

TABLE II. Brain Hormone Activity of Physiologically Vital Active Substances.

Tested compounds	Dose (μ g)	Activity
Farnesol	40	—
Squalene	40	—
Ascorbic acid	40	—
Gibberellin	40	—
Thyroxine	5	$\pm$
Adrenaline	50	—
Noradrenaline	.5	+
Parotin	60	—

+, positive; —, negative.

substances as a brain hormone without steroids from compounds known as vital active substances.

Noradrenalin yielded a positive bioassay but other substances a negative bioassay, though the result was inconclusive in the case of thyroxine (Table II).

Summary. The brain hormone activity of compounds known as biologically vital active substances in mammalian organisms or in insects was studied by the *Bombyx*-test. Several compounds, such as progesterone, hexestrol, diethylstilbestrol, cholestanol, cholesterol, 7-dehydrocholesterol, campesterol, and noradrenalin yielded positive bioassays.

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Ciliated Epithelial Cells in Normal Murine Intrahepatic Bile Ducts. (28663)

J. W. GRISHAM*† (Introduced by E. L. Alpen)

U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.

Prior to use of the electron microscope, ciliated cells in bile ducts of mammals had not been described(1). In recent studies using this instrument cilia have been noted on epithelial cells of proliferated intrahepatic bile ducts in rats with various experimental alterations(2,3,4) and in human beings with extrahepatic biliary obstruction(3). In these studies ciliated cells were not noted in nor-

mal intrahepatic bile ducts although the possibility of their existence was pointed out (3). This report describes the rare occurrences of ciliated cells in small interlobular and intralobular bile ducts of normal adult rats and discusses their possible significance.

Materials and methods. Livers from many untreated normal rats, both male and female, of the Wistar albino strain were examined as controls during many investigations of experimental alterations of hepatic ultrastructure. Small blocks of tissue were fixed in 1% osmium tetroxide in veronal buffer or in Dalton's chromate buffer at pH 7.6. Fixation was carried out at 5°C for 1 hour. Dehydration was accomplished by passage through

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† Present address: Department of Pathology, Washington University School of Medicine, St. Louis, Mo.

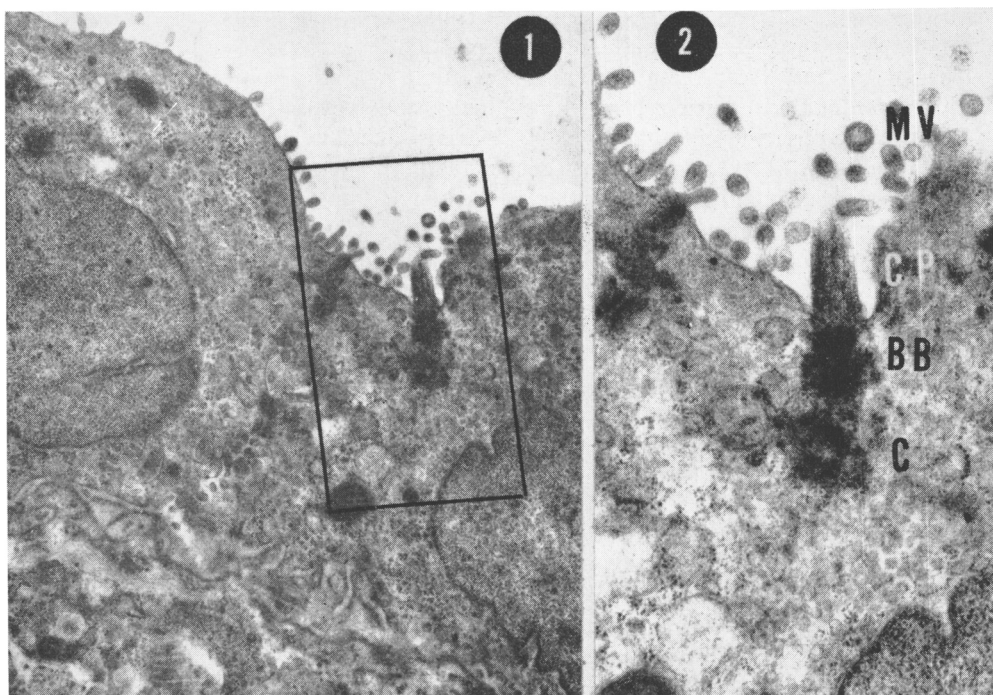


FIG. 1. A portion of an intralobular bile duct from a normal rat showing a cilium projecting into the lumen of the duct. Magnification $\times 13,000$.

