EDGEWOOD ARSENAL

TECHNICAL REPORT

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THE PINEAL GLAND: A REPORT OF SOME RECENT PHYSIOLOGICAL STUDIES

by

Russel J. Reiter

September 1967

DEPARTMENT OF THE ARMY
EDGEWOOD ARSENAL
Research Laboratories
Medical Research Laboratory
Edgewood Arsenal, Maryland 21010

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FOREWORD

This work was conducted under Task 1C014501B71A02, Basic Research in Life Sciences, Chemical (U). The work was started in September 1965 and completed in August 1966.

In conducting the research described in this report, the investigators adhered to the "Guide for Laboratory Animal Facilities and Care" as promulgated by the Committee on the Guide for Laboratory Animal Resources, National Academy of Sciences-National Research Council.

DIGEST

In view of information gathered from recent biochemical and physiological investigations, the opinion that the pineal gland is a mere evolutionary vestige should be abandoned. There is ample evidence now that the pineal gland of at least some animals imposes a strong influence on endocrine functions. The following conclusions concerning epithalamo-hypothalamo-pituitary-endocrine relationships, based on data presented in this report, are added in support of this statement:

Removal of the eyes (optic enucleation) of adult male hamsters (Mesocricetus auratus) is followed, within 5 to 7 wk, by involution of the gonads. If eyeless hamsters with atrophic testes are pinealectomized, the gonads regenerate within 8 to 10 wk. Even though the testes of blinded hamsters regress, the spermatogonia remain mitotically active, as evidenced by their uptake of exogenously administered H^3-thymidine.

If eyeless male hamsters are maintained for long periods of time (circa 20 to 25 wk), the testes, after a period of regression, undergo a spontaneous and total regeneration.

Involution of the gonads of eyeless male hamsters is not influenced either by the presence of other male hamsters, hysterotomized females, or ovariectomized females.

The season of the year seems to have little role in determining the rate of gonadal involution in either blinded male or female hamsters.

Bilateral removal of the olfactory bulbs (olfactoriectomy) of the female hamster is followed by regression of the uterus, which is manifested 8 wk after the operation. If both the olfactory bulbs and the pineal gland are removed, the uterus does not regress.

Subjecting adult female hamsters to either optic enucleation or cold exposure causes gonadal involution. When blinded animals are placed in the cold, the effects of the two insults are additive. Pinealectomy prevents only the involution caused by enucleation.

The subcutaneous implantation of melatonin (a pineal substance) or serotonin pellets does not affect the size of the reproductive organs of male hamsters.

The pineal gland depends on an intact autonomic innervation for its autacoidal effects since bilateral superior cervical ganglionectomy, like pinealectomy, prevents the gonads of blinded hamsters from regressing. The

transplantation of pineal glands to kidneys of blinded, pinealectomized hamsters does not influence reproductive organ size, probably because of the loss of the sympathetic innervation of the grafted pineal glands.

Removal of the eyes from weanling (25-day-old) male and female albino rats results in a retardation of the development of the endocrine system in both sexes; pinealectomy negates the effects of optic enucleation. Optic enucleation of weanling (25-day-old) male and female hamsters does not retard maturation of the reproductive system, but once the adult condition is reached, the gonads regress, a response that is counteracted by removal of the pineal gland. Optic enucleation alone or combined with pinealectomy (at 40 days of age) has no effect on growth of the endocrine or reproductive organs of albino mice.

The endocrine response to blinding or short daily photoperiods differs for adult black and albino rats. In eyeless or dark-exposed black rats, some endocrine organs exhibit a significant decrease in weight; if the pineal glands are removed, no changes in organ weights are detected. The size of the endocrine organs of adult albino rats is not greatly changed by blinding or short daily increments of light. Male gerbils respond to darkness with only moderate decreases in the weight of the accessory sex organs (seminal vesicles and coagulating glands).

The ovaries of blinded female hamsters respond to the exogenous administration of follicle stimulating hormone and luteinizing hormone, as evidenced by a marked increase in ovarian weights, an increase in the number of corpora lutea, and a significant rise in uterine weights.

