J. Anat. (1971), **108**, 2, pp. 291–293
With 4 figures
Printed in Great Britain

Patterns of mucin secretion in human intestinal mucosa

S. G. SUBBUSWAMY
Newcastle General Hospital, Newcastle upon Tyne 4

(*Received* 18 *December* 1969)

INTRODUCTION

This paper is a report of the results obtained by staining sections from different parts of adult human intestines with a combined Alcian blue–P.A.S. technique to demonstrate acid and neutral mucins.

MATERIAL AND METHODS

The sections studied were from the jejunum, the ileum, the appendix, the caecum and different parts of the large intestine. All specimens were from adults. Most were from grossly and histologically normal areas of organs removed surgically for various reasons. The remaining sections were from well preserved autopsy specimens.

All specimens were fixed in 10% formalin for at least 24 h. Sections cut at 5μm thickness were stained by a combined Alcian blue–P.A.S. technique, as described by Culling (1963). (The Alcian blue was of 0·1% strength, at pH of about 2·7.) Several sections were stained by either Alcian blue or P.A.S. alone for comparison.

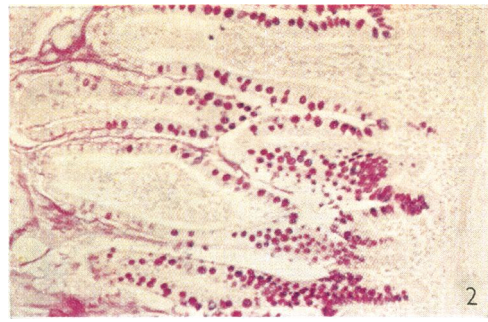
RESULTS

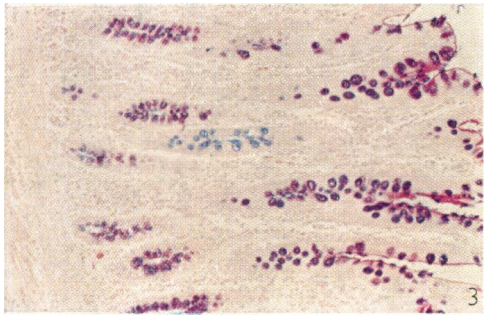
With the Alcian blue–P.A.S. technique, acid mucins stain a bright blue, while neutral mucins stain pink or purple. Intermediate forms representing mixtures of the two forms can also be seen (Greco, Lauro, Fabbrini & Torsoli, 1967).

In the present series, the goblet cells of the small intestine stained predominantly pink (Figs. 1, 2), a few taking up intermediate colours. These intermediate forms were seen more frequently at the base of crypts, and were commoner in the ileum than the jejunum. The goblet cells lining the villi in both regions stained almost entirely with P.A.S. alone.

The caecum contained a moderate number of intermediate forms, but apart from these, most of the goblet cells in the large intestine stained bright blue (Figs. 3, 4). Those at the surface stained somewhat less intensely than those lying deeper. The type of staining, however, was the same throughout the thickness of the mucosa.

The goblet cells of the appendix also stained bright blue for the greater part, but there was a much higher percentage of intermediate forms. A number of goblet cells were stained pink; these were commoner at the surface of the mucosa.





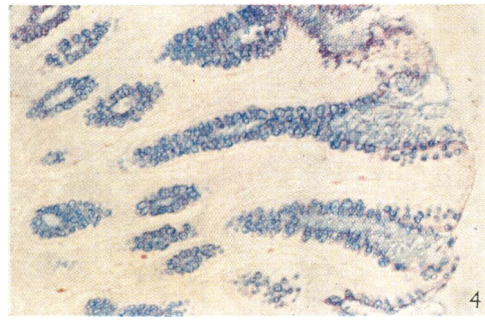


Fig. Jejunum: almost all goblet cells contain neutral mucin (staining with P.A.S.). Alcian blue–P.A.S., × 40.

Fig. 2. Ileum: showing a similar picture to Fig. 1. Alcian blue–P.A.S., × 40.

