CHAPTER III

MORPHOLOGY OF THE PINEAL GLAND OF THE FEMALE GERBIL, TATERA INDICA CUvierI

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INTRODUCTION

One of the known functions of the pineal gland in relation to reproduction is its involvement in timing the reproductive activity with seasonal photoperiodic changes. Many studies support the view that in mammals, the pineal gland participates in the photoperiod-related seasonal changes of an endocrine nature. The reproductive status of various animal species varies markedly as a function of pineal activity (Cardinal and Vacas, 1980; Reiter, 1980). Our understanding of the mechanism by which the mammalian pineal gland influences the reproductive activity is far from clear.

The studies on the pineal gland have been restricted to common laboratory rodents, such as rat, hamster, and mouse. Not much is known about the pineal gland and its function in the wild species occurring in the natural conditions. This chapter aims to contribute towards an understanding of the functional morphology and the glandular aspects of the pineal gland of the female gerbil in normal and in females kept under experimental conditions.

MATERIAL AND METHODS

The studies on the pineal gland of the gerbils were made in the following groups of females:

Group 1 The post-natal development: The post-natal development of the pineal gland was studied in the infant and young gerbils with a body weight range of 4, 10, 60, 80 and 100 gm.

Group 2 Adult mature gerbils (body weight 100 gm and above) collected during the breeding and non-breeding months of the year.
Group 3 Adult mature gerbils which were maintained in the laboratory during the breeding season and exposed to total continuous light (TL) 24 hours for a period of 20 days.

Group 4 Adult female gerbils kept in total darkness (TD) of 24 hours for a period of 20 days in a chamber specially made for the purpose and were fed in dark without altering the given experimental conditions.

Group 5 Control gerbils were maintained under the conditions of alternating equal light and equal darkness of 12 hours each (12 L : 12 D) for a period of 20 days.

Three females were used in each group. The gerbils were fed with standard rat pellets (Hind Leaver Ltd) every day at 19-00 hours and water was provided ad libitum. During autopsy, the gerbils were killed using an over dose of ether. On opening the skull, the brain with the pineal gland was removed immediately fixed in 10% neutral formalin or Bouin's fluid after slicing the brain into three parts in the parasagittal plane. After fixation for 24 hours duration, the part of the brain containing the pineal gland was processed routinely through graded alcohols, xylene and embedded in paraffin wax. Serial sections were cut at 5-7 μ thick in a Rotary microtome and the slides were stained with haematoxylin-Eosin and also by the following methods:

1. Aldehyde fuchsin method by the oxidation with potassium permanganate for neurosecretory material (Halmi, 1952).

2. Periodic acid Schiff/orange G/methyle blue method (Wilson and Ezrin, 1954) for the demonstration of cytoplasmic basophilia.
3. Chrome alum haematoxylin and phloxine method (CAHP) for the neurosecretory material (Gomori, 1941).

The pineal size was determined in each case by projecting the stained pineal sections on to a paper at a known magnification. Measurements at right angles to each other in the largest section of the pineal gland was taken for calculation. The pineal size, pineal cell and its nuclear sizes were also determined from randomly selected 10-20 cells according to Barlow and Sherman (1972, vide Chapter II).

OBSERVATIONS

A. GROSS ANATOMY: The pineal gland of the female gerbil, lies in the postero-dorsal roof of the diencephalon between the habenular and posterior commissures (Text Fig.1; Figs. 1, 2, 3). In the female gerbil, the pineal gland is triangular in shape and solid in structure (Fig.4). The gland is not well separated from the roof of the diencephalon and its Volume ranges from 0.0096 mm$^3$ in the new born gerbil to 0.0148 mm$^3$ in an adult female.

Within the pineal gland of the normal female two distinct zones can be distinguished topographically. One
the pineal proper or the superficial pineal and the other the deep pineal, surrounding the pineal recess and the part which is continuous with the pineal stalk (Fig.5). The third ventricle extends into the pineal recess.

