Lens Regeneration After Mature Galactose Cataract Formation[1] (35055)

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When galactosemia is produced in young rats, mature cataracts develop in about 23 days (1). A mature cataract appears suddenly over a period of 24–48 hr and may be readily seen with the unaided eye through the pupil of the rat iris. If the pupil is dilated, the opacity appears more dense in the central region. This anatomical change is accompanied by a sudden change in the permeability characteristics of the lens. Although the epithelium remains intact, the internal structure is disrupted and the concentration of solutes within the lens tends to come into equilibrium with those in the extralenticular fluid (2, 3). If a lens with a new mature cataract is opened, the nucleus of the lens may be identified as a dense opaque sphere.

During the course of the development of a mature galacotose cataract, the process becomes irreversible at about 15 days and a mature cataract will develop even if the galactose diet is discontinued (4). Experiments are usually discontinued after the appearance of a mature cataract. This paper describes changes in the lens if the rats are continued on a galactose diet, or if the galactose diet is discontinued after the appearance of mature cataracts.

Methods. Male Sprague-Dawley rats, weighing 80–85 g, were placed on a diet consisting of 35% galactose and 65% ground Purina chow. Mature cataracts developed within 4 weeks. On day 40, the rats were divided into two groups of six rats each, all of which had mature bilateral cataracts. One group was continued on a galactose diet and the second group was fed Purina chow. The animals were observed for an additional 65 days. Thereafter, the animals were sacrified by decapitation and the eyes were removed as previously described (5). For histological studies, the whole eyes were fixed in Kolmer's fixative in the dark for 24 hr, embedded in paraffin, and sectioned at 5 μ. Sections were stained with hematoxylin and eosin.

Results. The lenses of the rats that were continued on the galactose diet after the appearance of mature cataracts became increasingly more opaque as shown in Fig. 1. The lenses of the rats that were given a normal diet following the development of mature cataracts, had a dense white nucleus about 1 mm in diameter with very clear surrounding lenticular material, as shown in Fig. 2. A histological section through the bow region of a lens from a rat, which had been on a normal diet following the development of a mature cataract, is shown in Fig. 3. The epithelium and the fibers both appear normal. The epithelial cells are no longer redundant.

Discussion. It is evident from these observations that the lens epithelium which persists after the development of a mature cataract is capable of producing new fiber which displace the debris within the lens and surround the dense nuclear opacity. This observation is consistent with a similar finding in man (6).

The observations described in this paper suggest that a lens with a recent cataract can be used as a model for the study of the function of various lens components. It is apparent that a lens with a newly formed mature cataract consists of a capsule, a functional epithelium, and an inert central mass. This preparation can be used to study intact epithelium in terms of metabolism and perhaps of transport. It can also be used to study the process of new fiber formation.

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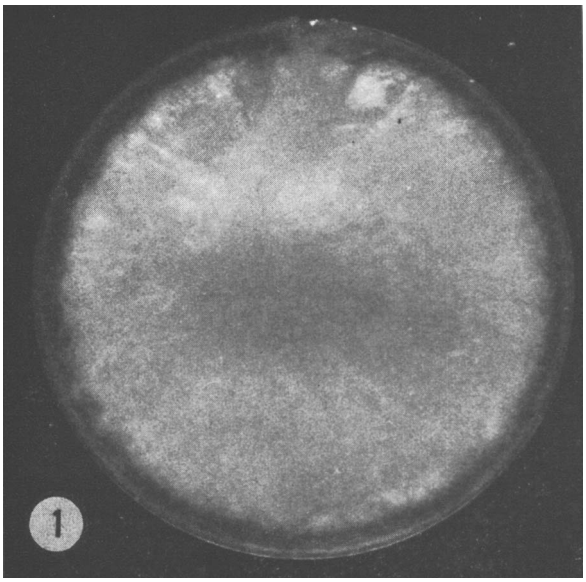

FIG. 1. Lens from a rat receiving a 35% galactose diet for 105 days.

