Kasetsart J. (Nat. Sci.) 18 : 186–191 (1984)

Differentiation of the Parietal and Chief Cells in Stomach of the Foetal Pig

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ABSTRACT

The differentiation of the parietal and chief cells of the gastric mucosa has been studied with histological methods in the foetal pig at different stages of development. The first differentiation of partietal cell was found in a foetus at 6 cm CRL, which corresponds to an age of about 5 weeks, whereas the chief cell was observed at 16 cm CRL at the age of about 9 weeks.

INTRODUCTION

The stomach of the pig embryo is formed by the primitive gut and can be seen clearly by a dilatation at a crown-rump length (CRL) about 10 mm (Patten, 1959). The first differentiated specific gastric gland cells have been reported to be parietal cells in pig (Bensley, 1903; Kirk, 1910) and in humans (Plenks, 1931; Tuovinen, 1946; Salenius, 1962). Bensley (1903) found the parietal cells in the cardia and the fundus in a 7.5 cm foetus, and the appearance of the chief cells in the fundic region at the stage of 21 cm CRL of pig foetus. According to Kirk (1910) the parietal cells occurred in the porcine foetal stomach at 3 cm CRL. These cells are confined only to the cardiac region, whereas the differentiation of the parietal cells in the fundus glands showed in 6 cm CRL. The chief cells appeared at about the 19–20 cm stage.

Heidenhain and Rollet (1870) were the first to discover the chief cells in the gastric glands of the adult pig. Sewal (1879) in sheep, Toldt (1880) in pig and cat, Johnson (1910) in humans stated that the parietal and chief cells differentiate at the same stage of foetal development. The differentiation of the chief cells was found in the pig foetus at about 10–20 cm CRL, whereas the parietal cells differentiate at a later stage (Needham, 1931). Ascoli (1901) maintained that the parietal cells appear later than the chief cells.

In view of the variations presented in the literature an investigation of the stages of the differentiation the parietal and chief cells in the pig foetus has been undertaken.

MATERIAL AND METHODS

The material examined comprised 77 stomachs of foetuses from the Danish pig breed (Danish Landrace). The foetal CRL was measured, and the stomachs were fixed 30–60 minutes after slaughter. The fixatives used were either Bouin's fluid, formal-saline, or Helly's solution depending on the subsequent staining methods.

For the identification of the parietal cells the staining used was periodic acid-schiff (PAS) and counterstain with haemalum and aurantia. Besides, staining with haemalum-eosin and Cain's method for mitochondria were used for the same purpose. Heidenhain's iron hematoxylin was chosen for the identification of the chief cells. All staining techniques were carried out as recommended by Drury and Wallington (1967).

The age of the pig foetuses was determined by a slight modification of the method of measuring the length of the pig foetuses suggested by V. De Villiers et al. (1958).

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TABLE

No. of cases	CRL average in cm	Probable age in days (after conception) (after De Villiers et al.)	Treatment of the material I	II	III	IV
4	1.4	30	−	+	−	−
3	3.0		−	+	−	−
3	3.8		−	+	−	−
3	4.9		+	+	−	−
5	6.0		+	+	−	−
5	6.3		+	+	+	−
5	7.0	40	+	+	+	−
3	8.0		+	+	+	+
2	8.4		+	+	−	−
5	9.5		+	+	+	−
2	10.5		+	+	−	−
2	11.5		+	+	−	−
3	13.6	60	+	+	+	−
4	15.7		+	+	+	−
3	16.0		+	+	+	−
1	17.0		+	+	+	−
5	18.5		+	+	+	−
2	20.0	70	+	+	+	−
5	21.5		+	+	+	+
4	24.0	80	+	+	+	+
4	26.0		+	+	+	+
1	27.0		+	+	−	+
3	29.0	100	+	−	+	−

77 stomach + = treatment
− = non-treatment.

Explanation to the table :

Treatment of the material is seen in the table, where the CRL is shown in centimetres, age of foetuses in days after V. De Villiers et al. (1958). The last column shows the staining methods as follows :

I = PAS and haemalum-aurantia.
II = Haemalum-eosin.
III = Heidenhain's iron hematoxylin.
IV = Cain's method for mitochondria.

Observations

In the present study the following results were observed in the fundic region of the stomachs which had been localized on the basis of the histological method only.

Differentiation of the Parietal Cells

The gastric epithelium of the stomach of the smallest embryo, whose length was 1.4 cm, showed a typical pseudostratified columnar epithelium, and a few mitoses were found.