B. POST-NATAL DEVELOPMENT: In the pineal gland of the young and pre-pubertal gerbils the pinealocytes are predominant (Fig.6), and their differentiation into cell types are not definite. In the pre-pubertal female the pinealocytes are large and oval to round in shape. The
nucleus is clear and is centrally placed with a distinct nucleolus (Fig. 7). The cytoplasm of these pinealocytes shows affinity to PAS/methylene blue stains. The presumptive neurosecretory material (CAHP positive), to a little extent is also evident in the cytoplasm of these cells. Occasionally few thin processes are seen to contain granular material which stained purple red with chrome alum haematoxylin phloxine (Fig. 7, arrow). During the post-natal phase, the pineal gland increases from 0.0019 mm$^3$ to 0.0148 mm$^3$. During development the pineal cells show hypertrophy but the nuclear size decreases. With the advance of differentiation, the nuclear changes progress and crumpling or folding of the nuclear membrane is apparent. Text Fig. 2 shows the pineal size, cell and nuclear changes during post-natal development.

C. MICROSCOPIC ANATOMY: Within the pineal gland, three types of pinealocytes are apparent. Type I pinealocytes are smaller (8–10 μ), oval shaped with granular cytoplasm and contain centrally placed nuclei. The type II pinealocytes are bigger (13–15 μ), oval to round in outline and contain spherical nuclei in the center. The type III pinealocytes are the largest (18–20 μ) and have round to oval nuclei. The pinealocytes near the periphery of the pineal gland are smaller (Type I) than those of the cells found near the centre of the gland. Tinctorially, with the exception of Type I pinealocytes, the other two cell types are positive to PAS/methylene blue, aldehyde fuchsin and chrome alum haematoxylin phloxine (Figs. 8, 9, 10).

In addition to the pinealocytes, nerve and glial cells are also found within the pineal gland proper. At some places, the neural elements (nerve fibres) are found between the pinealocytes (Fig. 9). The CAHP positive neurosecretory material is also found in the nerve fibres and around and
within the walls of the blood vessels (Fig. 11). The proximal portion of the pineal recess contain bundles of nerve fibres (Fig. 12).

The pineal gland of the female gerbil in the breeding and non-breeding seasons does not show any significant and clear cut cytological differences.

D. PINEAL GLAND IN RELATION TO LIGHT AND DARKNESS: The pineal gland of the gerbil responds to the experimental conditions of total light (TL) and total darkness (TD). There is an insignificant increase in the pineal size (volume) in the gerbils exposed to total darkness when compared with the gerbils exposed to total light. Both the experimental conditions (TL and TD) resulted in a further increase in the cell and nuclear size, the latter being more pronounced. However, histologically, the pinealocytes of the gerbil exposed to total darkness showed an intense granular cytoplasm and CAHP positive material (Fig. 13), when compared with gerbils exposed to total light (Fig. 14). Further, the ovarian and uterine weight of the gerbils exposed to total darkness decreased but the uterine weight of the gerbils exposed to total light increased ($P > 0.005$; Table 1).

DISCUSSION

The pineal body is a circumventricular organ, comprising a part of the epithalamus. It arises from the roof of the diencephalon and is attached by a short stalk in the majority of the mammals studied (Quay, 1975). In the female gerbil, the pineal gland is located in the area of the postero-dorsal roof of the diencephalon between the habenular and posterior commissures. The gland proper is thus distinct from the diencephalic roof, in contrast to
the condition found in some species such as anteater, hedgehog, and deer mouse where the pineal gland lies within the diencephalic roof (Hartman et al., 1968).

Anatomically, the pineal gland of the female gerbil resembles that of the Mongolian gerbil (Japha and Eder, 1974), but differs from that of hyrax (Quay and Miller, 1971). The pineal gland in the gerbil is solid in structure and lacks follicular arrangement as seen in lemming (Quay, 1978). The gerbil pineal gland consisting of a portion associated with habenular commissure and the other portion located at the confluence of the sinusus just beneath the skull, can be compared to the deep and superficial pineal components of the pineal system. In the Peromyscus leucopus the pineal gland is also composed of an anterior basal part around pineal recess and the posterior part in the dural portion. The former portion corresponds to the deep pineal and the latter to the superficial pineal (Quay, 1956a). Similarly in the golden hamster, Sheridon and Reiter (1970) reported that two components of the pineal system, one lying in the dural portion as the superficial pineal and the other mass associated with the habenular commissure as the deep pineal. According to Sheridon and Reiter (1970) the deep pineal is non-functional in relation to the anti-gonadotrophin effects and perhaps represents an embryonic vestige near the original site from which the pineal gland developed.