Any theory regarding the etiology of mature galactose cataracts must be consistent with the observation that the epithelium is still viable and capable of regenerating new fibers. It may be said that the observation of the complete degeneration of the internal structure of the lens, which accompanies the appearance of mature cataracts, is not secondary to the complete destruction of the epithelium. However, the irreversible process leading to the degeneration of the fibers may be instituted by a relative deficiency of the whole epithelium or a complete deficiency of a portion of the epithelium.

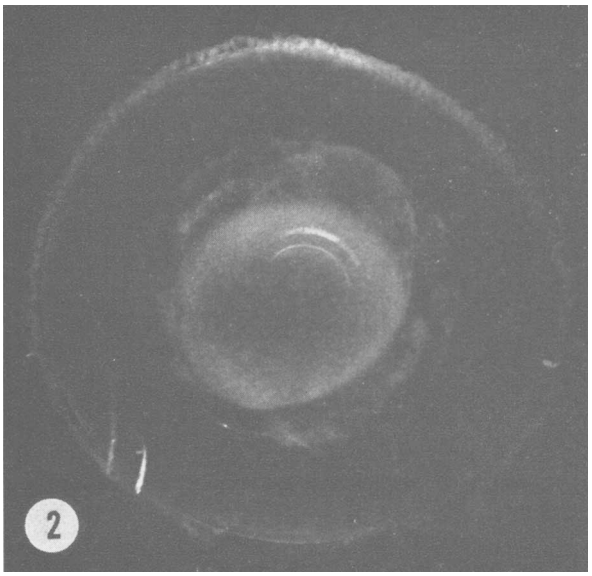

FIG. 2. Lens of a rat with 65 days of normal diet following the development of a mature cataract during a period of 40 days on a galactose diet.

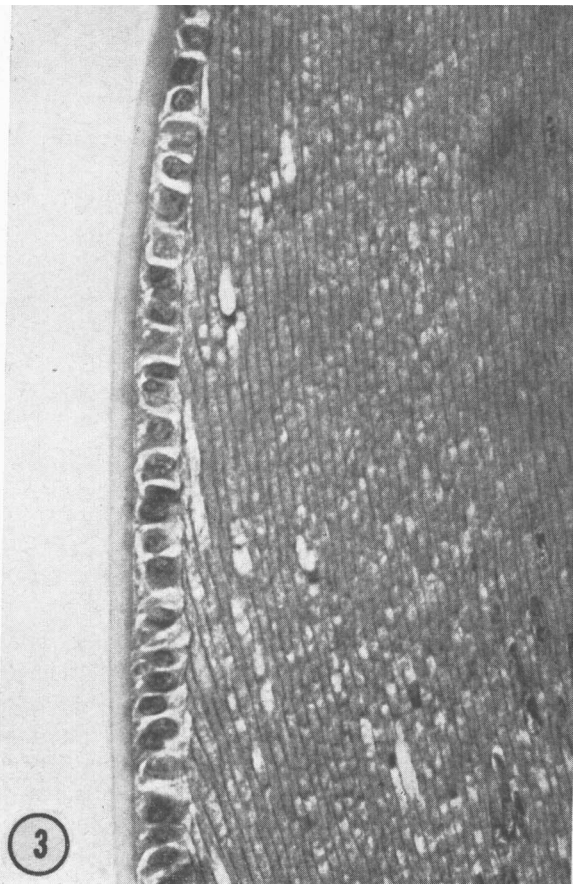

FIG. 3. Histological section of the cortical area of a lens comparable to that in Fig. 2.

A lens with a newly formed mature cataract is viewed as consisting of a capsule and intact epithelium surrounding a fluid mass having a composition similar to extracellular fluid. A dense, opaque lenticular nucleus is suspended in this liquid mass. It appears, therefore, that as new lens fibers generate, they are exposed on their central surface to a fluid having the composition of extracellular fluid. This suggests that fiber membranes are capable of surviving under these circumstances.

Summary. Following the development of mature cataracts in the lenses of rats, one group of rats was placed on a normal diet and a control group continued on the galactose diet. New healthy lens fibers were formed around a dense opaque nucleus in the lenses of rats on the normal diet. Those that were continued on a galactose diet had lenses that were completely opaque. The implication of this observation for further experimental studies and for the interpretation of the etiology of cataractogenesis is discussed.

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