Fig. 3. Caecum: showing predominance of acid mucin (staining with Alcian blue). Alcian blue–P.A.S., × 40.

Fig. 4. Sigmoid colon: all goblet cells contain acid mucin. Alcian blue–P.A.S., × 40.

DISCUSSION

The P.A.S. and Alcian blue techniques have been used by various authors to differentiate between the mucin patterns of different parts of the intestines. Lillie (1951) found that in rodents small intestinal goblet cells stained strongly with P.A.S., while the cells of the colon showed a varying picture of intense to negative staining. Martin (1961) showed that all parts of the intestines of the dog stained uniformly with P.A.S.; the intestinal tracts of the guinea-pig and the rabbit showed differences in intensity of staining in different areas.

Lauren (1961) stated that the human sigmoid colon stained strongly with Alcian blue but only weakly with P.A.S., while the small intestine and the caecum stained strongly with both stains. Lev & Spicer (1965) demonstrated differences in intensity of staining, the goblet cells of the small intestine staining much more strongly with P.A.S. than those of the colon.

The results obtained with the separate P.A.S. and Alcian blue techniques in the present series were very similar to those obtained by the above authors. The combined technique, however, brought out the differences much more sharply. The general

principle appears to be that small intestinal goblet cells secrete predominantly neutral mucin, while large intestinal goblet cells secrete predominantly acid mucin.

One question that has to be answered is whether this difference is a fundamental difference in cell types or merely an expression of environmental differences. The results obtained with the combined Alcian blue–P.A.S. technique on specimens of intestine showing metaplastic change are of interest in this context. In every example the mucin pattern was that of the tissue which the epithelium morphologically resembled. In one specimen, islands of mucosa resembling that of the colon, the small bowel and the pylorus were found side by side; the colonic type of mucosa stained blue while the other two types stained pink. The type of mucin produced thus appears to be a characteristic of the mucosal cell and not merely a function of the environment.

The Alcian blue–P.A.S. technique is an extremely simple procedure and appears to differentiate sharply between colonic and small intestinal mucosa. It might prove to be of value in the study of metaplastic and neoplastic states. An added advantage of the combined technique is that the P.A.S. acts as a strong red counterstain, bringing out the blue colour of the acid mucin. This might be of value in demonstrating small amounts of acid mucin.

SUMMARY

A combined Alcian blue–P.A.S. technique has been used to demonstrate that goblet cells of the small intestine produce predominantly neutral mucin, while those of the colon predominantly produce acid mucin. This appears to be a fundamental difference between the cell types, and not merely caused by differences in environment.

My grateful thanks are due to Dr B. E. Tomlinson for permission to use material from the files of the Pathology Department of the Newcastle General Hospital, to Mr D. S. Smith for his technical assistance and to Miss D. Kitchener for helping with the photographs. I would like to thank the Newcastle Regional Hospital Board for bearing the cost of colour prints, making this paper possible.

REFERENCES

CULLING, C. F. A. (1963). *Handbook of Histopathological Techniques.* (2nd ed.), p. 233. London: Butterworth.

GRECO, V., LAURO, G., FABBRINI, A. & TORSOLI, A. (1967). Histochemistry of colonic epithelial mucins in normal subjects and in patients with ulcerative colitis. *Gut* **8**, 491–496.

LAUREN, P. (1961). The cell structure and secretion in intestinal cancer. *Acta path. microbiol. scand.* (suppl.), **152**, 109–110

LEV, R. & SPICER, S. S. (1965). A histochemical comparison of human epithelial mucins in normal and in hypersecretory states including pancreatic cystic fibrosis. *Am. J. Path.* **46**, 23–47.

LILLIE, R. D. (1950). Histochemical comparison of the Casella, Bauer and periodic acid oxidation—Schiff leucofuchsin technique. *Stain Technol.* **26**, 123–136.

MARTIN, B. F. (1961). The goblet cell pattern in the large intestine. *Anat. Rec.* **140**, 1–15.