The pineal gland is incapable of preventing pituitary hypertrophy following castration of either blinded male albino rats or blinded male golden hamsters. The pineal gland does inhibit significantly the degree of compensatory ovarian hypertrophy after unilateral ovariectomy of dark-exposed [light dark (LD) 1:23] adult albino rats.

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THE PINEAL GLAND: A REPORT OF SOME RECENT PHYSIOLOGICAL STUDIES

I. INTRODUCTION.

In several earlier reports, [1, 2, 3, *] the authors discussed and formulated hypotheses concerning possible functions of the pineal gland. Many of the proposals were tested subsequently while others still await definitive investigation. The present paper summarizes some of the more recent work and offers the advantage of presenting the material in an unabridged form within a single publication. Until recently, only cautious generalizations were made concerning pineal-endocrine relationships; however, new work by a number of investigators has led us to the threshold of some understanding of pineal function. It is therefore the purpose of this report to recount some of our findings and discuss them in relation to the recent publications of other workers. It is hoped that the curiosity of other investigators will be aroused and that the report will assist in stimulating research on the pineal gland.

II. EXPERIMENTATION.

A. Animals and Techniques Used.

Both pigmented and nonpigmented rodents were used in the present series of investigations. These included rats (Rattus norvegicus), hamsters (Mesocricetus auratus), mice (Mus musculus), and Mongolian gerbils (Meriones unguiculatus). Unless otherwise specified, animals of the same species were kept several per cage and appropriate food and water were supplied ad libitum. The temperature in the animal rooms varied from 22° to 30°C, although during some experiments, it was maintained at 22° ±1°C. Within these limits, temperature had no noticeable effect on the response of the animals to darkness, blinding, or pinealectomy. Also, unless otherwise noted, the light-dark (LD) cycles in the animal rooms were maintained at 16 hr of light and 8 hr of darkness per 24-hr period. Fluorescent lights were used.

The surgical procedures employed were unilateral or bilateral removal of the eyes (blinding or optic enucleation), [4] pinealectomy, removal of the olfactory bulbs (olfactoriectomy), superior cervical ganglionectomy, gonadectomy (both males and females), and hysterotomy. Surgical procedures

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* Reiter, R. J., and Hester, R. J. Metabolic Regulation of Physiological Activity. III. Neuroendocrinological Interrelationships. pp 12-18. Medical Research Laboratory, Edgewood Arsenal, Maryland. 1966. Unpublished Report.

were usually carried out with the animals under sodium pentobarbital (Pentosol) anesthesia. Occasionally animals were maintained on a 1% to 2% aqueous solution of oxytetracycline hydrochloride (Cosa-Terramycin, Pfizer) as drinking fluid for several days after an operation, and usually a powdered sulfa compound (Furacin, Eaton Laboratories) was applied to the wound after pinealectomy.[2,5]

At necropsy, animals were killed by exsanguination during ether anesthesia. The weights of the carcasses, endocrine glands, and reproductive organs were recorded routinely, the tissues being fixed in 10% neutral formalin or Bouin's fluid. When the term "accessory organs" is used, it refers to the seminal vesicle and attached coagulating gland. After being processed tissues were stained by the technique of Movat,[6] periodic acid-Schiff (PAS), aldehyde fuchsin, hematoxylin and eosin (H&E), PAS-trichrome, or by the Feulgen technique.

When used, radioautography was by the liquid-flim technique of Messier and Leblond[7] following the injection of tritiated-thymidine. The specific activity of the labeled compound was 1.9 C/mM (Schwarz Bioresearch) and the dose, administered intraperitoneally, varied from 0.6 to 1.0 μC/gm of body weight. Physiological saline was used to dilute the original stock solution of Thymidine. Tissues were fixed for radioautography in 10% neutral formalin. Tissue radioactivity was detected with NTB2 liquid-flim emulsion (Eastman Kodak); exposure time varied from 24 to 36 days with the coated slides being kept in light-tight boxes at 4° to 5°C. Tissues were stained either before (with Feulgen) coating with the film or after (with H&E) coating, development, and fixation. For development of the radioautograms, Dektol (Eastman Kodak) was used for 2 min at 17°C, the fixer also being maintained at this temperature. Radioautograms taken after tritiated-thymidine injection accurately localize sites of deoxyribonucleic acid synthesis and subsequent mitotic activity.