In mammals, the most important aspect of the pineal development particularly concerns the transitory surface modifications of the primitive pineal cells which border the pineal lumen or the follicles i.e., apical cytoplasmic bulges which bear cilia like processes. The ciliary structure is reminiscent of developing photoreceptor cells of the sub-mammalian species (Sateyni, 1960). The definite parenchymatous cells which are conspicuous in the adult
condition are not apparent in the early post-natal life of the female gerbil. Jeane (1973) reported in the rat and hamster that the definite cellular types are not evident until between 7 and 17th Day of the post-natal life. The growth of the pineal gland of the gerbil in the post-natal life is by further increase in the pineal cell size. In the rat, Quay (1957) reported that the proliferative phase occurs during 10 weeks following birth. During the post-natal development in gerbil, the pineal size increase from 0.0019 mm$^3$ in the stage body weight of 40 gm to 0.0148 mm$^3$, in the female gerbil with a body weight of 60 gm.

The most striking feature of the pineal cell is a remarkable nuclear pleomorphism. During the early developmental stages of the female gerbil, the pineal cell possesses round nucleus and with the advance of differentiation, the increasing or folding of the nuclear membrane occurs and as a result the volume of the nucleus is increased. These observations are in agreement with those of Takashi and Mastsuchima (1967) in the mouse pineal gland.

The pineal gland proper is composed of a parenchyma of pinealocytes or chief cells as in the other rodents (Mastsuchima and Reiter, 1975a, 1975b). Whether the subdivision of the pineal cells into sub-cell types based on location, structure and cytological characters representing truely differentiated type or merely stages in a secretary or ageing processes is still in doubt. Tilney and warr n (1919) distinguished within the pineal gland four cell types based on cytoplasmic volume, granularity, nuclear size and intensity of staining with routine histological procedures. Wisloki and Dempsey (1948) also distinguished by means of glycogen content, two types of functional status of pinealocytes in rhesus monkey. Similarly, Mikami (1951)
distinguished in pig, goat, and horse pineal glands two types of pinealocytes (a) numerous approximately spherical cells with large lobulated nucleus and basophilic cytoplasm but lacking glycogen and (b) relatively few smaller cells with branched but cytoplasmic processes containing large vesicles. In the rat, Quay (1956b) described acidophils, chromophils and chromophobes among the parenchymatous cells and opined that they represented different phases of secretory process. In the mouse and rat, chromophils stain with orange G. In the cattle epiphysis, many chromophils in the centre of the organ are stained with aniline blue, while some are stained with orange G. As in the swine, orange G staining cells are relatively more numerous in the peripheral zone of the bovine pineal gland. On application of CAHP technique, Quay (1956b) concluded that the parenchymatous cells in the rat pineal gland take part in the secretory process.

In the gerbil, the three types of parenchymatous cells show positive reaction to PAS, orange G, methyl blue and aldehyde fuchsin. Gomori's CAHP also stains morphologically similar material in the nucleus. Support for the concept of a pineal basophil have been advanced by Hunderford and Pomerat (1962). They found such a cell in large numbers in the rat pineal tissue culture. The cytoplasmic granules of the cells are stained strongly with aldehyde fuchsin and CAHP in the pineal gland of the white footed mouse Peromyscus leucopus Quay (1956a). According to Quay (1956b) CAHP positive parenchymatous cells are secretory in function. The pineal gland of the golden hamster is made up of light and dark cells. The pineal gland displays axons, nerve endings, pineal cell processes, occasional glial processes which ramify in the parenchyma of the gland and has neural connection via the pineal stalk (Dafry, 1982). Andrew and Reiter (1975), using histochemical technique distinguished at least three cell types in the pineal glands of bovine
and monkey with reference to their positive reaction to CAHP and aldehyde fuchsin. They presented histochemical evidence for the secretion of polypeptides. In addition to the parenchymatous cells in the gerbil pineal gland, a large number of processes were seen to contain a granular material which stain with CAHP. In the rat, electron microscopic studies have also shown that certain bulbous adrenergic nerve endings of unknown origin lie adjacent to the capillaries and among the parenchymal cells (Michal et al. 1983). The endings contain small vesicles most of which enclose a dense granule, reminiscent of neurohypophyseal neurosecretion according to Milofsky (1957).

