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Scanning Electron Microscopic Observation on the Rat Oviductal Epithelium in each Segment during Normal Sexual Cycle

Jae-Hyun Lee
(Department of Veterinary Medicine, College of Agriculture, Kyung-Buk National University)

白鼠卵管上皮의 走査電子顯微鏡的 觀察

李 在 鉉
(慶北大學校 農科大學 獸醫學科)

要 約

正常 性週期를 나타내는 白鼠의 卵管에서 各 領域에 分布하는 上皮細胞를 走査電子顯微鏡으로 觀察하여 다음과 같은 結果를 얻었다. 즉, 白鼠卵管上皮細胞는 섬모세포와 無섬모세포로 구성되며, 無섬모세포는 4가지 細胞型으로 區別할 수 있고 또한 이들 各型의 細胞는 性週期時 特定領域에 分布하였다.

INTRODUCTION

In the mammalian oviducts, two types of epithelial cells have been identified; ciliated and non-ciliated cell. The writer distinguished the rat oviductal epithelium by the transmission electron microscopical studies into four types generally (Lee, 1979) and he divided the oviduct into five segments according to the distribution of various types of cells by the light microscopic observation in the rat (Lee et al, 1976).

There are no report on the rat oviductal epithelium by the scanning electron microscopic (SEM) observation except the reports of Gaddum-Rosse & Blandau (1976) and Lee (1977) they described the junctura cell of junctura part of the rat oviduct.

Using the scanning electron microscope the present writer have exmined the epithelial surfaces of whole segments of oviducts from normal rats showing normal sexual cycle, and the morphological characteristics of each cell type in each segment will be described in this paper.

MATERIALS AND METHODS

Fifteen white wistar normal cycling rats aged 3 to 5 months were used as materials. The oviducts were quickly dissected from each rat and placed in a physiological saline solution. The oviducts were separated from the uterus and ovary, and trimmed off fats and other extraneous tissues under a stereoscope. The oviducts were extended and cut into segment by the method of Lee et al (1976). Each segment was dissected free longitudinally with razor. Mucin was removed by the method of Dirksen and Satir(1972). The tissues were dehydrated in su ccessive grades of ethanol. The ethanol was replaced with iso-amyl acetate, and the specimens were critical point dried (HCP-I) using carbon dioxide with gold in the ion coater and were examined with a MSM-4T type scanning electron microscope operating at 10 to 15kV in the secondary electron mode.

RESULTS

A. The cell type of rat oviductal epithelium:

Rat oviductal epithelium could be generally distinguished into two types of cells; ciliated and non-ciliated cell.

1. Ciliated cell (CC); This cell had cilia which was measured approximately 0.2μ in width and 3~5μ in length. The cilia was protruded toward the lumen from the cell surface. The proportion of ciliated cells various, with the greatest number of ciliated cells being found in the segment I and very few in the segment Ⅳ (Figs. 3~5).

2. Non-ciliated cell; This cell was characterized by having microvilli or cytoplasmic protrusion. The cell surface is thrown into numerous slender extensions of microvilli which was measured approximately 0.1μ in width and 1~6μ in length. According to the length of microvilli and the distribution in each segment, this cell was further subdivided into four types as follows:

a) Type Ⅰ non-ciliated cell (NC-Ⅰ) had rarely microvilli on the cell surface. This cell was mainly distributed in the segment Ⅰ, but a few in the segment Ⅱ, Ⅲ and Ⅴ (Fig. 10).

b) Type Ⅱ non-ciliated cell(NC-Ⅱ) had somewhat dense short microvilli on the cell surface, and mainly distributed in the segment Ⅱ, Ⅲ and Ⅴ (Figs. 1,2).

c) Type Ⅲ non-ciliated cell(NC-Ⅲ) had dense long microvilli on the cell surface, and mainly distributed in the segment Ⅳ, but a few in the segment Ⅲ (Figs. 3,4,5).

d) TypeⅣ non-ciliated cell (NC-Ⅳ) had short sparse microvilli on the cell surface and was seen to have the cytoplasmic protrusions. This cell was mainly distributed in the segment Ⅱ and Ⅲ (Figs. 2,5,6,8).