Statistical analysis of the numerical data included determination of means and standard errors; hence the data in the tables* are expressed as means plus or minus standard errors. Significant differences between means were determined by calculating the least significant difference, which is the value by which any two means must differ to be significantly different at the 95% level of probability. The statistical analyses were carried out in conjunction with the Biostatistics Office, Medical Research Laboratory, Edgewood Arsenal, Maryland.

* Tables 1 through 72 are in the appendix.

Although the present report, for the most part, deals only with gross morphological changes in sizes of endocrine and reproductive organs, histological studies were also conducted. With very few exceptions the microscopic finding emphasized what was found grossly. Hence, for the purposes of this report, the gross findings are in agreement with the histological data even though the latter may not be discussed.

B. Photoperiod-Pineal-Gonadal Relationships in Adult Hamsters.

1. Testicular Degeneration and Regeneration in Blinded Hamsters.

Earlier work proved conclusively that the pineal gland of the pigmented hamster acts to transduce photic stimuli into neurochemicals that, in turn, modulate hypothalamo-pituitary-endocrine relationships in such a way as to cause marked regression of the reproductive organs and probably produce inhibitory effects on other organs of internal secretions.[1,2,4,8,9] Although the precise action is still open to question, we have speculated that the pineal substance acts as a chalone at the hypothalamo-pituitary level to modify endocrine functions.[2*] Regardless of the specific mechanisms involved, darkness, either in the form of short daily photoperiods or blinding, leads to gonadal regression, a response that is counteracted readily by removal of the pineal gland. These observations hold true for both male and female golden hamsters.

With few exceptions, the animals used in earlier investigations were killed after 6 to 8 wk of treatment and little attention was paid to the rate of gonadal regression in blinded hamsters. In the present study, young adult male hamsters were blinded, and groups of five animals each were killed at weekly intervals for 8 wk.

One control group was left unoperated and one group was both blinded and pinealectomized. The results (table 1) show that during the first several weeks after blinding, the change in the weight of the testes is slight; however, between the fourth and sixth week there is a precipitous drop in mean testicular weight; i.e., from 1855 mg/100 gm of body weight 4 wk to 475 mg/100 gm of body weight at 6 wk. The changes in the weights

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* Reiter, R. J., and Hester, R. J. Metabolic Regulation of Physiological Activity. III. Neuroendocrinological Interrelationships. pp 12-18. Medical Research Laboratory, Edgewood Arsenal, Maryland. 1966. Unpublished Report.

of the accessory organs parallel those of the testes. In addition, the blinded animals showed significant increases in body weight, a change not related to age alone since the blinded, pinealectomized hamsters (group 2, table 1) did not exhibit a similar weight gain. The increased weight of the blinded animals was primarily a result of subcutaneous and abdominal fat deposition. Like the reproductive organs, the adrenal and pituitary glands also decreased in weight relative to the final body weight.

To ascertain whether the atrophied testes of eyeless hamsters still retained a basal level of mitotic activity, hamsters that had been blinded for various periods of time (2 to 8 wk) were given an intraperitoneal injection of tritiated thymidine in the concentration of 1 μC/gm of body weight. Radioautograms of partially or totally regressed testes from these animals revealed that, although sperm was not being produced, the spermatogonia were active mitotically. Even as long as 8 wk after removal of the eyes, many tubular epithelial cells were radioactive, indicating pending or recent mitoses.

The follow-up to these experiments was to examine the rate of testicular regeneration of blinded animals that were then pinealectomized; i.e., once the testes are atrophic is an intact pineal gland necessary to maintain them in a regressed state?

