from the cells could be similar in the various cases and the antigenic as well as the clinical implications involved in the potential penicillin-induced secretion of macromolecules by penicillin-susceptible bacteria should be borne in mind.

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Acyl Transfer Reactions of Retina†

J. G. Swartz* and J. E. Mitchell

ABSTRACT: Whole homogenate and subcellular fractions of the bovine retina incorporated labeled palmitate, oleate, and linoleate into phosphatidylcholine and phosphatidylethanolamine with and without added lysophosphatide acceptors. ATP and CoA were required, with the optimal concentration of CoA varying with the fatty acid supplied. Net phospholipid synthesis was noted with fatty acids and the lysophosphatides. Supplying multiple acyl donors as opposed to a single donor gave results indicating varying degrees of substrate preference and positional specificity of the transfer mediator(s) for the two lysophosphatides studied. Rod outer segments did not incorporate the fatty acids under the conditions of uptake by other retinal fractions but apparently an exchange of fatty acids occurred between lysolecithin molecules; this exchange was enhanced by addition of the 105,000*g* supernatant.

The demonstration of phospholipase activity in a number of tissues from various species (Waite, 1973; Franson *et al.*, 1971; Cooper and Webster, 1970; Blaschko *et al.*, 1967; de Haas *et al.*, 1971; Ottolenghi, 1964; Gatt, 1968) continues to raise questions concerning the removal of the monoacyl phosphoglycerides formed in these tissues. The high degree of specificity exhibited by the phospholipases and transacylases from different subcellular fractions (Robertson and Lands, 1964; Waite and Sisson, 1971) points to intricate cellular and subcellular mechanisms for the control of the concentration of fatty acids, lysophosphatides, and phospholipids with definite fatty acyl substituents (Wood and Harlow, 1969; Montfoort *et al.*, 1971).

Alterations in the fatty acid composition of structural phospholipids have been correlated with changes in the permeability of cell membranes (Walker and Kummerow, 1964) and Waite *et al.* (1969) demonstrated changes in membrane structure to accompany hydrolysis of mitochon-

† From the Departments of Ophthalmology and Biochemistry, The George Washington University School of Medicine, Washington, D. C. 20037. *Received June 4, 1974.* This work was supported by Grants No. EY 00407 and EY 01092 from the National Eye Institute of the U. S. Public Health Service.

drial phosphoglyceride. The highly membranous discs of the rod outer segments (ROS) of the retina, with little or no phospholipase activity (Swartz and Mitchell, 1973), did not show rapid or differential uptake of injected, labeled fatty acids (Young and Bibb, 1973). These findings suggest an unusual mechanism for phospholipid–fatty acid transfer and phospholipid renewal in structures (ROS) not capable of de novo phospholipid biosynthesis but anatomically in contact with structures with active CDPcholine:1,2-diacylglycerol cholinephosphotransferase [EC 2.7.8.2 (Swartz and Mitchell, 1970)].

The recent finding of relatively high phospholipase and lysophospholipase activity within the retina proper and pigment epithelium (Swartz and Mitchell, 1973) and the hypothesis that lytic substances or enzymes may disrupt retinal lysosomes in certain degenerative processes (Burden *et al.*, 1971) indicated that the normal retina must contain very active acyltransferase mechanisms. We report here on studies of the conditions of acyl group incorporation into retinal phospholipids.

Materials and Methods

Fresh bovine tissue was treated and fractionated as previously reported (Swartz and Mitchell, 1973). Cross-contamination of particulate fractions was followed by cytochrome *c* oxidase (Smith, 1955) and glucose 6-phosphatase (Swanson, 1955) assays.

The basic incubation mixture contained retinal homogenate or particulate suspension yielding 1.7–2.0 mg of protein, 0.1 M phosphate buffer (pH 7.0), 2.5 mM $MgCl_2$, 2.5 mM ATP, 100 μg of bovine serum albumin, and 17 nmol of ^{14}C-labeled fatty acid(s) (17 nmol/1 μCi) in a final volume of 2.0 ml. Coenzyme A was added in the following concentrations; 100 μM with palmitate as substrate, 200 μM with oleate, and 250 μM with linoleate.

The conditions of pH and type of buffer, CoA, ATP, and protein concentrations were conditions which proved optimal in preliminary experiments with whole homogenate.