B. The cell distribution in each segment:

1. Segment I: The ciliated cell was mainly distributed in this segment, but a few of NC-Ⅰ and NC-Ⅱ were also found. The cilia have attained their full length. The non-ciliated cell was tend to be found more at metestrus and diestrus than the other sexual stages during normal sexual cycle (Figs. 9,10).

2. Segment II: A number of the ciliated cells were mainly distributed in this segment, and moderate NC-Ⅱ and NC-Ⅳ were also distributed. Numerous folds were found. The proportion of ciliated and non-ciliated cells was generally three to two. In the metestrus a number of NC-Ⅳ were partially found (Figs. 7,8).

3. Segment III: The NC-Ⅱ was mainly distributed in this segment, but a number of NC-Ⅲ were also found relatively. The proportion of ciliated and non-ciliated cells was generally one to two, and the NC-Ⅳ showing the apocrine secretion which was a secretory process were also found. The part of the protrusion of this NC-Ⅳ type was formed bumpy in shape (Figs. 5,6).

4. Segment IV: In this segment the NC-Ⅲ was mainly distributed, and these cells had dense long microvilli. A few ciliated cells were found between the folds which distributed with NC-Ⅲ (Figs. 3,4).

5. Segment V: In the intramural part of this segment, the NC-Ⅱ which was flate and had dense short microvilli were mainly distributed. The tubular gland-like structures are also found (Fig. 1). In the extramural part the epithelial cells were somewhat protruded, and the morphology of each cell was found more clearly in shape than the cells of the intramural part. The type Ⅱ non-ciliated cells had more dense long microvilli than the cells of intramural part. The NC-Ⅳ which was apocrine-like form in shape was appeared in the proximal part of the segment Ⅳ (Figs. 1,2). In this segment the ciliated cell could not be found throughout the sexual cycle.

DISCUSSION

Scanning electron microscopic (SEM) studies on the mammalian oviductal epithelium have been reported by many investigators; Dirksen & Satir (1972), Dirksen (1974) and Dirksen & Staprans (1975) on the mouse, Ferenczy et al (1972) and Patek et al (1972) on the human, Kanagawa et al(1973) and Rumery & Eddy (1974) on the rabbit, Stalheim et al (1975) on the bovine, porcine, equine, and caprine, Nayak (1977) on the camel, and they suggested that the oviductal epithelium consisted of two types of cells; ciliated and non-ciliated cell.

In the rat oviduct, on the other hand, there are no reports by SEM observation except for Gaddum-Rosse & Blandau (1976) and Lee (1977) grossly

described the epithelium of junctural part. The proportion of ciliated and non-ciliated cells in each segment was different from the species (Dirksen& Satir, 1972; Ferenczy et al, 1972; Kanagawa et al, 1973; Rumery & Eddy, 1974, Stalheim et al, 1975). Kanagawa et el (1973) reported that the proportion of ciliated cells on the rabbits oviducts gradually increased from the isthmus (30%) to the ampulla (50%), and the fimbriae were composed of approximately 70~85% ciliated cells. Dirksen & Satir (1972) reported that the proportion of ciliated to non-ciliated cells was varied, with the greatest number of ciliated cells being found in the fimbria and very few in the isthmus. On the other hand, a number of the ciliated cells of human oviduct by SEM observation were mainly found in the covering epithelium of the folds (Ferenczy et al, 1972), but in the other mammalian oviducts those were found between the folds (Kanagawa et al, 1973; Rumery & Eddy,1974; Stalheim et al, 1975).

With regard to the length of cilia of ciliated cells on the oviductal epithelium, there are considerable disagreements depend on the species(Anderson, 1951; Björkman & Fredricsson, 1962; Brenner, 1969; Dirksen & Satir, 1972; Dirksen, 1974; Lee, 1979; Nayak, 1977; Nilsson, 1957; Nilsson & Reinius, 1969; Stalheim et al, 1975).