The gastric pits were formed as a result of depression in the gastric epithelium towards the basement membrane when the pig foetuses were 3 to 3.8 cm long (Fig. 1). The expanded portion of the pit thus formed the gastric gland, and the morphological differentiation of a few cells at the bottom of the pit could be observed at the 6 cm CRL stage. These cells were stained yellow by aurantia corresponding to the stainability of the parietal cells of the adult pig. They nearly corresponded in shape too. These differentiated cells were seen more clearly and occurred more abundantly in the older foetuses and some of them could be found closer to the surface of the pit (Fig. 2).

With Cain's staining method the mitochondria were seen plentifully in the parietal cells (Fig. 3).

Differentiation of the Chief Cells

For the above purpose the tissue was stained with Heidenhain's iron haematoxylin. Cells containing black granules emerged clearly in 16 cm long foetuses (Fig. 4). The sections of stomachs from the foetuses whose CRL was 18.5 cm, 21.5 cm, and 24.0 cm, stained by this method showed the same black granules morphologically, and they were abundant in all cases (Fig. 5).

With Cain's staining method at the base of the gastric glands small granules were seen in some cells and these might be considered as secretion granules of the chief cells.

DISCUSSION

The results of this investigation are in agreement with those of most previous investigators with regard to the sequence of differentiation of both the parietal and chief cells.

Most investigators thus believe that the parietal cells are the first to differentiate and are stained by acid dyes (Kirk, 1910; Plenk,

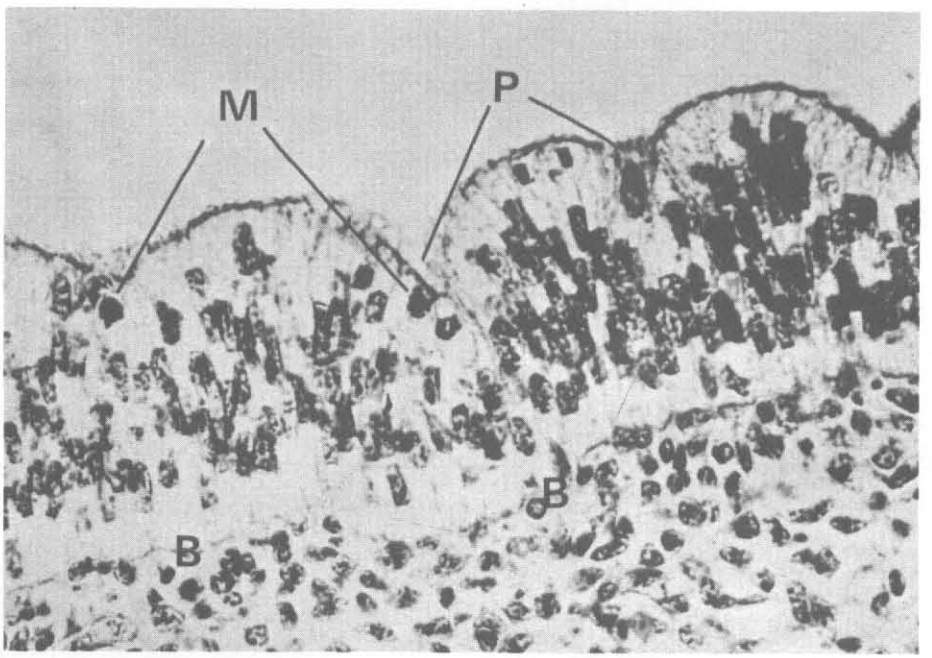

Fig. 1. Gastric mucosa of the foetal pig, 3.8 cm CRL, gastric epithelium showing the gastric pits and mitotic figures (H & E) 500 X.
M = Mitotic figures; P = Gastric pit; B = Basement membrane.

