

**ANSC/NUTR 618**  
**LIPIDS & LIPID METABOLISM**  
**Triacylglycerol Composition**

## I. Triacylglycerol composition and structure

### A. Dietary lipids

#### 1. Animal lipids

- a. Typically higher in saturated fatty acids than plant oils.
- b. Composition is influenced by the combination of endogenous synthesis and dietary fatty acids.

Table 3.1 The fatty acid composition of some animal storage fats\* (g per 100 g total fatty acids)

	4:0- 12:0	14:0	16:0	16:1	18:0	18:1	18:2 <i>n</i> -6	20:1+ 22:1	20:5 <i>n</i> -3	22:6 <i>n</i> -3	total
<i>Adipose tissue</i>											
Cow		3	26	9	8	45	2				93
Human (1)		2	19	7	3	48	13				92
Human (2)		2	20	4	5	39	24				94
Lamb		3	21	4	20	41	5				94
Pig (1)		1	29	3	14	43	9				99
Pig (2)		1	21	3	12	46	16				99
Poultry		1	27	9	7	45	11				94
<i>Milk</i>											
Cow	10	12	26	3	11	29	2				93
Goat	20	11	26	3	10	26	2				98
<i>Egg yolk</i>											
Hen			29	4	9	43	11				96
<i>Fish oils</i>											
Cod (liver)		6	8	10	3	17	3	25	10	11	93
Mackerel (flesh)		8	16	9	2	13	1	26	8	8	91
Herring (flesh)		9	15	8	1	17	1	39	3	3	96
Sardine (flesh)		8	18	10	1	13	1	7	18	9	85

Fatty acid composition of Atlantic salmon, ground beef, and bovine and human plasma (g per 100 g total fatty acids)

	14:0	16:0	16:1	18:0	18:1	18:2	18:3	20:5	22:6	18:1-trans
Atlantic salmon	3.2	14	5	3	22	1	0.7	4.5	12.2	--
Ground beef										
Grass-fed	0.5	28	2	15	16	1.5	0.6	0.3	0.05	11.6
Grain-fed	2.8	24	3	16	37	2.2	0.3	0.02	0.01	4.4
Bovine plasma										
Grass/grain-fed	1.5	13	--	18	13	34	4.5	1	--	--
Grass/grain/sunflower oil	1.3	12	--	19	14	36	4.1	0.9	--	--
Human plasma										
Older men	0.8	24	2	8	22	30	0.7	0.5	0.4	0.2
Young men	0.9	23	1	10	20	27	1.4	0.3	0.9	0.3
Women	0.4	21	1	9	21	37	0.5	0.2	0.1	0.5

#### 2. Plant lipids

- a. Contain *n*-6 and *n*-3 fatty acids, but not eicosapentaenoic acid (20:5*n*-3) or docosahexaenoic acid (22:6*n*-3).

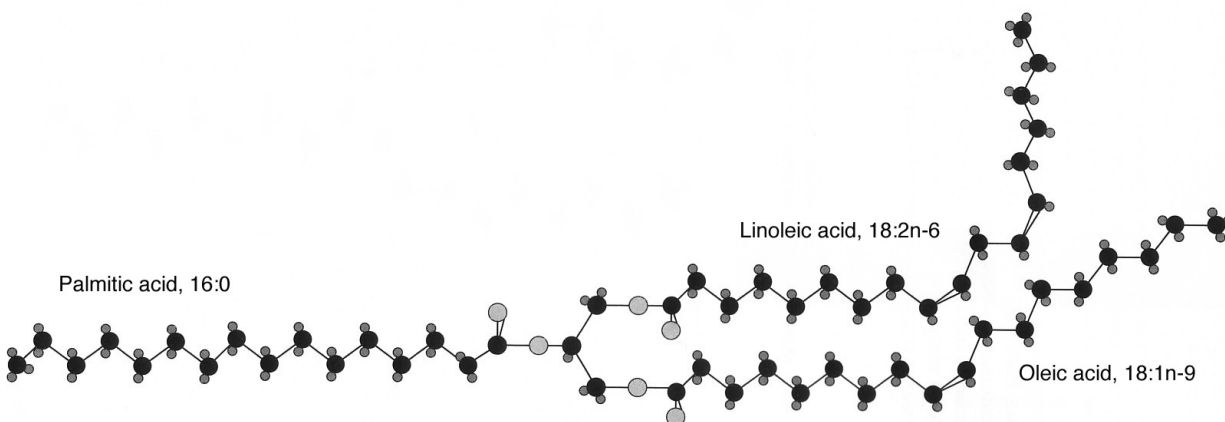
- b. Stearic acid typically is very low except in cocoa butter.
- c. Oleic acid can be abundant.
- d. *trans*-Fatty acids are not synthesized in plants.