In the present study the writer observed by SEM in the whole length on the rat oviduct, and known that the cells which distributed on the epithelial linning of oviduct were ciliated and non-ciliated cells. The morphology of ciliated cells was well in accordance with previous other works. The ciliated cells had always cilia which was measured 0.2μ in width and 3~5μ in length throughout the sexual cycle. This cell was distributed mainly in the segment Ⅰ, while there was a successive decrease in the number of ciliated cells towards the segment Ⅳ. Especially this cell in the segment Ⅳ distributed between the folds. Nilsson (1957) reported that the cilia on the rat oviducts was measured 3~5μ in length and 500~600Å in diameter. On the other hand, the length of cilia on the mouse oviduct was 5μ (Dirksen, 1974; Dirksen & Satir, 1972).

In the present observations, non-ciliated cells which had microvilli in various length covering the free surface could be found throughout the whole oviduct. The proportion of this cell was tended to be found the reserve to that of ciliated cells. The non-ciliated cells could be subdivided into four types according to the distribution and the length of microvilli; NC-Ⅰ, NC-Ⅱ, NC-Ⅲ and NC-Ⅳ. Moreover, NC-Ⅰ and NC-Ⅱ was mainly found in the segment Ⅰ, Ⅱ and a few in the segment Ⅲ and Ⅴ. NC-Ⅲ was mainly found in the segment Ⅳ. NC-Ⅳ was mainly found in the segment Ⅱ, Ⅲ and a few in the extramural part of the segment Ⅴ.

The length and diameter of the microvilli was different from the species and the each segment (Dirksen & Satir, 1972; Nayak, 1977; Stalheim et al, 1975). Nilsson & Reinius (1969) on the rat oviduct by TEM suggested that the length of microvilli was measured 2μ in the ampulla, 5μ in the isthmus and 1~2μ in the junctura part. On the other hand, Lee (1979) on the rat oviduct reported that the non-ciliated cells were distinguished into three types (SSC, LSC, JC) according to the length of microvilli. In the present observation, the microvilli was mesured approximately 1~6μ in length and 0.1μ in width.

It is well in accordance with report that Gaddum-Rosse & Blandau (1976) have found the secretory cells having short, typical microvilli in the rat isthmus near the utero-tubal junction, and the writer have been found the type Ⅱ non-ciliated cell in the extramural part of the segment Ⅴ. Furthermore, as report by Rumery & Eddy (1974), apocrine-like structure of non-ciliated cells was also found.

With regard to the morphology of junctura cells, a few reports are there by SEM and TEM (Gaddum-Rosse & Blandau, 1976; Nilsson &Reinius, 1969; Lee, 1977) during normal sexual cycle. Lee (1977) reported that the activity of secretory function of JC was quite different from the other secretory cells after hormone treatments. The SEM observations also revealed that after estradiol the JC had more irregular and long microvilli on the surface that after progesterone treatment. In the present study, JC also had unique morphology different from the other non-ciliated cells. Although

the ciliated and four types of non-ciliated cells were appeared at unique segment or each sexual stage, the distinct result on the relationship between the proportion of these cells and sexual cycle could not obtained. Further studies are needed.

SUMMARY

Scanning electron microscopic observation of the oviductal epithelium was carried out on the virgin white Wistar rat during normal sexual cycle, and obtained the results as follows;

Rat oviductal epithelium during the normal sexual cycle generally consisted of two types of cells: ciliated and non-ciliated cell. The ciliated cells had cilia which was measured 0.2μ in width and 3-5μ in length. According to the length of microvilli and the distribution in each segment, the non-ciliated cell was further subdivided into four types of cells; NC-Ⅰ, NC-Ⅱ, NC-Ⅲ, and NC-Ⅳ. The morphologic characteristics of each type of cells were also ascertained by SEM observations.