Phospholipids were emulsified in 0.1% Triton X-100 and fatty acids were treated according to Meier *et al.* (1952) to form a fine "aqueous" suspension. The activity of buffered homogenate and cellular fractions was compared to activity in tissue preparations containing Triton, Triton plus substrate, concentrated substrate solutions in a minimal quantity of organic solvent, and microliter quantities of the organic solvent. Using 0.1% Triton X-100 as emulsifying agent, we did not observe a masking of the effects of adding the lysophosphatides (Mookerjea and Yung, 1974).

Incubation was routinely for 60 min at 37.5° to follow "total" fatty acid incorporation. Maximal incorporation rates differed with the fatty acid(s) used, as discussed in the text, but generally the highest rate of uptake was from 3 to 20 min.

Lysophosphatides (1-acyl phosphoglycerides) were obtained commercially or prepared from extracted bovine retinal phospholipids subjected to *Crotalus adamanteus* venom, reisolated, and purified by tlc (Swartz and Mitchell, 1973). No attempt was made to determine the fatty acid constituent of the 1 position of the lyso compounds. The position of the incorporated labeled fatty acids was determined by the decrease in radioactivity of the isolated reaction products following *C. adamanteus* treatment (de Haas *et al.*, 1962).

The lipid extraction procedure following incubation, the chromatographic techniques, and lipid and protein determinations were as reported earlier (Swartz and Mitchell, 1970). Individual phospholipids were scraped from tlc plates, extracted by the method of Webb and Mettrick (1972), placed in a scintillation liquid, and counted in a Beckman LS-250 liquid scintillation system. A silicic acid blank was prepared by scraping off an area between developed phospholipid spots and any radioactivity recorded with this blank was subtracted from the activity noted in the phospholipids.

Incubation mixtures were tested at 10, 20, 40, and 60 min to determine the degree of translocation of label during the relatively long incubation period. Translocation of label during incubation, as determined by venom treatment, could account for an error of 3–8% in final results.

Homogenate and cellular fractions heated for 4 min at near 100° and tissue preparations containing isotope but no ATP, CoA, or Mg^{2+} served as controls in each experiment. The heated preparations, with the complete incubation medium and labeled fatty acids added, yielded phospholipids that matched silicic acid blanks in specific activity. The endogenous lipid phosphorus content of this series of retinas was determined to be 640 μg of lipid P/g wet weight tissue. Where phospholipids were added to the incubation medium, their contribution to the total lipid phosphorus was subtracted before calculating lipid concentration. Internal standards and recovery of added lipids were assayed with each series of incubations. The results are given as mean averages of no less than four experiments assayed in duplicate or triplicate.

Fatty acids, labeled in the 1-^{14}C position were obtained from the Amersham-Searle Corp. of Arlington Heights, Ill.; the specific activity of the palmitate was 57.9 Ci/mol, that of oleate, 58.9 Ci/mol, and that of linoleate, 58.0 Ci/mol. Nonlabeled fatty acids were supplied by The Hormel Instit., Austin, Minn.

L-α-Dipalmitoyllecithin was a product of Schwarz/Mann Research Lab., Orangeburg, N.Y.; phosphatidylethanolamine (grade I), lysophosphatidylethanolamine (grade I), and lysolecithin (grade I) were supplied by Cyclo Chemical Lab., Los Angeles, Calif. *C. adamanteus* venom was purchased from Sigma Chemical Co., St. Louis, Mo., and other chemicals were products of the Fisher Scientific Co., Pittsburgh, Pa.

Results

The incorporation of [1-^{14}C]palmitate, -oleate and -linoleate, into phospholipids of retinal homogenate, with and without lysophosphatides as acceptors, is shown in Table I. Incubation of the fatty acids in the basic medium at constant fatty acid and protein concentrations (column a) showed that palmitate was preferentially incorporated into phosphatidylcholine (PC),[1] the oleate label found equally distributed between PC and phosphatidylethanolamine (PE), and the more unsaturated linoleate incorporated to a relatively high extent into both phospholipids, with the greater activity in the PE fraction. Under the conditions of the experiment, incorporation of label into PC was linear with time for about 3 min with palmitate and for 4–8 min with oleate and linoleate. After a 10-min incubation period, the amount of detectable radioactivity using linoleate was almost five times greater than with palmitate and three

[1] Abbreviations used are: PC, phosphatidylcholine; PE, phosphatidylethanolamine; lysoPC, lysophosphatidylcholine; lysoPE, lysophosphatidylethanolamine.

