}O_2$	278.43	(278.225)	-
18:3ttc$\Delta^{8,10,12}$	8E,10E,12Z-octadecatrienoic	α-calendic	$C_{18}H_{30}O_2$	278.43	(278.225)	40–40.5
18:3t$\Delta^{8,10,12}$	8E,10E,12E-octadecatrienoic	β-calendic	$C_{18}H_{30}O_2$	278.43	(278.225)	77–78
18:3ctc$\Delta^{8,10,12}$	8Z,10E,12Z-octadecatrienoic	jacaric	$C_{18}H_{30}O_2$	278.43	(278.225)	43.5–44
18:3c$\Delta^{9,12,15}$	9Z,12Z,15Z-octadecatrienoic	α-linolenic	$C_{18}H_{30}O_2$	278.43	(278.225)	−11 to −11.3
18:3t$\Delta^{9,12,15}$	9E,12E,15E-octadecatrienoic	linolenelaidic	$C_{18}H_{30}O_2$	278.43	(278.225)	29–30
18:3ctt$\Delta^{9,11,13}$	9Z,11E,13E-octadecatrienoic	α-eleostearic	$C_{18}H_{30}O_2$	278.43	(278.225)	48–49
18:3t$\Delta^{9,11,13}$	9E,11E,13E-octadecatrienoic	β-eleostearic	$C_{18}H_{30}O_2$	278.43	(278.225)	71.5
18:3ctc$\Delta^{9,11,13}$	9Z,11E,13Z-octadecatrienoic	punicic	$C_{18}H_{30}O_2$	278.43	(278.225)	43.5–44
18:3ttc$\Delta^{9,11,13}$	9E,11E,13Z-octadecatrienoic	catalpic	$C_{18}H_{30}O_2$	278.43	(278.225)	31.5–32
18:3cct$\Delta^{9,11,13}$	9Z,11Z,13E-octadecatrienoic		$C_{18}H_{30}O_2$	278.43	(278.225)	61.5–62.5
18:3t$\Delta^{10,12,14}$	10E,12E,14E-octadecatrienoic	pseudoeleostearic	$C_{18}H_{30}O_2$	278.43	(278.225)	77–77.5
20:3ctc$\Delta^{8,12,14}$	8Z,12E,14Z-icosatrienoic		$C_{20}H_{34}O_2$	306.48	(306.256)	8

I.3.2.5 TETRAENOIC UNSATURATED FATTY ACIDS

acid			chemical formula	molecular weight	(exact mass)	melting point (°C)
symbol	**systematic name**	**common name**				
16:4c$\Delta^{6,9,12,15}$	6*Z*,9*Z*,12*Z*,15*Z*-hexadecatetraenoic		$C_{16}H_{24}O_2$	248.36	(248.178)	-
18:4tcct$\Delta^{3,9,12,15}$	3*E*,9*Z*,12*Z*,15*E*-octadecatetraenoic		$C_{18}H_{28}O_2$	276.41	(276.209)	−30
18:4c$\Delta^{4,8,12,15}$	4*Z*,8*Z*,12*Z*,15*Z*-octadecatetraenoic	morotic	$C_{18}H_{28}O_2$	276.41	(276.209)	-
18:4c$\Delta^{6,9,12,15}$	6*Z*,9*Z*,12*Z*,15*Z*-octadecatetraenoic	stearidonic	$C_{18}H_{28}O_2$	276.41	(276.209)	−57.4 to −56.6
18:4cttc$\Delta^{9,11,13,15}$	9*Z*,11*E*,13*E*,15*Z*-octadecatetraenoic	α-parinaric	$C_{18}H_{28}O_2$	276.41	(276.209)	85–86
18:4t$\Delta^{9,11,13,15}$	9*E*,11*E*,13*E*,15*E*-octadecatetraenoic	β-parinaric	$C_{18}H_{28}O_2$	276.41	(276.209)	95–96
20:4c$\Delta^{5,8,11,14}$	5*Z*,8*Z*,11*Z*,14*Z*-icosatetraenoic	arachidonic	$C_{20}H_{32}O_2$	304.47	(304.240)	−49.5
22:4c$\Delta^{7,10,13,16}$	7*Z*,10*Z*,13*Z*,16*Z*-docosatetraenoic	adrenic	$C_{22}H_{36}O_2$	332.52	(332.272)	-

I.3.2.6 PENTAENOIC AND HEXAENOIC UNSATURATED FATTY ACIDS

acid			chemical formula	molecular weight	(exact mass)	melting point (°C)
symbol	**systematic name**	**common name**				
20:5c$\Delta^{5,8,11,14,17}$	5*Z*,8*Z*,11*Z*,14*Z*,17*Z*-icosapentaenoic	timnodonic	$C_{20}H_{30}O_2$	302.45	(302.225)	−54.4 to −53.8
22:5c$\Delta^{4,8,12,15,19}$	4*Z*,8*Z*,12*Z*,15*Z*,19*Z*-docosapentaenoic		$C_{22}H_{34}O_2$	330.50	(330.256)	−78
22:6c$\Delta^{4,7,10,13,16,19}$	4*Z*,7*Z*,10*Z*,13*Z*,16*Z*,19*Z*-docosahexaenoic	clupanodonic	$C_{22}H_{32}O_2$	328.49	(328.240)	−44.5 to −44.1
24:6c$\Delta^{4,8,12,15,18,21}$	4*Z*,8*Z*,12*Z*,15*Z*,18*Z*,21*Z*-tetracosahexaenoic	nisinic	$C_{24}H_{36}O_2$	356.54	(356.272)	-