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Explanation of Figures

Fig. 1. NC-Ⅱ type cells and tubular gland-like structure (arrow) are present in the segment Ⅴ.
X7,000

Fig. 2. Numerous NC-Ⅱ type cells and moderate NC-Ⅳ type cells are present in the segment Ⅴ.
X1,000

Fig. 3. NC-Ⅲ type cells forming the folds and the ciliated cells (arrow) are present between the folds in the segment Ⅳ.
X2,000

Fig. 4. Numerous NC-Ⅲ type cells with long microvilli and a few ciliated cells(CC) are observed in the segment Ⅳ.
X5,000

Fig. 5. NC-Ⅲ type cells, NC-Ⅳ type cells showing the cytoplasmic protrusion and ciliated cells with long and regular cilia are present in the segment Ⅲ.
X3,000

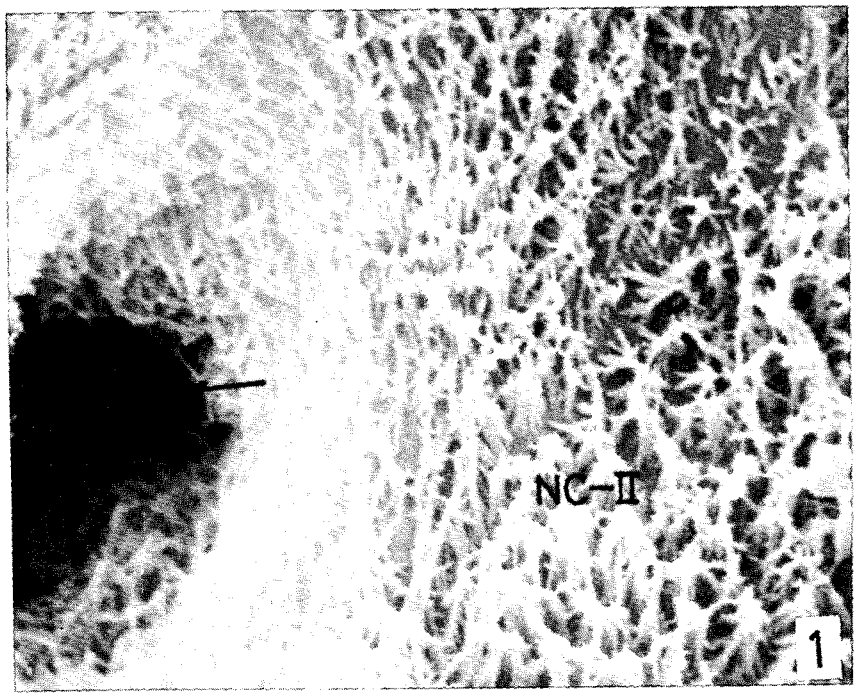
Fig. 6. Higher magnification of Fig. 5.
X5,000

Fig. 7. Numerous folds are present in the segment Ⅱ.
X400

Fig. 8. Numerous ciliated cells and NC-Ⅳ type cells (arrow) are present in the segment. Ⅱ.
X2,000