TABLE I: Effect of Lysophosphatides on Fatty Acid Incorporation into Retinal Homogenate.[a]

	pmol of ^{14}C Acid per μg of Lipid P per mg of Protein								
				Supplements				Endogenous Products of Venom Treatment Column d	
	Column a		μmol added	LysoPC Column b		LysoPE Column c			
	PC	PE		PC	PE	PC	PE	PC	PE
Palmitate	16.9	4.8						109.0	2.2
			0.1	176.3	19.6	6.0	30.2		
			1	102.8	5.3	124.7	136.5		
			3	1.75	0.0	18.9	10.0		
			5	0.45	0.0	17.9	6.1		
Oleate	18.5	18.5						71.1	4.8
			0.1	129.0	86.0	27.5	58.6		
			1	273.1	4.0	63.6	180.0		
			3	76.1	4.2	3.7	6.4		
			5	19.7	14.8	12.3	24.0		
Linoleate	51.3	64.2						10.8	23.3
			0.1	111.0	30.9	153.2	1146.0		
			1	333.1	27.1	56.2	222.5		
			3	147.8	25.6	7.2	27.0		
			5	81.9	25.3	14.6	47.3		

[a] Columns headed PC and PE denote radioactivity recovered in phosphatidylcholine and phosphatidylethanolamine, respectively. The basic medium was as described in the Materials and Methods section. Each beaker contained 1 μCi (17.0–17.2 nmol) of the added fatty acid. Protein concentration was also held constant at 1.7–2.0 mg. Incubation was for 60 min at 37.5°.

times greater than with oleate. Incorporation of the palmitate into PE was at a low rate and nonlinear, linear for almost 10 min with linoleate, and linear for 4–6 min using oleate.

The addition of serially increasing amounts of unlabeled lysophosphatidylcholine (lysoPC, 1-acyl-lysoPC) or lysophosphatidylethanolamine (lysoPE) to serve as exogenous acyl acceptors (columns b and c) revealed that the exogenous acceptors could "direct" the incorporation of fatty acids to a given phospholipid and that the quantity of acceptor available could control, to a variable extent, fatty acid incorporation into the phospholipid. In comparing the activity of the isolated products of nonsupplemented *vs.* supplemented media, the addition of 0.1–1.0 μmol of acyl acceptor generally resulted in very significant increases in uptake of the fatty acids, with a specific acceptor increasing the incorporation into one product "at the expense" of another. One notable exception to this observation was the incorporation of palmitate in near equal quantities into PC and PE, with added lysoPE. High levels (above 1 μmol) of the lyso derivatives showed a decreasing ability to prevent uptake of the labeled compounds with the increasing degree of unsaturation of the fatty acids.

Anderson and coworkers (1970) found in mature bovine retina a phosphatidylcholine and phosphatidylethanolamine (+ plasmologen) content of 43.2 and 34.1 mol % lipid phosphorus, respectively. The distribution of the three fatty acids included in the present study was found to be (on a weight % basis) palmitate, 41.0 in PC and 10.4 in PE; oleate, 18.5 in PC, 7.7 in PE; linoleate, no greater than 1.0 in either compound. Our own analyses of bovine retinal phospholipids gave results within 5% of the figures given by Anderson *et al.* To obtain the lyso derivatives (1-acyl derivatives) of endogenous phospholipids, retinal homogenate was first subjected to *C. adamanteus* venom and after readjustment of pH, protein content and addition of EDTA to complex with the calcium used in the incubation, fresh homogenate containing the basic supplements was added. Prior to venom treatment, it was found that lysoPC contributed 0.2% and lysoPE 0.08–0.1% of the total lipid phosphorus of the tissue preparation; PC and PE contributed approximately 43 and 34%, respectively, as stated above. The venom treatment always resulted in hydrolysis of at least 80% of the 2 position fatty acids. The results obtained after adding labeled fatty acids to the venom-treated homogenate and isolating labeled phospholipids are given in Table I, column d. The incorporation of palmitate followed a pattern very similar to that noted with the addition of 1 μmol of lysoPC. Oleate [found in a 2.4 ratio (weight %) in PC/PE], when added to the mixture, yielded PC with an activity almost 15 times greater than the activity of the PE. The linoleate label was incorporated into phospholipid to a much lesser extent than even in the non-venom-treated basic medium. It is interesting that this fatty acid was the most preferred "substrate" in the transferring mechanism with the two exogenous lysophosphatides.