The first demonstration that the structure and function of the mammalian pineal gland are regulated by environmental lighting was made by Fiske et al. (1960). They reported that the pineal gland decreased in weight of about 25% in light treated animals. Subsequently, Wurtman (1967), suggested that the mammalian pineal gland might act as a 'Biological clock' in the control of rhythmicity of several biological processes based on the observations that the biosynthesis of melatonin and 5 hydroxy tryptamine (Franchini and Martini, 1970), Hydroxy indole O methyl transferase (HIOMT) (Wurtman et al., 1965; Wells et al. 1966), is cyclic depending on the environmental light conditions. The ratio of light to darkness changes drastically as a function of season for animals in their natural state and it might be that the pineal glandular tissue would inhibit an annual cycle of activity, since darkness serves as a stimulus to the pineal biosynthetic mechanism. It might be further more predicted that the greatest activity of the pineal gland occurs during winter months (Reiter, 1974).
Quay (1956b), found in the rat pineal, a large number of phloxine positive granules in the parenchymatous cells which arrange more in number perinuclearly in animals maintained in darkness, in contrast to those animals kept under the influence of increased light. From this finding, Quay suggested that the changes resulted in a greater protein activity in the former and possibly concerned with postulated anti-gonadotrophic activity of the pineal. Ruth et al. (1962), studied specific changes in the pineal morphology induced by continuous lighting. They found that the pineal parenchymatous cells of treated animals are smaller in size and contained few nuclei and little cytoplasmic basophilia. They suggested that the environmental lighting influences the pineal weight by depressing the synthesis of RNA and protein. Further the reaction of the cytoplasmic granules with methyl blue indicates the cytoplasmic basophilia, thus representing cytoplasmic RNA. Similarly, these findings are in accordance with the observations (Wisloki and Dempsey, 1948) of large amounts of cytoplasmic RNA in the pineal cells of the young rhesus monkey. The electron microscopic studies (Raslyn et al., 1976) have shown a significant reduction in pinealocyte and golgi complex size on the constant light treatment as well as marked changes in the concentration of lipid droplets. The cross sectional area of pinealocyte, pericapillary terminals and the number of granulated vesicles also decreased significantly.

Raslyn et al. (1976) correlated the ultrastructural features with well known reduction in the pineal weight, protein synthesis and anti-gonadotrophic activity that are seen in the pineal gland of animals exposed to constant light. The marked decrease in the concentration of pinealocyte granulated vesicles in constant light treatment gave morphological support to the theory that these vesicles contain an anti-gonadotrophic secretory material (Franschini, 1969;
Franschini and Martini, 1970; Motta et al., 1971; Shino et al. 1974). Further the sub-cutaneous implantation of melatonin prevented the atrophy of the reproductive organs (Reiter and Vaughan 1975; Reiter et al., 1975) and also brought about the inhibition of ovulation (Shen Yao Ying and Greep, 1973).

The pineal gland of the female gerbil responds to the experimental conditions of the total light (TL) and total darkness (TD). The changes induced include an increase in the pineal size in the gerbils subjected to total darkness, in contrast to the pineal size of the gerbils exposed to total light. Though the difference in the pineal size is not significant, but the experimental conditions (TL & TD) resulted in an increase in the pineal cell and nuclear size in the pineal glands of the gerbil exposed to total darkness. Histologically, the pineal gland of the gerbil subjected to total darkness showed an intense granular cytoplasm with prominent nucleus. The nuclear granules showed an intense positive reaction to the aldehyde fuchsin and CAMP, indicating a greater protein synthetic activity. This study indicates that the pineal gland is active in the dark period. The phloxine positive materials provide a rough index of the rate of synthesis of nucleoprotein and also appear likely that the quantity of illumination to which the gerbils are exposed directly influence the nucleoprotein and protein synthesis in the pineal gland.

The pineal gland of the female gerbil does not exhibit any histological changes during the period of breeding and non-breeding unlike in the rat (Quay, 1956a; Quay and Bernard, 1957).