Fig. 9. Numerous ciliated cells are present in the segment Ⅰ.
X2,000

Fig. 10. Numerous ciliated cells (CC) and a few NC-Ⅰ type cell (arrow) or NC-Ⅱ type cells are present in the segment Ⅰ.
X3,000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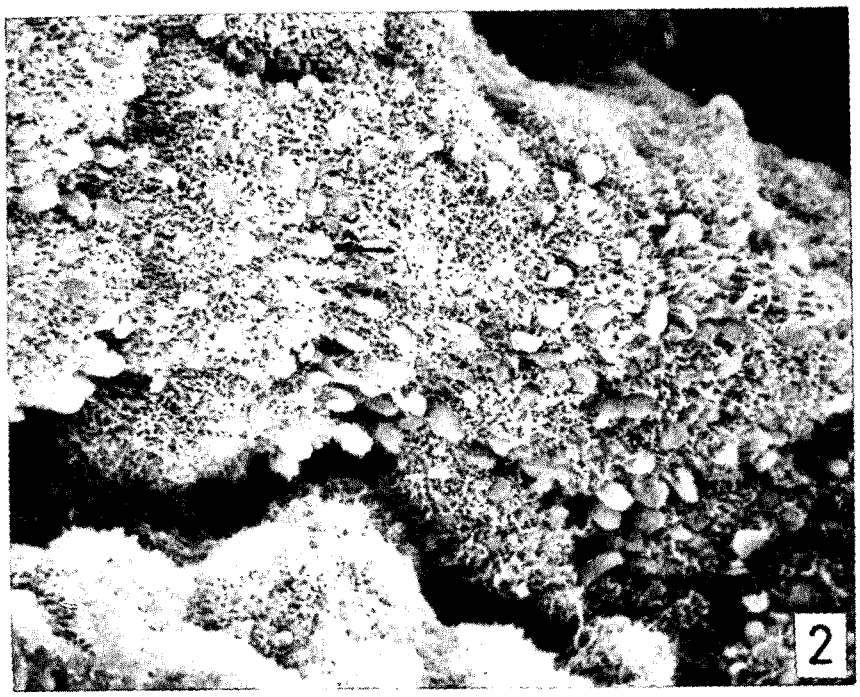
