oleic or elaidic monolayers and would need continuous monitoring for the detection of short-term changes.

The slower photo-contraction of elaidic acid films may be due to their different structure or to the lower oxidation rate of the *trans*-isomer[8]. The rapid initial contraction of oleic acid films, even in the dark, is due to dissolution of oxidation products present in the bulk phase. The slow contraction in the absence of light indicates that thermal oxidation and breakdown of monolayer molecules also occurs.

Zusammenfassung. Nachweis, dass die Photokontraktion von *cis*- und *trans*-Isomeren der 9-Oktadecensäure, als monomolekulare Schicht auf einer Luft/Wasser-Oberfläche ausgebreitet, stufenweise erfolgt. Daraus wird geschlossen, dass der Kettenbildungsprozess der Selbstoxidation, der zur Vergrösserung Oberfläche/Molekül führt, von einem Kettenabbruch gefolgt wird, den die aus dem Spaltungsprozess gebildeten kleinen Moleküle bewirken.

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Mitochondrial Morphological Changes in Mucosal Epithelial Cells

Morphological and biochemical evidence has consistently shown that the matrix containing regions of mitochondria are surrounded by a rather complex system of membranes[1–7]. The complexity is due to or is largely associated with the functions of the cristae. These membranous invaginations contain mitochondrial constituents which are essential in oxidative processes and energy conservation. Cellular energy demands can cause rapid changes in mitochondrial respiration rates, nucleotide and ion distribution, enzyme activities, and substrate levels. Such noted metabolic and chemical alterations frequently are indicated by conformational changes in the structure of the mitochondria[8]. During high rates of coupled respiration the matrix of mitochondria becomes greatly condensed and the inner membrane system undergoes

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Fig. 1. A condensed mitochondrion in the nuclear region of a mucosal epithelial cell of the rat jejunum after 3 min incubation in a mixture of amino acids (1 mg/ml) with added D-glucose (28 m*M*). Note slight mid-region constriction (arrow) suggestive of mitochondrial division. Compare with Figures 2 and 3. ×60,000.

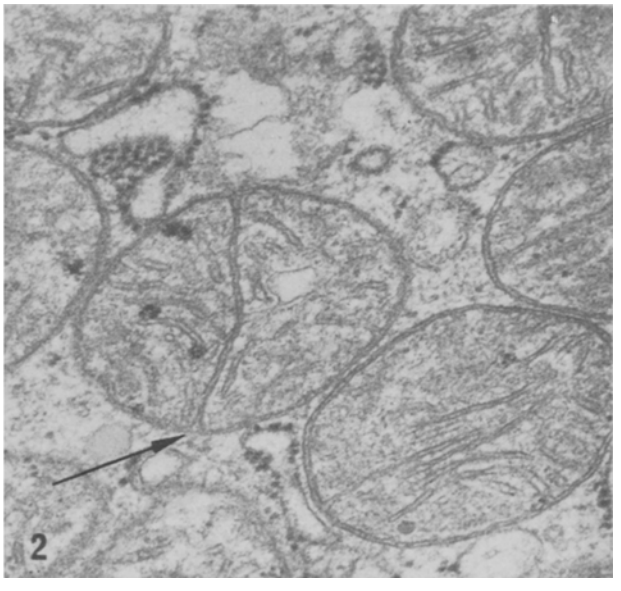

Fig. 2. A portion of the nuclear region of a mucosal epithelial cell in which paired cristael membranes of an orthodox-appearing mitochondrion extends from one side to the other where they join the inner membrane (arrow). The sample is from an intestinal slice incubated in 28 m*M* D-glucose for 30 sec. ×50,000.

reorganization[7,8]. This is accompanied by a decrease in the volume of the inner matrical region and a corresponding increase in the sizes of intracristael spaces[6,7]. These structural shifts are usually clearly evident and substantiate a commonly accepted two-compartment concept of mitochondria.

In our studies on the small intestine of the rat, we have noted an unusual structural modification in which only a portion of the matrix of a single mitochondrion undergoes condensation. This results in what might be described as an 'orthodox-condensed hybrid', in which approximately one-half of the mitochondrion retains a loosely-scattered form of matrix that gives only this region the more typical mitochondrial appearance. Although such mitochondria seemingly possess a continuous outer compartment then, they appear to contain two distinct inner compartments. To the author's knowledge, this type of organelle has not been previously reported. The purpose of the present communication is to record this morphological phenomenon and discuss its possible origin and significance.