The acyl-transferring activity of the retina is not confined to a single fraction or compartment (Table II). The microsomes were generally the most active organelles in incorporating the fatty acids into phospholipids. The mitochondrial fraction mediated the acyl transfer to a significant extent, appearing most active in the transfer of the more unsaturated fatty acids. In comparing these data with those obtained using whole homogenate, it appears that phospholipid transfer may have occurred in homogenate between mitochondria and microsomes, *via* the soluble fraction (Akiyama and Sakagami, 1969; Wirtz and Zilversmit, 1968). The rod outer segments (ROS) showed very little ability to in-

TABLE II: Incorporation of Fatty Acids Into Retinal Fractions and Rod Outer Segments.

	pmol of ^{14}C Acid per μg of Lipid P per mg of Protein					
	Supplements					
	Palmitate		Palmitate + LysoPC		Palmitate + LysoPE	
Part a	PC	PE	PC	PE	PC	PE
Microsomes	0.88	2.0	81.2	9.4	143.3	162.4
Mitochondria	3.46	5.4	36.8	29.3	68.5	8.4
Soluble Fraction	7.5	1.7	6.7	1.6	2.5	4.7
ROS	0.25	0.1	0.22	<0.1	0.25	0.12
Part b	Oleate		Oleate + LysoPC		Oleate + LysoPE	
Microsomes	31.6	40.2	295.6	7.1	211.1	104.0
Mitochondria	25.3	50.5	133.3	8.0	120.8	18.2
Soluble Fraction	10.6	0.0	12.0	0.0	9.6	0.0
ROS	0.21	0.18	0.35	0.2	0.35	0.17
Part c	Linoleate		Linoleate + LysoPC		Linoleate + LysoPE	
Microsomes	63.2	279.8	164.5	672.5	147.9	750.5
Mitochondria	36.9	136.7	78.5	243.2	58.0	284.1
Soluble Fraction	11.5	0.0	12.1	0.0	11.6	0.0
ROS	<0.1	0.45	0.27	0.55	0.21	0.65

[a] The fractions were incubated under the same conditions as whole homogenate, *i.e.*, CoA added as 100 μM with palmitate, 200 μM with oleate, and 250 μM with linoleate. Lyso compounds were added at levels which gave maximum incorporation in whole homogenate for a given fatty acid and acceptor.

corporate fatty acids under the conditions of the experiment. Marker enzyme studies revealed that all of the activity noted in the ROS could be attributed to microsomal activity; 5-10% of the activity noted in the mitochondrial fractions was from microsomal contamination as based on glucose 6-phosphatase assays. Cytochrome *c* oxidase assay of the microsomes showed that less than 2% of the acylation activity was from contaminating mitochondria. The 105,000*g* supernatant or soluble fraction was active in the incorporation of fatty acids into PC but PE was not detected chromatographically in extracts of the soluble fraction. Waite *et al.* (1970) noted a difference in the utilization of the fatty acid of linoleoyl-CoA and ATP-CoA-linoleate by rat liver mitochondria. Microsomes incorporated the fatty acid at about the same level in both systems.

The data presented should be evaluated in terms of net synthesis of phospholipids during the incubation period (Table III). All of the fatty acids were incorporated into phospholipid of whole homogenate and microsomes as the phospholipid content was increasing. Net synthesis of phospholipids under very similar conditions was noted by Waite *et al.* (1970), though in our preparation the retinal mitochondrial lipid phosphorous level increased very little.

The level of radioactivity recovered in PC and PE on addition of labeled fatty acids was governed not only by the concentration of the monoacyl acceptors but by the presence of multiple acyl donors (Table IV). Homogenate was supplemented with combinations of the fatty acids and the labeled PC and PE formed were isolated and subjected to *C. adamanteus* venom to determine the activity remaining after removal of approximately 80% of the substituent at the 2 position of the phospholipids (de Haas *et al.*, 1962). The results of venom treatment indicated that palmitate, without other fatty acid supplements, is incorporated into positions 1 and 2 of PC and into position 1 of PE. Oleate very effectively prevented uptake of palmitate-^{14}C into PC but enhanced uptake into position 1 of PE. Linoleate had the same effect as oleate on palmitate uptake into PC but increased uptake into the 1 position of PE by over 35-fold. Oleate and linoleate in combination with palmitate had the same qualitative effect on incorporation of palmitate into PC as the two fatty acids had when supplemented separately but the increased incorporation into PE noted with palmitate-linoleate is reduced almost twofold with palmitate-oleate-linoleate. It appears also that oleate and linoleate can successfully "compete" with palmitate for position 2 of PC.