To test this, a large group of pigmented male hamsters was blinded. Nine weeks later some of the animals were killed and the remainder were pinealectomized; these animals were divided into smaller subgroups and were killed at 2-wk intervals after pinealectomy. The data (table 2) reveal that an intact pineal gland is indeed required to maintain the testes in the regressed condition. Following pinealectomy, apparently normal pituitary-gonadal relationships are reestablished with a consequent regrowth of the testes. Eight weeks after pinealectomy of the blinded animals, the testicular size was approaching that of the untreated animals. Hence, it appears that the time interval required for regeneration (8 to 10 wk) is slightly greater than the time interval required for testicular degeneration (5 to 7 wk). Possible minor seasonal differences in the rate of gonadal atrophy of blinded hamsters will be discussed later. The regeneration and degeneration experiments were conducted during the months of December-January, and July-August, respectively.

2. Influence of Long-Term Dark Exposure.

In 1965, while studying the effects of short daily photoperiods and ambient temperature differences on the endocrine systems of male golden hamsters. Hoffman, Hester, and Townes [10] reported that, although exposure

of the animals to LD cycles of 2:22 resulted in gonadal atrophy, prolonged exposure (for 22 wk) to reduced periods of light was followed by a spontaneous regeneration of the testes. Since it has now been shown that gonadal involution attendant upon dark exposure is a consequence of an activated pineal gland, the findings of Hoffman and others suggest that, after long periods of darkness, the gonads either become refractory to pineal inhibitory substances or the pineal gland stops secreting antigonadotropic factors. At any rate, the importance of the findings and the fact that the initial observation was made on a small number of animals led us to reinvestigate the problem. Four groups of variously treated adult male hamsters (table 3) were maintained in LD cycles of 14:10, with an ambient temperature that varied between 21° and 29°C. Some animals of each group were killed after 12 wk of treatment and the remainder at the end of 24 wk. As with earlier investigations, the blinded animals with intact pineal glands (group 3, table 3) that were necropsied after 12 wk had involuted reproductive organs. Conversely, the sizes of the testes and accessory organs were similar in all groups of animals killed at 24 wk (table 4). Thus, it is apparent that although the pineal gland, in the absence of light, caused regression of the reproductive organs; the testes either overcame or were released from the inhibition in approximately 20 wk. The recrudescent gonads were normal histologically. Because of these results and their possible importance in seasonal breeders, this problem is being further investigated in both sexes of hamsters.

3. Influence of Social Interaction.

In earlier reports, we postulated that a number of conditions may modify the response of the gonads of hamsters to darkness since, invariably, the testes of a small percentage of blinded hamsters fail to regress.[2, 11] It is possible that this variability could be explained on the basis of some exteroceptive factors interfering with and, in fact, overriding the effect of darkness on the pituitary-gonadal axis. Because of the important role that social contact and cohabitation play in the reproductive cycles of some animals,[12-15] they could account for the failure to regress. To test this, blinded male hamsters were either caged with other male hamsters, with hysterotomized females, or with ovariectomized females. The hysterotomies were performed in the following manner. Both uterine horns of anesthesized hamsters were exposed through a ventral midline incision. After appropriate ligatures, a 2-mm section was removed from each horn and the uterus was returned to the abdominal cavity. When ovariectomies were done, the gonads were removed through the dorsolateral body wall. Following the operation, the female hamsters were caged with blinded male hamsters for 8 wk, then all were killed. The degree and rate of atrophy of testes of eyeless males were not affected by the presence of female animals (table 5). In fact, after 8 wk, the testes of the males caged with either hysterotomized or ovariectomized females were smaller than the testes of blinded males caged alone.