Materials and methods. Young adult male albino rats (150–250 g) were sacrificed by a head stun and cervical dislocation. Segments of the jejunum were removed and fixed in cold (0–5 °C) 2% glutaraldehyde (0.1 *M* sodium cacodylate or phosphate buffer, pH 7.2). Post fixation was in phosphate buffered 1% osmium tetroxide (pH 7.2). Prior to fixation some sample segments were incubated at 37.5 °C in a modified Krebs bicarbonate Ringer medium with added amino acids (1 mg/ml) and/or D-glucose. All tissue samples were embedded in Epon 812. Sections were cut with diamond knives on a Porter-Blum MT-2 Ultramicrotome. Electron microscope observations were made with either a Siemens 1A or a Zeiss EM 9S.

Results and discussion. Mitochondria exist and function in any of 5 steady states[9]. It has already been established that structural changes in organization of the mitochondrial inner membrane system and matrix are characteristics which distinguish the functioning level or metabolic state of different mitochondria[4,6,7]. It is state III during which respiration is maximum and the mitochondrial matrix is highly condensed[4,7]. A mitochondrion with a high degree of condensed matrical material is illustrated in Figure 1. The tissue for the sample was part of an intestinal slice which was incubated in a mixture of amino acids with added D-glucose for 3 min.

Normally, D-glucose addition as a substrate prevents K^+ loss and reduces the effect on the morphological organization of intestinal epithelial mitochondria caused by the presence of amino acids[4,8]. Generally, with glucose inclusion in the incubation medium the cristae of mitochondria of mucosal epithelial cells remain moderately uniform in appearance with an orthodox type of organization. Occasionally, however, the paired membranes of a single cristael profile will be found to extend the full mitochondrial width joining the inner limiting membranes on either side (Figure 2). Such a structural pattern seemingly could result in a mitochondrion with two structurally distinct inner compartments. This has been found to be the case in some instances as suggested by the organelle illustrated in Figure 3. Here, it can be seen that the matrical regions of two major portions of a single mitochondrial profile differ considerably in the degree of condensation. Areas of distinct condensation differences are evidenced by the separation occuring from the extended paired cristael membranes. Figure 3 also clearly illustrates that the mitochondrial side with greater matrix condensation shows an increase in the size of its outer compartment or intracristael spaces. Of the more than 300 mitochondria tabulated for the present report, less than 2% was observed to be of this 'orthodox-condensed hybrid' type. The origin of such mitochondria is believed to come about when a pair of membranes of the cristae extend the full mitochondrial diameter dividing a single inner compartment into two major matrical regions (as shown in Figure 2). The 2 regions are then evidently capable of existing in separate metabolic states, as indicated by the difference in matrix condensation and inner membrane conformation. This is thought to be due to an asynchrony of the oxidative processes within the different regions of the mitochondrion.

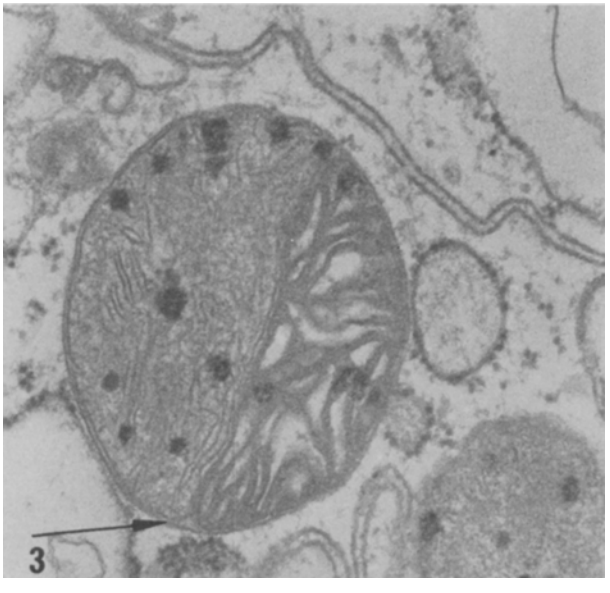

Fig. 3. Mitochondrion from a tissue sample similar to and treated as that for Figure 2. Observe variation in condensation of matrix and division of inner compartment (arrow). It is clear that the region of high matrical condensation also demonstrates enlargements of intracristael spaces. It is believed that the 2 sides are in different functional states. Dense osmiophylic granular structures are also present in the matrix region, as in other figures. ×50,000.

Zusammenfassung. Elektronenmikroskopische Beobachtungen zeigen, dass die Innenmembran der Mitochondrien von Epithelzellen des Darms invaginieren und die Innenabteilung in zwei Einheiten teilen kann, jede mit einem unterschiedlichen Grad von Matrixverdichtung.

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