I.3.2.7 BRANCHED-CHAIN FATTY ACIDS

acid			chemical formula	molecular weight	(exact mass)	melting point (°C)
symbol	systematic name	common name				
i5:0	3-methylbutanoic	isovaleric	$C_5H_{10}O_2$	102.13	(102.068)	−37.6
i8:0	6-methylheptanoic	isocaprylic	$C_8H_{16}O_2$	144.21	(144.115)	0
ai9:0	*d*-6-methyloctanoic	-	$C_9H_{18}O_2$	158.24	(158.131)	-
i9:0	7-methyloctanoic		$C_9H_{18}O_2$	158.24	(158.131)	−18.5
ai11:0	8-methyldecanoic	-	$C_{11}H_{22}O_2$	186.29	(186.162)	−18.5
i12:0	10-methylundecanoic	isolauric	$C_{12}H_{24}O_2$	200.32	(200.178)	41.2
ai13:0	*d*-10-methyldodecanoic	-	$C_{13}H_{26}O_2$	214.34	(214.193)	6.2–6.5
i13:0	11-methyldodecanoic	isoundecylic	$C_{13}H_{26}O_2$	214.34	(214.193)	39.4–40
i14:0	12-methyltridecanoic	isomyristic	$C_{14}H_{28}O_2$	228.37	(228.209)	53.6
ai15:0	*d*-12-methyltetradecanoic	-	$C_{15}H_{30}O_2$	242.40	(242.225)	25.8
i15:0	13-methyltetradecanoic	isopentadecylic	$C_{15}H_{30}O_2$	242.40	(242.225)	52.2
i16:0	14-methylpentadecanoic	isopalmitic	$C_{16}H_{32}O_2$	256.42	(256.240)	62.4
ai17:0	*d*-14-methylhexadecanoic	-	$C_{17}H_{34}O_2$	270.45	(270.256)	38.0
i17:0	15-methylhexadecanoic	-	$C_{17}H_{34}O_2$	270.45	(270.256)	60.5
-	10-methylheptadecanoic	-	$C_{18}H_{36}O_2$	284.48	(284.272)	33.5
i18:0	16-methylheptadecanoic	isostearic	$C_{18}H_{36}O_2$	284.48	(284.272)	69.5
-	*l*-D-10-methyloctadecanoic	tuberculostearic	$C_{19}H_{38}O_2$	298.50	(298.287)	13.2
ai19:0	*d*-16-methyloctadecanoic	-	$C_{19}H_{38}O_2$	298.50	(298.287)	49.9–50.7
i19:0	17-methyloctadecanoic		$C_{19}H_{38}O_2$	298.50	(298.287)	67.3–67.8
i20:0	18-methylnonadecanoic	isoarachidic	$C_{20}H_{40}O_2$	312.53	(312.303)	75.3
ai21:0	*d*-18-methylicosanoic	-	$C_{21}H_{42}O_2$	326.56	(326.318)	55.6
i22:0	20-methylhenicosanoic	isobehenic	$C_{22}H_{44}O_2$	340.58	(340.334)	79.5
ai23:0	*d*-20-methyldocosanoic	-	$C_{23}H_{46}O_2$	354.61	(354.350)	62.1
i23:0	21-methyldocosanoic		$C_{23}H_{46}O_2$	354.61	(354.350)	73.5
i24:0	22-methyltricosanoic	isolignoceric	$C_{24}H_{48}O_2$	368.64	(368.365)	83.1
ai25:0	*d*-22-methyltetracosanoic	-	$C_{25}H_{50}O_2$	382.66	(382.381)	67.8
i25:0	23-methyltetracosanoic		$C_{25}H_{50}O_2$	382.66	(382.381)	82.4–82.6
i26:0	24-methylpentacosanoic	isocerotic	$C_{26}H_{52}O_2$	396.69	(396.397)	86.9
ai27:0	*d*-24-methylhexacosanoic	-	$C_{27}H_{54}O_2$	410.72	(410.412)	72.9
i28:0	26-methylheptacosanoic	isomontanic	$C_{28}H_{56}O_2$	424.74	(424.428)	89.3
ai31:0	*d*-28-methyltriacontanoic	-	$C_{31}H_{62}O_2$	466.82	(466.475)	80.7
-	2,4,6-(D)-trimethyloctacosanoic	mycoceranic (mycocerosic)	$C_{31}H_{62}O_2$	466.82	(466.475)	27–28
i5:1cΔ^2	2-methyl-2*Z*-butenoic	angelic	$C_5H_8O_2$	100.12	(100.052)	45
i5:1tΔ^2	2-methyl-2*E*-butenoic	tiglic	$C_5H_8O_2$	100.12	(100.052)	65.5
i6:1cΔ^3	4-methyl-3-pentenoic	pyroterebic	$C_6H_{10}O_2$	114.14	(114.068)	-
-	*d*-2,4(L),6(L)-trimethyl-*trans*-2-tetracosenoic	C_{27}phthienoic (mycolipenic)	$C_{27}H_{52}O_2$	408.70	(408.397)	39.5–41

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