4. Influence of Season.

Because of the possibility that gonadal sensitivity to the photoperiod and epithalamo-hypothalamo-endocrine relationships may vary with the time of the year, it was important to test the effect of darkness on the gonads of animals during various seasons. A seasonal variation in reproductive competence of hamsters has been reported by at least two groups of workers;[16, 17] i.e., hamsters reproduce more prolifically during the summer than during the winter months even when kept under controlled environmental conditions. Moreover, Cusick and Cole[17] reported that increasing the length of the daily light period during the interval of decreased fertility counteracted this phenomenon. There are strong indications that, in their natural habitat, hamsters are hibernators and seasonal breeders.[18-20]

To test for potential seasonal variations in the sensitivity of the gonads to darkness, the following experiment was repeated four times during a 12-mo period (January-February, April-May, July-August, and October-November). Young adult male and female hamsters were divided into four groups: (1) one eye removed, sham pinealectomized; (2) unilaterally blinded, pinealectomized; (3) bilaterally blinded, sham pinealectomized; and (4) bilaterally blinded, pinealectomized. Some animals of each group were killed 25 days, and the remainder were killed 50 days, after the operations.

The results (tables 6-9), show that the female hamsters killed during the months of May or November, 25 days following removal of the eyes, had uteri that were significantly smaller than those of blinded, pinealectomized hamsters. Conversely, uteri of animals killed during February or August, 25 days after treatment, were equal in size regardless of the type of operation. This period of treatment (25 days), was without effect on the relative sizes of the ovaries, adrenal glands, and pituitary glands irrespective of the month during which the hamsters were necropsied.

When female hamsters were killed 50 days after treatment (tables 10-13), the inhibitory effects of blindness on the endocrine system were obvious, as reflected by the decrease in the size of the uterus and pituitary gland. These inhibitory effects were evident regardless of the month during which the animals were killed.

A similar bimodal seasonal variation in the sensitivity of the testes was noted (tables 14-17). In male hamsters killed in February or November, 25 days after blinding, the testicular weights were less than those of pinealectomized control hamsters; however, during May and August, 25 days of darkness was not sufficient to cause a change in testicular size. Regardless of the month during which the animals were necropsied, 50 days of darkness invariably led to significant gonadal involution in male hamsters (tables 18-21).

All animals used for these studies were of uniform stock, and were young adults (40 to 50 days of age) when the experiments began. The results demonstrate conclusively that after long periods of darkness (about 50 days), the reproductive organs of both male and female hamsters regress regardless of the time of the year during which they are studied. The length of the dark period necessary to cause involution of the gonads, however, seems to vary, to a slight degree, with the time of year. Whether this has any biological importance remains to be demonstrated.

C. Olfactory-Pineal-Gonadal Relationships in Adult Hamsters.

The literature on the importance of olfaction in mammalian reproduction has been reviewed recently.[21] The work of Whitten and others shows that the estrous cycles of female mice are modified by the presence of males of the same species[22-27] and, furthermore, that the integrity of the female reproductive tract depends on intact olfactory bulbs.[28] In a recent experiment in this laboratory, it was noted that the uteri of female hamsters had regressed significantly 8 wk after olfactoriectomy. Thus, the uteri of 21 adult anosmic hamsters averaged 153 mg/100 gm of body weight whereas the mean uterine weight of eight intact animals was 327 mg/100 gm of body weight. Since it was shown recently that the pineal gland plays a role in the regulation of reproductive functions in male and female hamsters, its possible role in the response of female hamsters to olfactoriectomy was tested.

Adult female golden hamsters weighing 87 to 110 gm were used. Twenty-one animals were subjected to removal of the olfactory bulbs and sham pinealectomy, and 14 hamsters were both pinealectomized and olfactoriectomized. The olfactory bulbs were removed as follows: anesthetized hamsters were mounted in a stereotoxic instrument base and a 1/2-in. anteroposterior incision was made in the scalp between the eyes. The olfactory bulbs were exposed bilaterally by drilling holes, 2 mm in diameter, in the skull overlying them and they were removed by suction. To prevent postoperative infections, a powdered sulfa compound was dusted onto the wound, and the incision was closed with 00 sutures. The animals were maintained in LD cycles of 14:10 and were killed 8 wk after surgical treatment.