With oleate-^{14}C-palmitate, we confirmed that oleate was indeed in position 2 of PC but no explanation can be given for the increased degree of incorporation of oleate-^{14}C into PE with added palmitate. Linoleate, unlike palmitate, seemed to be capable of competing with oleate for position 2 of both PC and PE.

Venom hydrolysis of isolated products using linoleate-^{14}C as the labeled fatty acid showed that this fatty acid was preferentially incorporated into position 2 of the phospholipids. The combination linoleate-palmitate, as noted above using labeled palmitate, resulted in a stimulation of uptake of label into position 2 of the products. Unlabeled oleate, expected to compete with labeled linoleate for position 2 and have a dilution effect, instead highly stimulated uptake of the more saturated compound into the phospholipids. It appears that linoleate is the much preferred substrate for transfer to position 2 of PC and PE. We can offer no explanation for the effects of palmitate-oleate on linoleate-^{14}C incorporation.

We previously reported the apparent absence of phospholipase activity in ROS (Swartz and Mitchell, 1973) and the

TABLE III: Net Synthesis of Phospholipid with Added Fatty Acids and Lysophosphatides.[a]

	Net μatoms of Lipid P/mg of Protein					
	Supplements					
	Palmitate	Palmitate + LysoPC	Oleate	Oleate + LysoPC	Linoleate	Linoleate + LysoPC
Whole homogenate	0.022	0.093	0.107	0.244	0.222	0.51
Microsomes	0.045	0.297	0.318	0.634	0.202	0.933
Mitochondria	0.01	0.02	0.024	0.041	0.06	0.085
Soluble fraction	0.003	0.031	0.043	0.117	0.089	0.130

[a] Analysis of lipid phosphorus was as described earlier and noted in the Materials and Methods section. The lipid P added as lyso derivatives was subtracted from the total lipid P. Internal standards were used and recovery of added lipid determined as outlined in the Materials and Methods section. The lyso compound was added at concentrations which gave maximum incorporation into whole homogenate, using a specific fatty acid.

TABLE IV: Effect of Multiple Donors on Fatty Acid Incorporation.[a]

	Unlabeled Fatty Acids			DPM × 10^3 per μg of L-P per mg of Protein			
Labeled Fatty Acid	Palmitate	Oleate	Linoleate	PC	Venom Treated	PE	Venom Treated
Palmitate-^{14}C				2.2	1.0	0.60	0.49
		+		0.64	0.60	1.4	1.2
			+	0.70	0.60	51.1	41.6
		+	+	0.53	0.49	26.6	23.7
Oleate-^{14}C				2.4	0.32	2.4	0.47
	+			1.8	0.30	21.0	4.6
			+	0.45	0.09	5.6	1.0
	+		+	0.87	0.10	6.3	2.7
Linoleate-^{14}C				6.7	0.57	8.3	1.9
	+			10.3	2.8	11.3	2.7
		+		41.3	6.5	61.5	20.5
	+	+		6.5	0.52	40.0	7.1

[a] Incubation mixtures contained 17 nmol of each fatty acid indicated above. All other conditions were as described under Materials and Methods.

data of Table II showed that little or no acyl transfer took place in the segments under conditions that promoted a relatively high rate of transfer in the retina proper. The problem of fatty acid transfer and phospholipid renewal in the ROS is further compounded by the observation that de novo synthesis of phospholipids does not take place in these structures (Swartz and Mitchell, 1970) and injected, labeled fatty acid was apparently incorporated very slowly and unselectively by the membranous segment discs (Young and Bibb, 1973). The possibility of a lysolecithin–lysolecithin exchange of fatty acid in the outer segments (Erbland and Marinetti, 1962; Elsbach, 1966) has been explored (Table V). Labeled lysolecithin (1-acyl-PC), without added "acceptor" (unlabeled lysoPC) or cofactors, when incubated with ROS yielded labeled lecithin. Addition of soluble fraction (105,000*g* supernatant) enhanced the exchange or transfer of label. Increasing the concentration of labeled exogenous lysolecithin under these conditions did not appreciably change the activity detected in PC. With the addition of unlabeled endogenous lysoPC and soluble fraction to the medium, the activity of the lecithin could be increased over fivefold. This increase was unexpected as an isotope dilution effect could be predicted. CoA and ATP, added in serially increasing increments to the two systems, inhibited the incorporation of the fatty acid at all concentrations tested. The data shown were obtained using concentrations of the cofactors that favorably promoted acyl transfer in the retina proper. We have observed the transfer of choline- and ethanolamine-^{14}C labeled phospholipid from microsomes and mitochondria into ROS, in the presence of retinal homogenate soluble fraction (unpublished data). It may be possible that ROS contain systems for phospholipid renewal, catabolism, and anabolism similar to other structures incapable of de novo phospholipid synthesis and lacking phospholipase activity (Oliveira and Vaughan, 1964; Waku and Lands, 1968; Bibb and Young, 1974).