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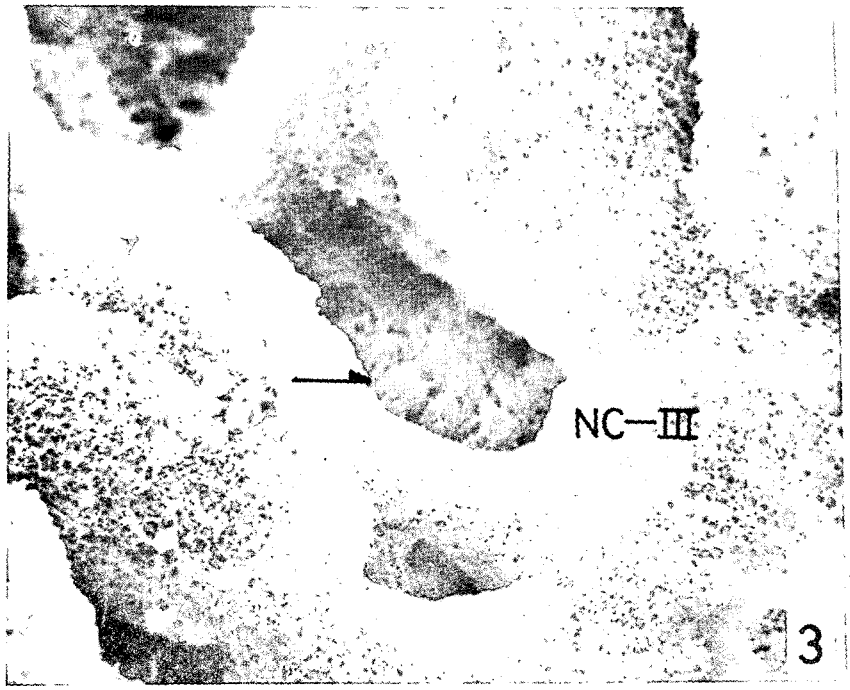
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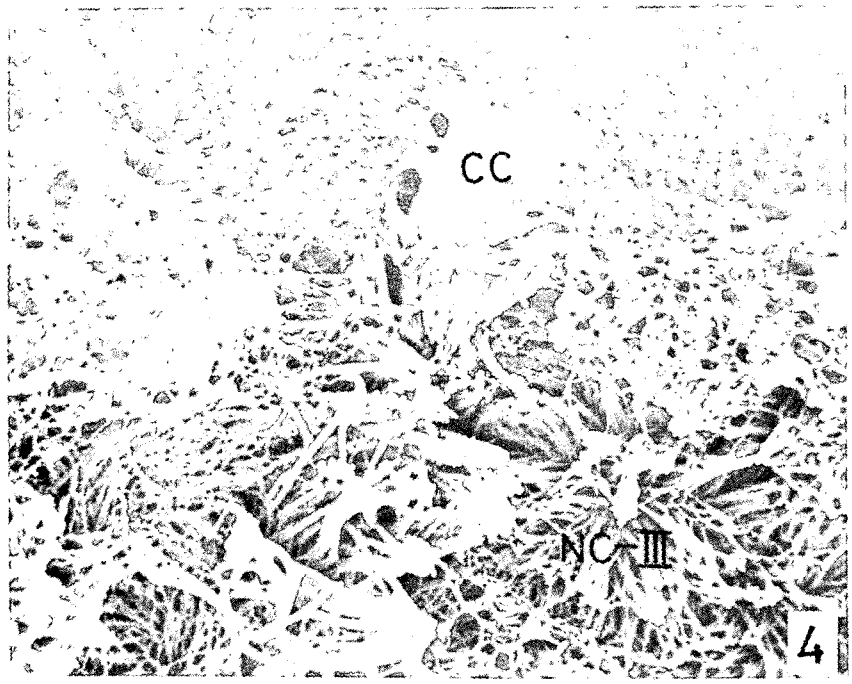
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NC—III
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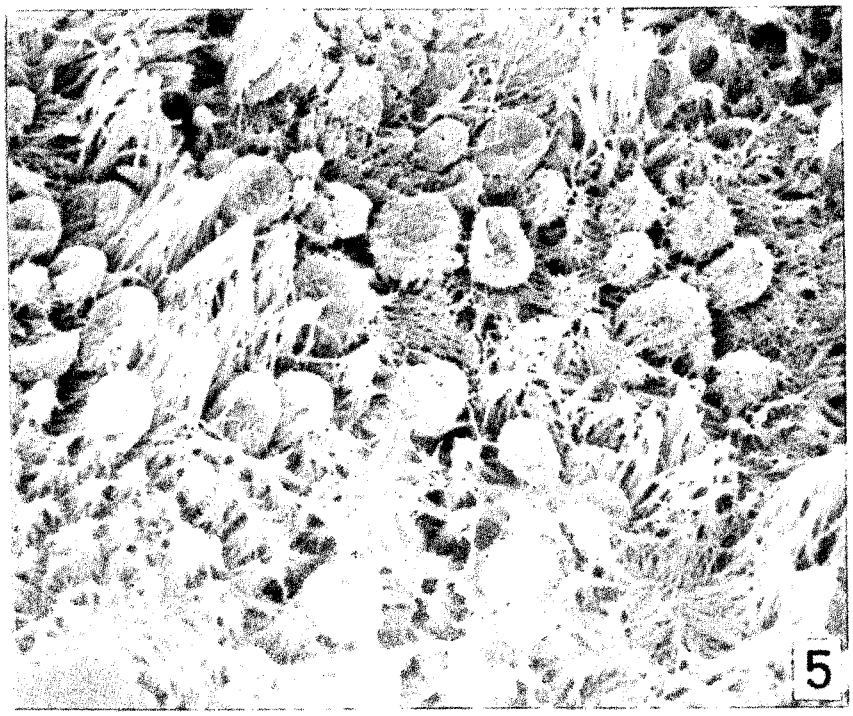