The studies on the photo-periodic control of reproduction in many laboratory species have provided much
information (Reiter, 1974, 1975; 1978), concerning the possible function of the pineal gland. Continuous light inhibits pineal activity there by diminishing its inhibitory influence on the pituitary ovarian axis. Continuous darkness on the other hand allows greater pineal activity and leads to the smaller size of the target organ (Ruth et al. 1962) in the male hamster (Hoffman and Reiter, 1965a). Removal of the eyes causes regression of the reproductive organs, adrenal gland and the pituitary glands of adult male hamster, while in the eye less females only the uteri exhibit significant decrease in their weights. The exposure of intact female hamster to LD cycles 1:23 hours caused a significant reduction in the weight of the uteri within 35 days. Likewise removal of the eyes led to the atrophy of the ovary. Histological studies on the ovary of the hamster exposed to dark and in blinded animals suggested that the hormonal output was minimal. The trophic response of the ovaries, uterus and the adrenal glands are prevented by pinealoctomy.

These data suggest that darkness activates the pineal gland to secrete substance/s which modified pituitary target organ relationship (Reiter and Hester, 1966). Light darkness 1:23 hours stimulated the pineal gland to produce a substance which inhibits gonads and the pituitary functions by decreasing the uterine weights. Reduced uterine weight in the normal animals exposed to LD cycle 1:23 hours suggests that synthesis or release of estrogen is reduced in animals exposed to this environment (Hoffman and Reiter, 1965b). The present observations in the gerbils exposed to TL and TD experimental conditions, support the concept that the pineal gland does modulate the reproductive cycles. The decrease in the relative weights of the ovary and uterus in the gerbils exposed to total
dark condition over the control (TL 12 : TD 12 Hrs) females indicates that the pineal gland is active in the dark period and the intense cytoplasmic basophilia seen in the pineal gland may be involved in synthesis or release of pineal principles in promoting the gonadal regression. On the other hand, increase in the ovary and uterine weights in the gerbils exposed to total light as in the white footed mice (Katharina et al. 1983) could indicate that the synthesis or release of the pineal principles are inhibited.

**SUMMARY**

This chapter deals with the structural morphology of the pineal gland of the female gerbils collected during different months of the year from the near by cultivated fields around Bangalore. The pineal gland of the gerbil anatomically resembles that of other rodents, such as hamster and Mongolian gerbil and is located between the habenular and posterior commissures. The pineal gland consists of a portion lying at the confluence of sinuses just beneath the skull and a portion associated with the habenular commissure and the pineal recess. These portions can be compared to the two pineal systems namely the deep pineal and the superficial as reported in the other rodents.

Histologically, three types of pinealocytes are distinguishable in the pineal gland and the cell types show affinity towards PAS/orange G, methyle blue, aldehyde fuchsin and CAHP. In addition to pinealocytes, nerve fibers, glial cells are also seen in and around the blood vessels and these histological studies give tentative support to the secretion of polypeptides as reported in other rodents.
The pineal gland of the new born gerbil measures 0.0096 mm$^3$ (body weight 10 gm) and the size increases in the adult condition to 0.0148 mm$^3$. In the pineal gland of the new born female, the pinealocytes are predominant and their differentiation into cells types are not apparent. During the post-natal development there is an increase in the cell, size and the nuclear foldings are common. The cells are positive to PAS, orange G, and methyl blue. A few CAHP positive granular material is also seen in the pineal cell types. The pineal gland of the female gerbil during the breeding and non-breeding phases does not show clear differences histologically. The glands respond to the experimental conditions of total light (TL) and total darkness (TD). Both the experimental conditions resulted in an increase in the pineal cell size but the pineal gland of the female gerbils exposed to total darkness exhibited an intense granular basophilia. Further the ovarian and uterine weight decreased in the females exposed to total darkness but the uterine weight increased in the females exposed to total light. These observations indicate that pineal gland is active during the dark period. The differential response of the reproductive organs of the gerbil thus seem to lend tentative support to the well known anti-gonadotrophic activity of the pineal gland. The involvement of the pineal in regulating the reproductive seasonality in the gerbil needs further experimental study.
The pineal gland of the new born gerbil measures $0.0096 \text{ mm}^3$ (body weight 10 gm) and the size increases in the adult condition to $0.0148 \text{ mm}^3$. In the pineal gland of the new born female, the pinealocytes are predominant and their differentiation into cells types are not apparent. During the post-natal development there is an increase in the cell, size and the nuclear foldings are common. The cells are positive to PAS, orange G, and methyl blue. A few CAHP positive granular material is also seen in the pineal cell types. The pineal gland of the female gerbil during the breeding and non-breeding phases does not show clear differences histologically. The glands respond to the experimental conditions of total light (TL) and total darkness (TD). Both the experimental conditions resulted in an increase in the pineal cell size but the pineal gland of the female gerbils exposed to total darkness exhibited an intense granular basophilia. Further the ovarian and uterine weight decreased in the females exposed to total darkness but the uterine weight increased in the females exposed to total light. These observations indicate that pineal gland is active during the dark period. The differential response of the reproductive organs of the gerbil thus seem to lend tentative support to the well known anti-gonadotrophic activity of the pineal gland. The involvement of the pineal in regulating the reproductive seasonality in the gerbil needs further experimental study.
Table 1. The effect of continuous light (TL) and darkness (TD) on the reproductive organs of the female gerbils*