Discussion

This investigation has led to the demonstration of acyl transferase activity in bovine retinal tissue which is dependent to varying degrees on the type of fatty acid available, the concentration of CoA, the presence of multiple acyl donors, and the concentration and nature of the lysophosphatide acceptor. van Golde *et al.* (1971) found bovine liver

TABLE V: Incorporation of Lysolecithin–Fatty Acid-^{14}C into Rod Outer Segment Phosphatidylcholine.

LysoPC–F.A.-^{14}C (μmol)	LysoPC (μmol)	Soluble Fraction	ATP	CoA	Recovered Radioactivity in PC (pmol per μg of Lipid P per mg of Protein)
1	0	0	−	−	1.2
1	0	+	−	−	2.3
3	0	0	−	−	1.3
3	0	+	−	−	2.4
5	0	0	−	−	1.3
5	0	+	−	−	3.2
10	0	0	−	−	0.3
10	0	+	−	−	3.0
1	1	+	−	−	3.2
3	3	+	−	−	6.0
5	5	+	−	−	6.9
10	10	+	−	−	6.8
5	0	+	+	+	0.2
5	5	+	+	+	0.7

[a] CoA was added at 200 μM and ATP at 2.5 mM. The soluble fraction added contained 100 μg of protein/beaker. Unlabeled lysoPC was exogenous retinal lysoPC. Other conditions were as described in the Materials and Methods section.

acyl-CoA:1-acyl-*sn*-glycero-3-phosphorylcholine and ethanolamine acyl transferase to be localized mainly in the microsomes with significant activity also noted in the Golgi complex. These investigators routinely used oleoyl-CoA as substrate, though free fatty acids with added ATP and CoA gave similar findings. No data were given concerning substrate specificity. Our system, requiring ATP, CoA, and Mg^{2+}, suggests also the presence in the retina of acyl-CoA synthetases (Kornberg and Pricer, 1953; Pande and Mead, 1968).

Robertson and Lands (1964) noted that the synthesis of either phosphatidylcholine or phosphatidylethanolamine is stimulated by adding the corresponding monoacyl derivative and the ability of phospholipids to stimulate a PC-cytidyl transferase (Fiscus and Schneider, 1966) and to regulate microsomal enzyme activity (Zakim, 1970) have been reported. In our experiments, with Mg^{2+} in the medium, a stimulation of either the cytidyl or glyceride transferase mechanism (Ottolenghi, 1964; Kennedy and Weiss, 1956; Smith *et al.*, 1957) would be an unlikely answer to the net phospholipid synthesis, unless high levels of endogenous diglyceride were present.

We regard the apparent ability of ROS to promote a lysolecithin–lysolecithin fatty acid exchange to represent only one of several possible mechanisms for lysophosphatide removal and phospholipid renewal in the segments. The reaction may resemble the intermolecular acyl transfer between plasma lecithin and cholesterol in having a very slow rate, requiring incubation periods of many hours or days, but resulting in significant quantities of fatty acids exchanged over a 24-hr period (Glomset, 1968). The lysolecithin may be bound to a type of protein (Switzer and Eder, 1965) and form a cycle with phospholipids transferable from microsomes and mitochondria. The present study, recent work by Bibb and Young (1974), and our study of phospholipase and lysophospholipase activity of retina and pigment epithelium (Swartz and Mitchell, 1973) point to retinal structures of high lipid-metabolizing activity surrounding ROS that depend on seemingly obscure mechanisms for fatty acid exchange and replacement of phospholipid molecules in addition to membrane replacement, per se.

The acyl transferase activity of the tissue in conjunction with lysophospholipase(s) offer effective mechanisms to prevent the accumulation of the highly cytolytic products of the phospholipases present. In addition, the acyl transferring reactions of the retina may serve in maintaining cellular integrity by removing the fatty acid residues produced by phospholipase activity (Bazan, 1971).

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