

## MORPHOLOGY AND PATHOMORPHOLOGY

# Structural Basis for an Epithelial Barrier in the Main Pancreatic Duct of Some Mammals

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The epithelium of the main pancreatic duct is studied histologically and histochemically in mammals of different alimentary specialization. The features of the mucous epithelial barrier are found to be different depending on the type of digestion. The epithelium of carnivorous animals is glandular, but its secretion contains neutral glycoproteins as well. The mucous secretion produced by goblet cells and deep glands of the duct in guinea pigs as well as in all herbivorous animals has a more protective action due to a high concentration of acid glycoproteins.

Key Words: pancreas; duct; epithelium; barrier properties

The changes occurring in pancreatic ducts, which result from duodenopancreatic and biliopancreatic refluxes against the background of canalicular hypertension, play a key role in the development of acute and chronic pancreatitis [1,3]. The barrier properties of the duct epithelium are in such cases very seriously compromised. However, the structural basis for the resistance of the epithelium lining the pancreatic ducts has been insufficiently studied in experiment. There is no established relationship with the functional peculiarities of the digestive system that depend on the chief diet of animals.

The cell composition and histochemical peculiarities of the mucous membrane epithelium of the main pancreatic duct (MPD) were studied here in common species of experimental animals.

### MATERIALS AND METHODS

Five intact dogs, 5 cats, 25 albino rats, 10 rabbits, and 20 guinea pigs were studied. The animals

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were killed with an overdose of hexobarbital. After fixation in 10% Formalin and Rouget's and Bouin's fluids, the samples were embedded in paraffin. Serial sections of analogous parts of the pancreas were stained with hematoxylin-eosin and iron and molybdenic hematoxylin and were processed histochemically and with special methods: with galloxyanin after Einarson, aldehyde-fuchsin after Gomori, Fenafoval original stain, acid solution of basic brown, alcian blue, toluidine blue at various pH values, the PAS-reaction, impregnation after Grimeus, and Schmorl's ferric ferricyanide method.

### RESULTS

Single-layer simple columnar epithelium and loose connective tissue situated externally were the tissue elements of the MPD in all studied animals. The general structure and histochemical peculiarities of the MPD epithelium in different animals are given in Table 1.

The mucous membrane of the duct is covered with a layer of simple low columnar epithelium in

rats. The majority of cell elements are main (coated) epitheliocytes ( $13.2 \pm 0.7 \mu$  in height). The cell surface and apical regions have a small amount of PAS-positive secretion that attests to a secretory capacity of the MPD surface epithelium which discharges neutral glycoproteins. Endocrine ("pale") cells are situated between the basal parts of main epitheliocytes mostly in tubular glandular-like invaginations of the mucous membrane ( $90\text{--}100 \mu$  in depth) which are typical for the rat MPD.

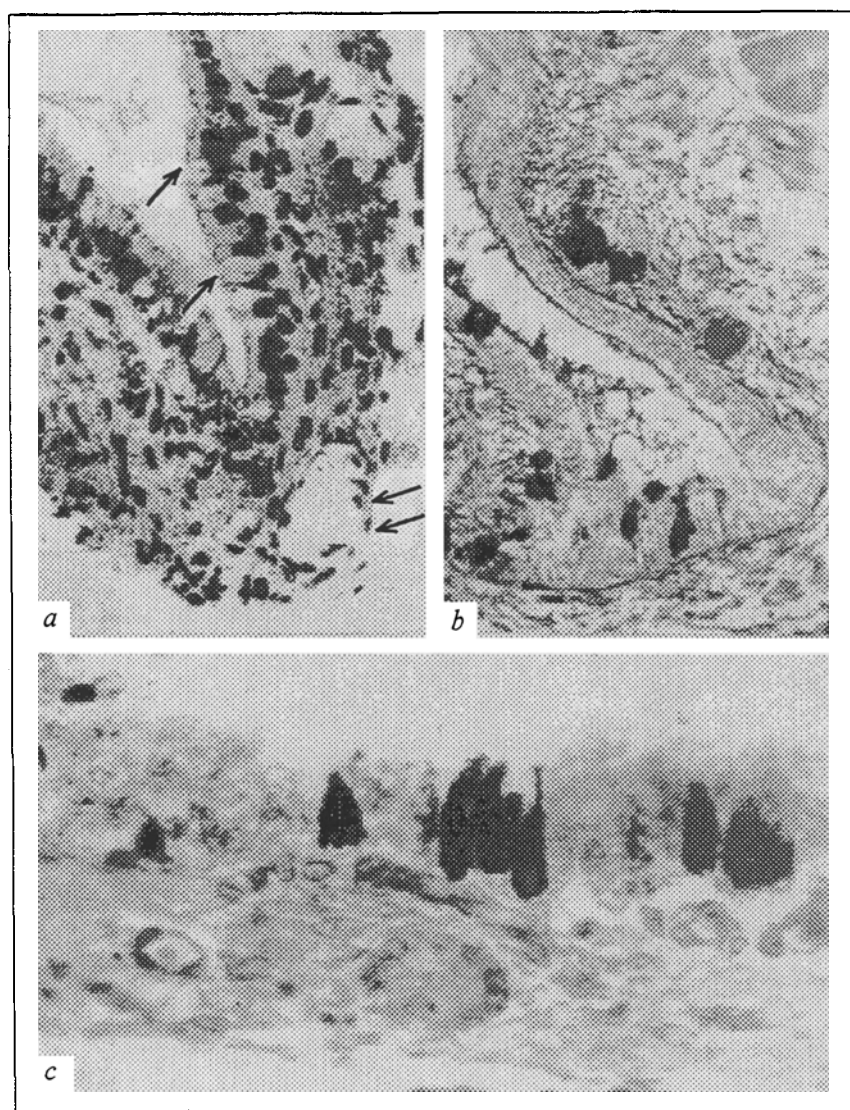
Single cell elements which have no signs of specific differentiation and among which mitoses occur may be designated as low-differentiated cells.