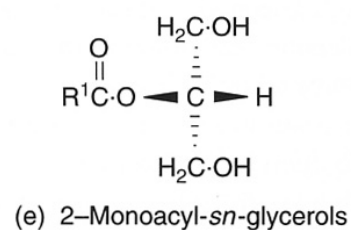
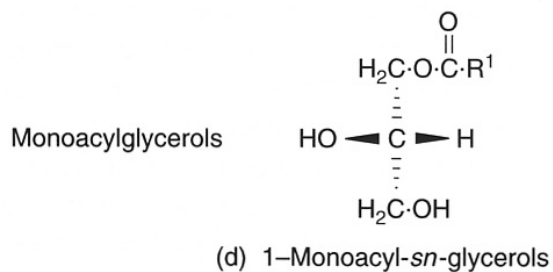
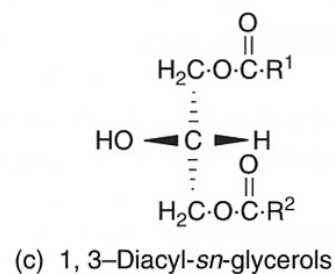
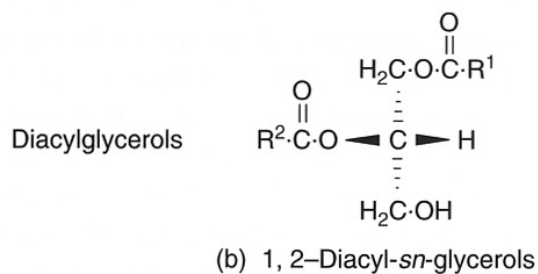
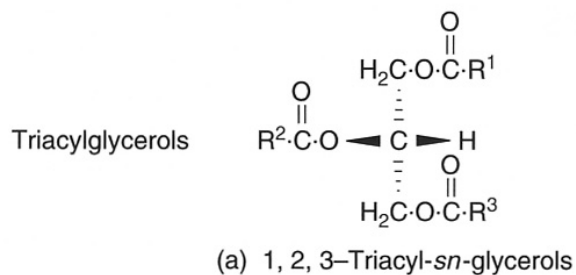
Table 3.2 The fatty acid composition of some vegetable oils\* (g per 100 g of total fatty acids)

	8:0	10:0	12:0	14:0	16:0	18:0	18:1 <i>n</i> -9	18:2 <i>n</i> -6	18:3 <i>n</i> -3	20:1+ 22:1	total
<b>A. Major edible oil crops</b>											
Cocoa butter					26	34	35	3			98
Coconut (3.4)	8	7	48	18	9	3	6	2			99
Corn (1.9)					13	3	31	52	1		100
Cottonseed (4.0)				1	24	3	19	53			100
Groundnut <sup>a</sup> (4.2)					13	3	37	41		2	96
Olive (2.7)					10	2	78	7	1		98
Palm (17.6)				1	43	4	41	10			99
Palm kernel (2.2)	4	4	45	18	9	3	15	2			100
Rape (Canola) (11.8)					4	2	56	26	10		100
Sesame (0.8)					9	6	38	45	1	1	100
Soybean (20.8)					11	4	22	53	8	1	99
Sunflower (9.3)					6	6	18	69			99

## B. Structure of acylglycerols

1. Fatty acids are distributed within triacylglycerols (TAG) with some specificity.
2. This specificity depends on both the species and the tissue site within the species in which the TAG was synthesized.
3. The stereospecific number (sn) indicates the position of the fatty acid on the glycerol backbone.





