MATERNAL AND FŒTAL LIPIDS OF SHEEP

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OVER the past few years investigations on the lipids of the total tissues, excluding wool, skin and hoofs, of maternal and fœtal sheep have been carried out in this Laboratory. As typical of the findings in this project we report the results obtained for a Romney ewe born in spring 1958 and killed on June 8, 1962 (when pregnant with two fœtuses 8–10 weeks old), and a Romney fœtal ram lamb, still-born on August 11, 1961. The tissues of the ewe (excluding fœtuses) and of the fœtal lamb were processed as described by Barton and Kirton[1] while the lipids were extracted as outlined by Shorland, Bruce and Jessop[2]. The characteristics of the lipids are given in Table 1.

Table 1. CHARACTERISTICS OF THE TOTAL MATERNAL AND FŒTAL LIPIDS OF ROMNEY SHEEP

	Total weight of tissue (kg)	Lipids (%)	Sap. (equiv.)	Unsap. (%)	Iodine value	Free fatty acids* (%)	P (%)	*Trans* (as elaidic acid) (%)
Maternal	36·6	32·3	289·5	0·67	46·3	0·97	0·08	12·0
Fœtal	4·4	2·8	310·4	6·27	58·1	6·67	0·83	0·6

*Calculated as oleic acid.

The relatively low lipid content of the new-born as compared with that of the well-nourished adult animal shown in Table 1 is in keeping with the observations of other workers[3].

Although the percentages of phospholipids and of unsaponifiable matter are shown in Table 1 to be approximately ten times greater in the fœtal as compared with the maternal lipids, when expressed on a fat-free basis the levels of these constituents in the two tissues are found to be similar.

Using the rubber membrane technique of Van Beers, de Iongh and Boldingh[4] the lipids were separated into phospholipid and triglyceride fractions. The fatty-acid composition (Table 2) of these fractions was determined by gas chromatography using 20 per cent polydiethylene glycol adipate on 'Celite 545' with argon carrier gas at 207° and a radioactive strontium detector[5] under the conditions described by Gerson[6].

The triglycerides of the maternal lipids are shown to contain (Table 2) substantial amounts of *n*-odd numbered (4·03 per cent) and of branched chain acids (1·11 per cent) as well as of linoleic acid (2·04 per cent) and linolenic acid (1·00 per cent). The aforementioned acids were not detected in the fœtal glycerides under the conditions of analysis used. However, the *n*-odd numbered and branched chain acids shown in Table 2 were found in trace amounts (less than 0·1 per cent) by gas chromatographic analysis of appropriate concentrates prepared by ester fractionation. These results together with the data for the fœtal phospholipids show that the *n*-odd numbered and branched chain acids do not pass readily from the mother through the placenta.

Table 2. FATTY-ACID COMPOSITION OF MATERNAL AND FŒTAL TRIGLYCERIDES AND PHOSPHOLIPIDS. FATTY ACIDS MOLES PER CENT*

Fatty acids		Maternal Tri-glycerides	Maternal Phospho-lipids	Fœtal[1] Tri-glycerides	Fœtal[1] Phospho-lipids
Saturated	C_{14}	1·63	0·42	0·62	1·16 (0·06)†
	C_{15}	0·76 (0·16)	0·42 (0·09)	—	0·68 (0·22)
	C_{16}	24·15 (0·32)	20·40 (0·02)	25·97	24·28 (0·23)
	C_{17}	2·27 (0·63)	1·26 (0·32)	—	0·70 (0·11)
	C_{18}	26·29	25·99	13·25	15·49
	C_{19}	—	—	—	0·17
	C_{20}	—	0·34	—	0·35
	C_{22}	—	—	—	0·28
Unsaturated	C_{14}:1	0·25	—	—	0·23
	C_{16}:1	1·84	2·19	1·45	5·88
	C_{17}:1 ‡	1·00	0·88	—	0·65
	C_{18}:1	37·74	35·28	58·71	46·86
	C_{18}:1 §	1·03	0·36	—	trace
	C_{18}:2	2·04	7·25	—	0·42
	C_{18}:3	1·00	2·18	—	—
	C_{20}:1–5	—	3·03	—	2·85

* Assuming areas under peaks are proportional to molecular concentrations.
† Figures in brackets indicate the amount of branched chain acid included.
‡ Includes some C_{18} branched chain acid.
§ Indicates *trans*-octadec-16-enoic acid.

The occurrence of considerable amounts (12·0 per cent) of *trans* acids in the maternal lipids as compared with 0·6 per cent found in the fœtal lipids is in agreement with the observations of other workers[7]. In this regard, it may be noted that whereas the maternal triglyceride fatty acids contained 1·03 per cent of *trans* octadec-16-enoic, this acid was absent from the fœtal triglycerides, although present to the extent 0·36 per cent in the corresponding phospholipid fatty acids. The relatively high stearic acid content of the maternal lipids as compared with that of the fœtus is also significant (Table 2).

The passage of unsaturated acids, including oleic and linoleic acids, across the placenta has been indicated for guinea pigs[8] while other workers have shown that the dienoic acids from corn oil and the hexaenoic acids from cod liver oil also pass across the placenta of the rabbit[9]. In the present work, although di- and poly-enoic acids were not found in the fœtal triglycerides there is evidence that linoleic but not linolenic acid occurs in the fœtal phospholipids.

Consistent with the possibility of the C_{20} unsaturated acids being mainly synthesized within the fœtus, rather than being transported through the placenta, is the occurrence of mainly eicosatrienoic acid in the fœtal phospholipids and of mainly eicosatetraenoic acid and eicosapentaenoic acids in the ewe phospholipids.

Using column[10] and paper[2] chromatographic techniques it was shown that the phospholipid fractions of the maternal and fœtal lipids were similar in composition containing approximately by weight (per cent) phosphatidyl choline, 50; phosphatidyl ethanolamine, 25; sphingomyelin, 10; phosphatidyl serine, 7; phosphatidyl inositol, 3, and unidentified, 5. However, as already indicated, the fatty acid composition of the total phospholipid fractions of the maternal and fœtal lipids showed minor differences.

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