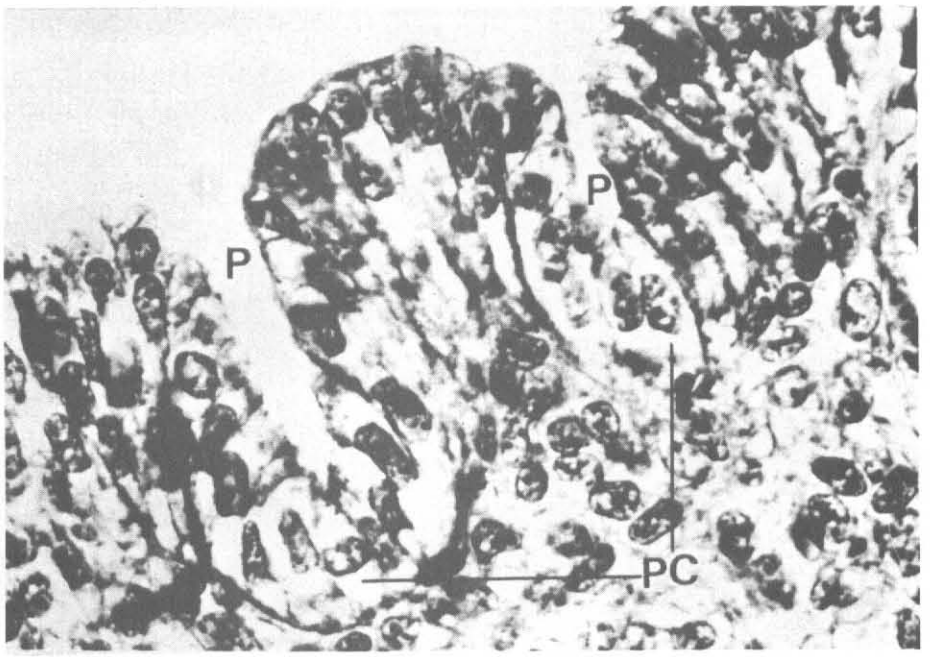

Fig. 2. Gastric mucosa of the foetal pig, 6 cm CRL, at the bottom of the gastric pits showing the differentiated parietal cells (PAS-haemalum-aurantia) 640 x green filter.
P. = Gastric pit; PC = Differentiated parietal cells.

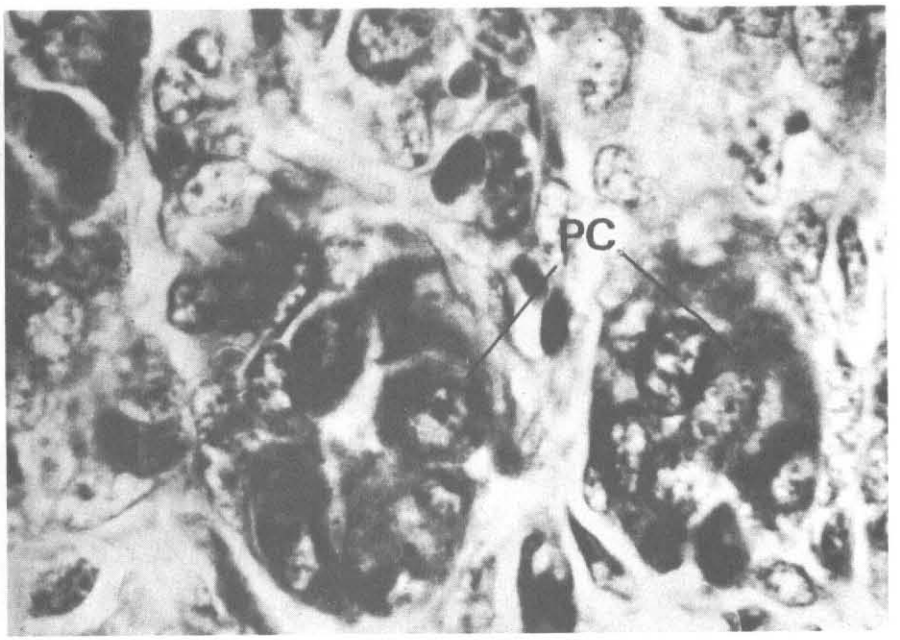

Fig. 3. Gastric glands of the foetal pig, 24 cm CRL, showing the mitochondria staining in parietal cells (Cain's method) 1,200 x, blue filter.
PC = Parietal cells.