### C. Distributions of fatty acids in dietary fats

1. Pig fat and human milk
  - a. 16:0 at sn-2
  - b. 18:1 at sn-1/3 positions
  - c. 18:2 at sn-1/3
2. Human, beef, lamb, and chicken fat
  - a. 16:0 at sn-1 (> 40%)
  - b. 18:1 at sn-2 positions (> 50%)
  - c. 18:2 primarily at sn-3, but variable
3. Cow milk
  - a. 14:0 and 16:0 at sn-1 and sn-2
  - b. 4:0 and 6:0 at sn-3
  - c. 18:1 at sn-1/3
  - d. 18:2 at sn-2

**TABLE 4** Positional Distribution of Individual Fatty Acids in Triacylglycerols of Some Natural Fats

Source	Position	Fatty acid (mol%)										
		4:0	6:0	8:0	10:0	12:0	14:0	16:0	18:0	18:1	18:2	18:3
Cow's milk	1	5	3	1	3	3	11	36	15	21	1	
	2	3	5	2	6	6	20	33	6	14	3	
	3	43	11	2	4	3	7	10	4	15	0.5	
Coconut	1		1	4	4	39	29	16	3	4		
	2		0.3	2	5	78	8	1	0.5	3	2	
	3		3	32	13	38	8	1	0.5	3	2	
Cocoa butter	1							34	50	12	1	
	2							2	2	87	9	
	3							37	53	9		
Corn	1							18	3	28	50	
	2							2		27	70	
	3							14	31	52	1	
Soybean	1							14	6	23	48	9
	2							1		22	70	7
	3							13	6	28	45	8
Olive	1							13	3	72	10	0.6
	2							1		83	14	0.8
	3							17	4	74	5	1
Peanut	1							14	5	59	19	
	2							2		59	39	
	3							11	5	57	10	
Beef (depot)	1						4	41	17	20	4	1
	2						9	17	9	41	5	1
	3						1	22	24	37	5	1
Pig (outer back)	1						1	10	30	51	6	
	2						4	72	2	13	3	
	3								7	73	18	

#### D. Enrichment of fatty acids at sn-positions in bovine adipose tissue

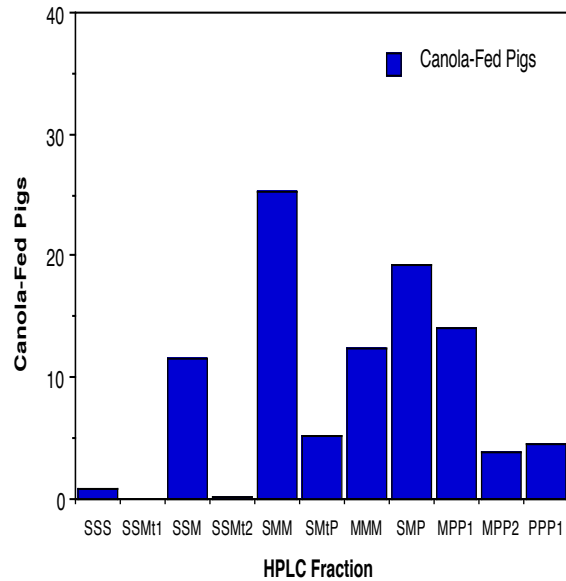
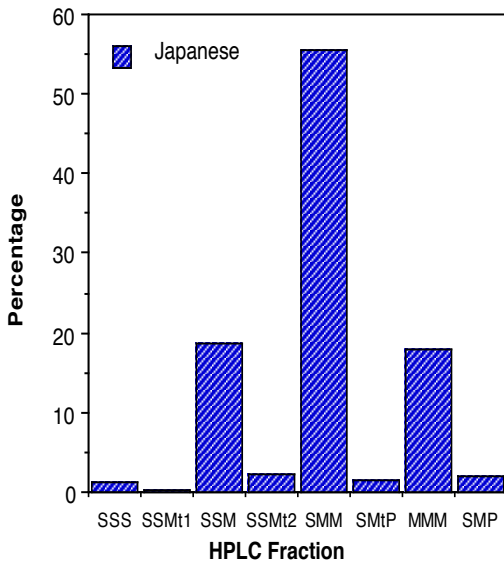
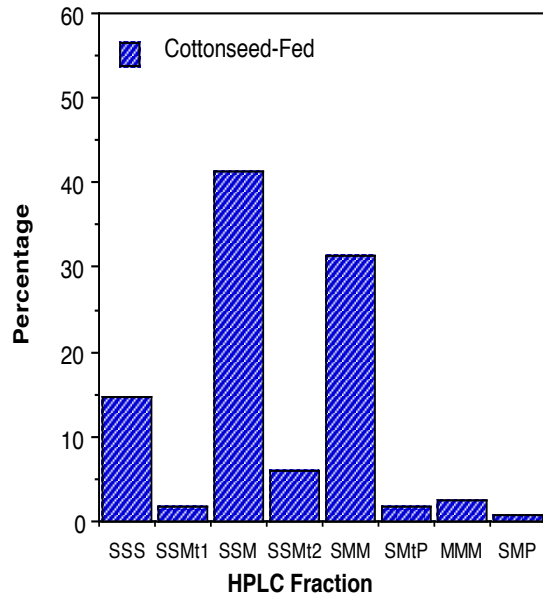
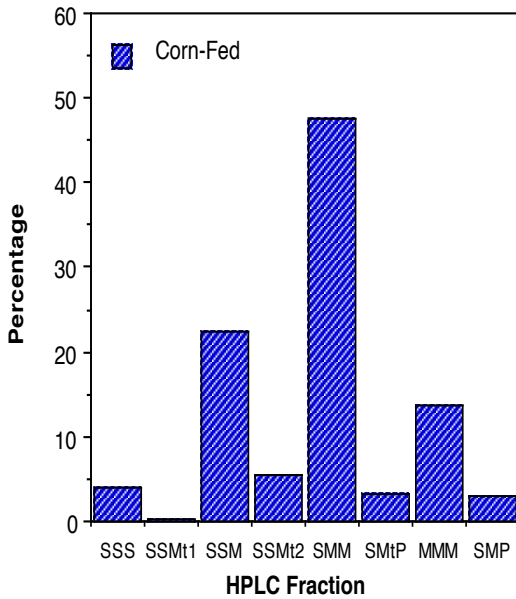
- 18:0 is increased at sn-1/3 in long-fed Australian cattle.
- 18:1 is increased at sn-1 in long-fed Japanese cattle.
- 16:0 and 18:1 *trans*-fatty acids are highest in the sn-1/3 positions.