<table>
<thead>
<tr>
<th>Condition/treatment</th>
<th>Pineal size (Volume) (mm³)</th>
<th>Ovary (mg)</th>
<th>Uterus (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light and Dark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 hrs : 12 hrs (Control)</td>
<td>0.0148</td>
<td>18 ± 50</td>
<td>50 ± 6.3</td>
</tr>
<tr>
<td>Total light</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 hrs</td>
<td>0.0150</td>
<td>19 ± 7.3₁</td>
<td>74 ± 6.5₁</td>
</tr>
<tr>
<td>Total Dark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 hrs</td>
<td>0.0154</td>
<td>15 ± 0.8₂</td>
<td>67 ± 5.5₂</td>
</tr>
</tbody>
</table>

* Experimentally treated/exposed for a period of 20 days. Results are Mean ± S.E. (n = 3)

₁,₂, p > 0.005, over control values.
Text Fig. 1. Diagramatic representation of the median sagittal section of the pineal gland of the female gerbil to illustrate the anatomical relations with the brain.
Text Fig: 2. Pineal growth in the post-natal phase. Results are means ± S.E., Bars represent S.E.
EXPLANATION OF FIGURES

PLATE I

Figures: 1 to 3 are the sagittal sections of the pinal gland of the female gerbil at different planes to illustrate the structure and its anatomical disposition.

Fig: 1. Pinal gland (P), sub-commisural organ (SO), Posterior commissure (CO). 10% neutral formaldehyde fixed, H and E X 50

Fig: 2. Pinal gland (P), pincal stalk (SK), III ventricle (arrow), pinal recess (•), Bouin's fixed, H and E X 50.

Fig: 3. Tubular commissure (HC), Dorsal sac (DS), Pinal gland (P). Bouin's fixed - PAS X 50.
PLATE-II

Fig: 4. Sagittal section of the pineal gland of the gerbil, showing triangular shaped pineal gland lacking follicular arrangement of the pinealocytes. CAHP X 50

Fig: 5. Sagittal section of the pineal gland of the gerbil showing superficial pineal (S), deep pineal (d) Pineal recess (°) and the sub-commissural organ (SO). PAS and Methyl blue. X 55

Fig: 6. Sagittal section of the pineal gland of the pre-pubertal gerbil showing pinealocytes. H and E X 55

Fig: 7. Sagittal section of the pre-pubertal gerbil (body wt. 60 gm) showing prominent pinealocytes-Type II (arrow head ), and nerve fiber (arrow), CAHP X 270.
PLATE-III

Fig.8. Sagittal section of the pineal gland of the gerbil showing cell types I(i), II(ii), and III (iii) CAHP

Fig.9. Sagittal section of the pineal gland of the gerbil showing nerve fiber present between the pinealocytes. CAHP

Fig.10. Sagittal section of the pineal gland of the female gerbil showing pinealocytes positive to PAS/orange G and methyl blue

X 270
PLATE IV

Fig: 11. Sagittal section of the pineal gland of the gerbil, showing CAMP positive purple red material (arrow) in and around the walls of the blood vessels. CAMP X 255

Fig: 12. Sagittal section of the pineal gland of the gerbil, showing nerve bundles stained purple red near the pineal recess - CAMP X 255

Fig: 13. Sagittal section of the pineal gland of the gerbil exposed to total darkness - showing intense affinity of the pinealocytes to CAMP X 255.

Fig: 14. Sagittal section of the pineal gland of the gerbil exposed to total light showing granular basophilia. CAMP X 255.