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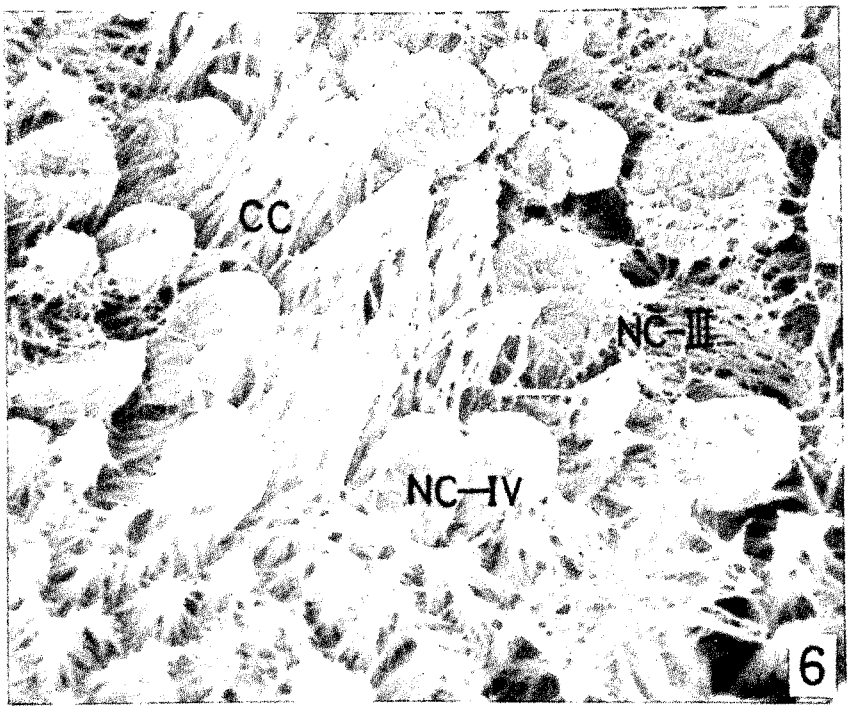
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NC-IV
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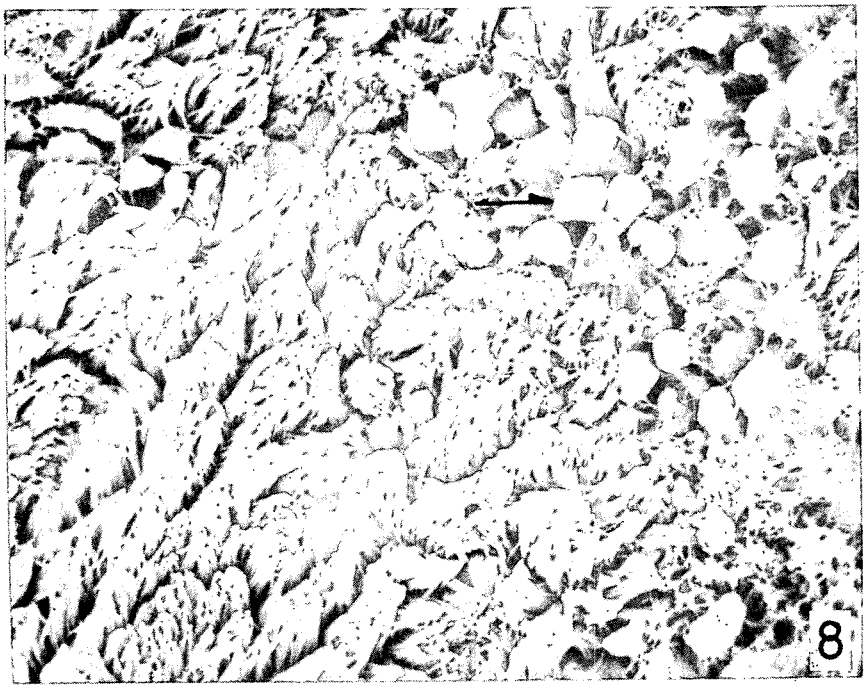
7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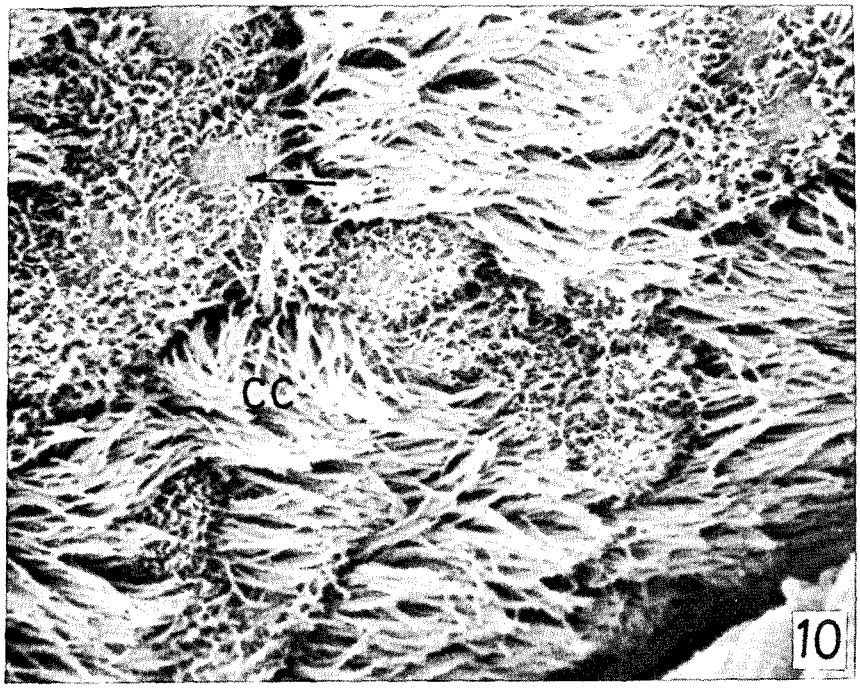
CC
10