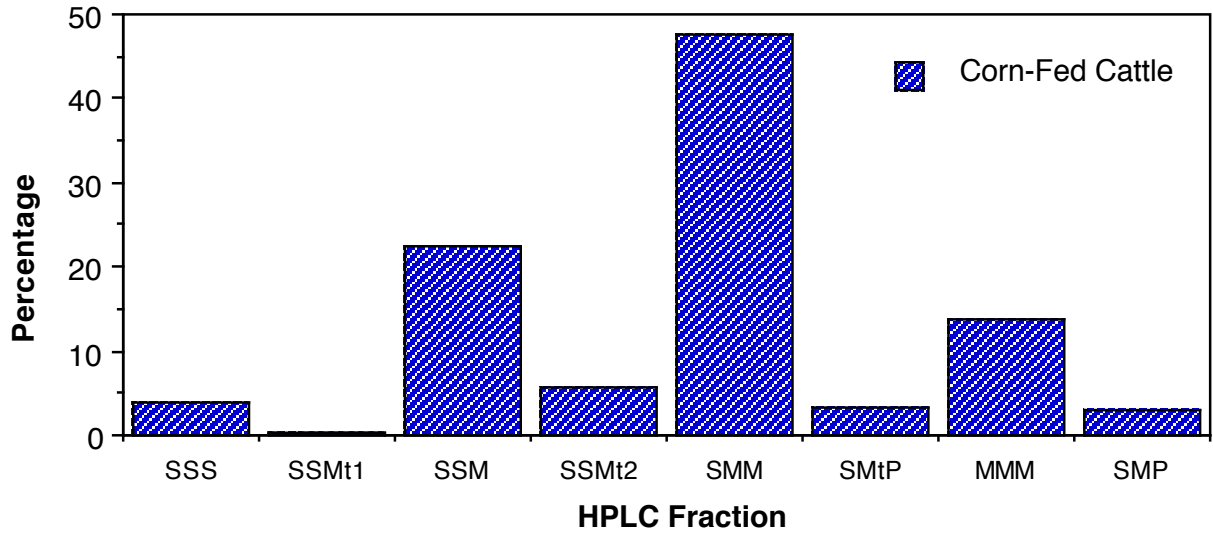
Total fatty and sn-fatty acids in adipose tissue of cattle fed grains for long periods of time