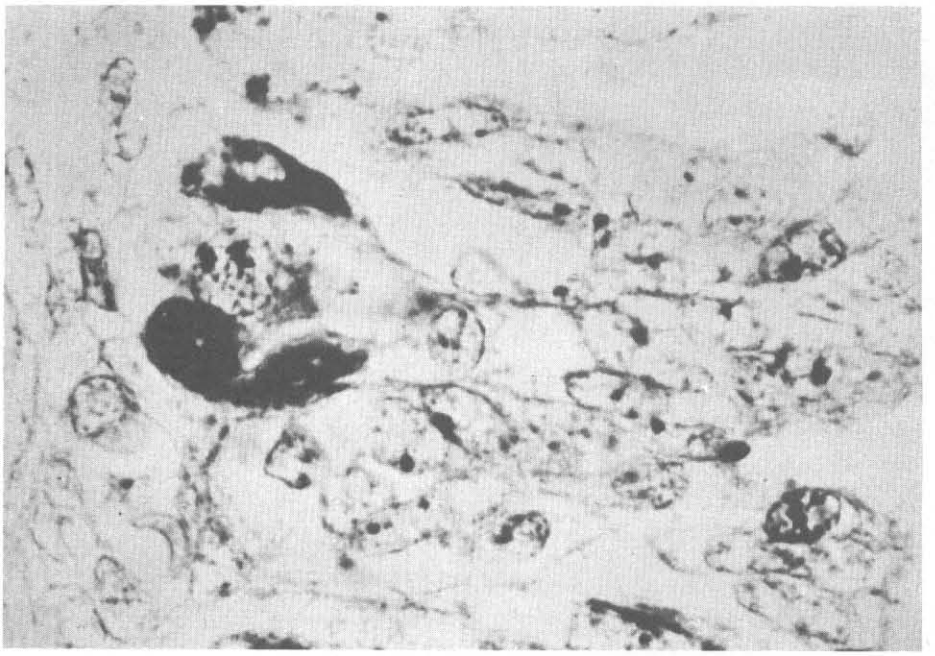

Fig. 4. Gastric mucosa of the foetal pig, 16 cm CRL, showing the differentiated chief cells in the gastric gland which cells containing black granules were seen clearly (Heidenhain's iron haematoxylin) 1,200 x.

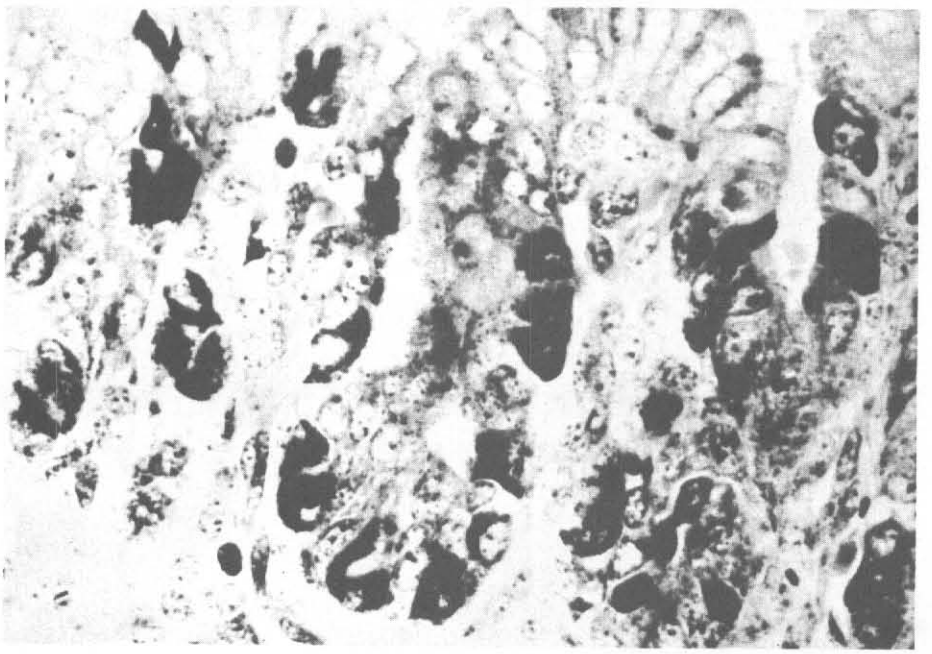

Fig. 5. Gastric mucosa of the foetal pig, 24 cm CRL, showing plenty of chief cells in different parts of the gastric glands which cells containing black granules were seen (Heidenhain's haematoxylin) 640 X. Green filter.

1931; Tuovinen, 1946; Salenius, 1962) as in adults. In the present material both the form and staining properties showed the same characteristics as mentioned above when treated with PAS-haemalum-aurantia, haemalum-eosin. By this distinguishable appearance it can be assumed that the differentiation of the parietal cells of the pig foetuses occurs at a CRL of 6 cm corresponding to an age of approximately 5 weeks.

Characteristic of the chief cells is their staining ability with basic dyes in the full-grown experimental animal and adult human. This has been explained as being due to its high content of ribonucleic acid (RNA). The protein synthesis takes place in all cells during the foetal period (Brachet, 1950). According to Putchler (1958) proteins are responsible for staining by Heiden-hain's iron haematoxylin, which is an important stain used for differentiation of the chief cells (Plenk, 1932). In the present material which had been treated accordingly were observed : The increasing amount of black granules had been found in the cytoplasm of some cells from the stomachs of pig foetuses, 16 cm long and about 9 weeks old. Thus the first differentiation of chief cells can be seen in a 9 weeks old pig foetus.

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