Surface epithelial cells of the MPD in rabbits and guinea pigs ( $22.8 \pm 0.9$  and  $21.4 \pm 0.3 \mu$  in height, respectively) do not exhibit secretory properties. Goblet cells produce the components of the mucous barrier in this epithelium. Their secretion is saturated with both neutral and acid (sulfated and sialated) glycoproteins. The most sizable mu-

cous barrier was found in guinea pigs. In addition to goblet cells, the mucous glands proper of the duct provide it via releasing secretion saturated with neutral and acid glycoproteins (Fig. 1, a, b). Among the argyrophilic endocrinocytes enterochromaffin (EC)-cells are clearly identified in epithelium of the MPD in rabbits and guinea pigs.

The epithelial lining of the MPD in dogs is characterized by the least variety in cell composition. The tall columnar epithelium ( $26.7 \pm 1.2 \mu$  in height) is both surface and glandular. The apical regions of cells are densely packed with PAS-positive granules. Argyrophilic endocrinocytes were not found but in acinar tissue they are clearly in evidence.

The epithelium of the MPD in cats is also represented by main cells ( $25.4 \pm 0.8 \mu$ ) which perform a secretory function. An abundance of argyrophilic endocrinocytes of both closed and open type is the fundamental dissimilarity from the epi-



**Fig. 1.** Histological structure of the main pancreatic duct in guinea pig (a, b) and cat (c). a) main and goblet (arrow) cells and glands proper (double arrow) of duct (stained with iron-hematoxylin,  $\times 144$ ); b) aldehyde-fuchsinophilic secretion in goblet cells and glandules of the duct (stained with aldehyde-fuchsin after Gomori,  $\times 144$ ); c) argyrophilic cells (impregnation after Grimelius,  $\times 240$ ).

TABLE 1. Epithelium of the MPD in Mammals of Different Alimentary Specialization

Epithelial cells	Rat ( <i>Rattus albus</i> )	Rabbit ( <i>Lepus cuniculus</i> )	Guinea pig ( <i>Cavia cobaya</i> )	Dog ( <i>Canis familiaris</i> )	Cat ( <i>Felis catus</i> )
Main (Surface)	+	+	+	+	+
Goblet cells	—	+	+	—	—
Endocrine	+	+	+	—	+
Low—differentiated	+	+	+	+	+
Histochemical composition of epithelial secretion	N	N, Sf, Si	N, Sf, Si	N	N

Note. Glycoproteins: N — neutral, Sf — sulfated, Si — sialated.

thelium of the dog MPD. EC cells are identified among open-type endocrinocytes (Fig. 1, c).

Thus, the cell composition of the MPD epithelium and its histochemical properties manifest a dependence on the main alimentary specialization of the studied animals. The least variety in cell composition and the simplest type of epithelial mucous barrier are typical for carnivores (dogs and cats). Being surface and secretory at once, the epithelium has a secretory component consisting of neutral glycoproteins.

The production of the mucous barrier components is associated with goblet cells in animals whose food is rich in cellulose and in some cases with the glands proper of the duct (in guinea pigs). The composition of the secretion is distinguished by a high content of sulfo- and sialomucins, which reportedly [4] have the most protective effect on mucous membranes. It should be noted that herbivorous animals have the lowest pH of the gastric contents and the

longest duodenal gland zone [5]. These data and the fact that the most sizable mucous barrier was found by us in the rabbit and guinea pig MPD are probably in direct correlation. The results of our study show that in guinea pigs the cell composition and histochemical properties of secretion of the duct epithelium as well as the glands of the duct are very similar to the human MPD [2].

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