	14:0	16:0	16:1	18:0	18:1	18:2	18:3	18:1-trans
Total								
U.S. cattle	1.6	24	5	11	49	1.8	0.4	2.5
Japanese cattle	1.3	24	5	8	53	2.0	0.2	0.7
Australian cattle	1.5	24	2	26	40	1.6	0.5	2.3
sn-2								
U.S. cattle	1.6	22	5	10	52	1.5	0.1	3.0
Japanese cattle	2.0	15	6	8	62	3.3	0.2	0.4
Australian cattle	2.0	20	2	21	50	2.1	0	1.9
Average sn-1/3								
U.S. cattle	1.6	33	4	13	35	1.9	0.5	4.5
Japanese cattle	0	42	4	8	35	0	0.3	1.1
Australian cattle	0.4	33	1	36	20	0.6	1.5	3.1

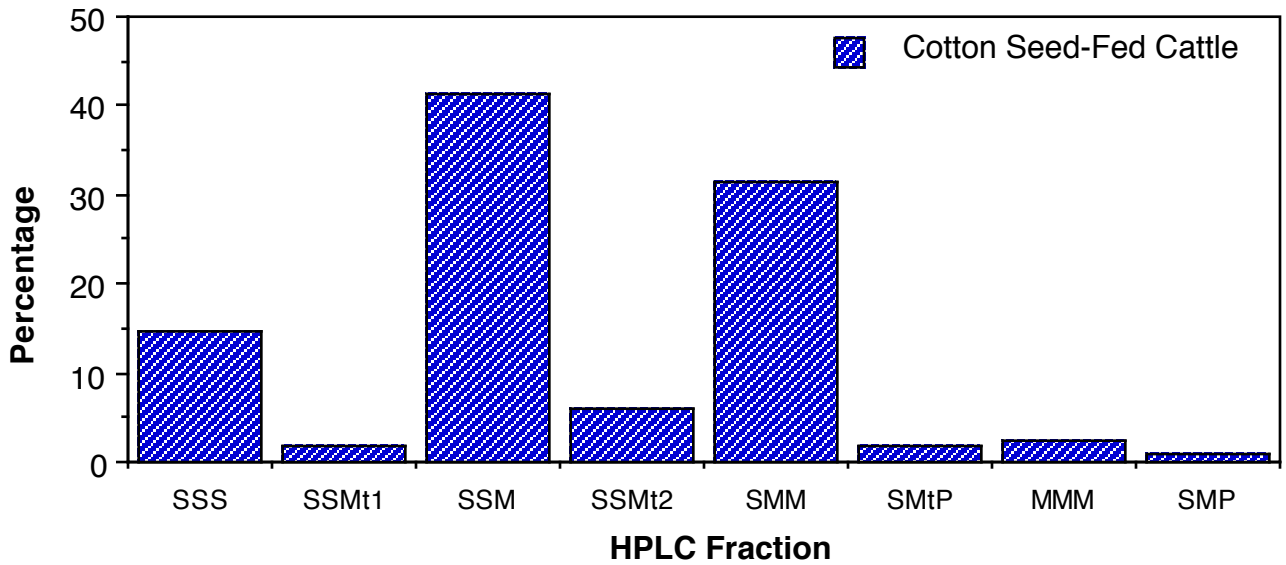
E. Heterogeneity of triacylglycerols

1. TAG can exist in pure form (i.e., containing only one fatty acid).
2. More often, TAG exist as combinations of fatty acids.
3. TAG can contain three saturated fatty acids (SSS), three monounsaturated fatty acids (MMM), three polyunsaturated fatty acids (PPP; quite rare in animal fat), or some combination of fatty acids.





14:0	16.0	6.0	1.5	1.4	4.3	0.5	4.3
16:0	50.1	37.8	20.7	22.4	14.2	0.4	20.3
18:0	32.1	17.9	12.9	6.0	9.8	0.2	10.3
18:1t11	0	1.4	21.6	0.13	13.7	0.5	0
18:1c9	0.1	29.1	38.4	57.4	42.0	77.1	33.5
18:2	0	0.1	0	0.1	7.9	0.8	27.1



14:0	6.1	2.9	1.3	0.5	0.6	0	0
16:0	30.6	23.2	18.1	15.9	11.3	2.8	22.7
18:0	61.5	34.5	18.3	11.6	33.1	13.9	9.7
18:1t11	0	0.6	16.2	0.1	3.7	0.8	0
18:1c9	0	35.4	43.4	67.1	40.3	76.0	33.8
18:2	0	0	0.1	0.1	8.6	1.8	30.2