FIG. 2. Enlargement of the outlined area. The ciliary process (CP) is sectioned tangentially. Basal body (BB) and centriole (C) are shown. Also indicated are numerous microvilli (MV). The lumen of the duct is at the top in both photographs. Magnification $\times 28,000$.

progressively ascending concentrations of ethyl alcohol solution at intervals of 5 to 10 minutes, and tissues were embedded in Epon 812 by the method of Luft(5). Thin sections were cut on a Porter-Blum ultramicrotome equipped with a glass knife and were examined in an RCA EMU 2B electron microscope after "staining" on the grid with saturated aqueous solution of uranyl acetate.

Results. Cilia were rarely encountered on cells of normal murine intrahepatic biliary epithelium; only 6 ciliated cells were noted in many hundreds of sections studied during a period of 5 years. Only one cilium was noted on any section of a biliary epithelial cell. In general structure the cilia resembled typical kinocilia (Fig. 1 and 2), measuring about $250\text{ m}\mu$ in diameter, having a basal body of approximately 150 by $300\text{ m}\mu$ and, in most instances, possessing an associated centriole of similar dimensions. The length and precise internal structure of the ciliary process could not be ascertained because fa-

vorable longitudinal sections and cross sections were not found in the few instances in which ciliated cells were encountered. All cilia seen were located on the luminal border of the cells and projected into the duct lumen. Cilia were not seen on hepatic parenchymal cells.

Discussion. Studies by electron microscopy have recently demonstrated cilia on several diverse types of cells which were previously not suspected to possess these structures. Epithelial cells of normal murine intrahepatic bile ducts may now be added to this heterogeneous group which includes renal tumor cells(6) and cells of normal renal epithelium(7), cells in pancreatic islets(8), neurons(9), Schwann cells of unmyelinated nerves(10), fibroblasts(11), smooth muscle cells(12), cells in the adenohypophysis(13), cells in the basal layer of the epidermis and cells of tumors arising from the latter(14), and proliferated intrahepatic biliary epithelial cells in rats(2,3,4) and in human beings(3).

The structure of the ciliary processes in these instances has been characteristic of kinocilia with 9 peripheral and 2 central filaments(3, 6) or a variation of this arrangement. In the latter instance the observed cilia have lacked central filaments(8,10,12,13), or possessed modified central filaments(11), or have had aberrant numbers of peripheral filaments in addition to lacking central filaments(2). In other studies including the present one, the internal structure of the ciliary process could not be determined(7,9). Cilia in proliferated biliary epithelium have been described as having the typical 9-2 filament pattern(3) or an unusual 7-0 filament pattern(2). Cilia have been thought to occur singly on each type of cell listed above except in renal tumors(6) and in some instances of biliary ductal proliferation(3) in which several cilia were noted on single cells.

The significance of the presence of cilia on biliary epithelial cells, as well as on the other types of cells previously mentioned, is a matter of speculation. The function of ordinary kinocilia is movement, but the apparent paucity of these structures in the types of cells noted above would seem to indicate that they are of limited importance in this regard. The lack of uniformity in ciliary structure and the heterogeneity of cell type on which they occur would seem to preclude any function common to the group. Various authors have conjectured that they might have such diverse functions as chemoreception(8,13), creation of turbulence in extracellular fluid(8, 7), or initiation of mitosis(14), or that they might be embryological remnants without function(8,11). Others have speculated that their presence indicates "metaplasia of the centriole"(4) or reversion of the cell to a more primitive developmental state(3). The latter two impressions were derived from the belief that cilia were present only on pathologically proliferated cells and not on the normal counterpart. These viewpoints are not justified in the case of proliferated biliary or renal epithelial cells since cilia are present on normal cells(7), as well as on proliferated cells(2,3,4,6).

Biliary epithelial cells of the young of several non-mammalian vertebrate species and of adult petromyzon and certain adult frogs, toads, and reptiles have long been known to possess cilia(1). It is possible that cilia on normal and proliferated murine biliary epithelium and on the other varied types of cells discussed above merely represent structures retained from embryogenic progenitors and that they confer no distinctive attributes on the cells possessing them.

Summary. Rare cilia have been noted on cells of normal murine intrahepatic biliary epithelium. In general structure these cilia resemble typical kinocilia, although the precise internal structure of the ciliary process has not been ascertained. The function or implication of the presence of cilia on these cells is not absolutely known although it is thought that they possibly represent embryological remnants without function.

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