The results summarized in table 22 confirm that olfactoriectomy does cause regression of the uteri of otherwise intact female hamsters, and the atrophic response is prevented by pinealectomy. Because of the importance of these findings, the experiment was repeated, adding a third group of untreated control animals. The animals were killed 8 wk after treatment. The findings matched those of the earlier experiments. Olfactory bulb removal led to significant regression of the uterus, while the uterine weights of animals subjected to both olfactoriectomy and pinealectomy were like whose of untreated animals (table 23).

To further check the response to olfactoriectomy, a fourth experiment was designed to determine whether superior cervical ganglionectomy would prevent uterine regression of anosmic female hamsters. We have already shown that either pinealectomy or superior cervical ganglionectomy (to be discussed) prevents gonadal atrophy in both sexes of blinded hamsters. This time, the animals were maintained for 12 wk and, although the mean uterine weight of the olfactoriectomized hamsters was less than those of the other three groups, the difference (when compared with the mean uterine weights of olfactoriectomized, pinealectomized and olfactoriectomized, ganglionectomized animals) was not statistically significant (table 24).

Olfactoriectomy also had no effect on the size of the reproductive organs of male hamsters when they were killed 12 wk after the operations (table 25).

D. Relationship of Ambient Temperature, Photoperiod, Pineal Gland and Reproduction in Adult Hamsters.

In addition to the daily photoperiod, another environmental factor, which is undoubtedly of importance in the regulation of reproduction of animals in their natural habitat, is the ambient temperature. Using male hamsters, Hoffman and colleagues[10] found that darkness and low environmental temperature independently caused regression of the reproductive organs, and when animals were subjected to both insults simultaneously, the inhibitory effects were additive. These workers did not test the response of female hamsters to darkness or cold, nor did they attempt to determine the influence of the pineal gland on the observed responses. In the following experiment, adult female hamsters were subjected to either unilateral or bilateral optic enucleation, pinealectomy or sham pinealectomy, and low (6°C) or high (22°C) ambient temperature. The LD cycles in both rooms were 16:8. Animals were killed either after 25 or 50 days of exposure to the various regimens.

Within 25 days, the uteri of the blinded animals kept at 6°C (table 26, group 7) exhibited pronounced atrophy (139 mg), whereas blinded animals kept at room temperature (group 3), those with one eye removed and kept in the cold (groups 5 and 6), and blinded, pinealectomized, cold-exposed animals (group 8) showed only moderate reductions in uterine weight. The results indicate that both darkness and cold are capable of causing gonadal involution and that, as in male hamsters, the effects are additive. It appears, however, that the cold-induced gonadal atrophy of the reproductive organs is not mediated through the pineal gland since pinealectomy did not affect either the rate or the degree of uterine regression in animals kept at low temperature.

After 50 days of treatment, the uteri of all cold-exposed animals showed marked reductions in weight; the response was again not influences by removal of the pineal gland (table 27).

E. Absence of an Effect of Melatonin on Hamster Gonads.

Hormonal properties are commonly ascribed to N-acetyl-5-methoxytryptamine (melatonin).[29-33] Melatonin and its synthetic enzyme, hydroxyindole-O-methyltranferase (HIOMT), have been found in the pineal glands of many species; the substances are characteristically confined to pineal tissue.[31, 34] The effects of melatonin have been studied under a variety of physiological conditions and, in fact, it affects many systems.[32, 33, 35-39] The biosynthesis of melatonin involves the N-acetylation of serotonin to form N-acetylserotonin and the subsequent O-methylation of this compound to form melatonin. The latter reaction requires HIOMT and is apparently rate limiting in the enzymatic synthesis of melatonin.[31, 40, 41]

Because of the obvious, potent effect which the pineal gland has on hamster gonads, and since it has been postulated that melatonin is a, if not the, pineal hormone, the influence of this substance on the integrity of the reporductive organs of adult male hamsters was tested. Pellets containing either 34% melatonin and 66% cholesterol, 34% serotonin and 66% cholesterol, or 100% cholesterol were subcutaneously implanted between the scapulae of blinded pinealectomized hamsters. Untreated, blinded, and blinded pinealectomized animals served as controls. All animals were necropsied 10 wk after treatment, and organ weights were tabulated (table 28). The testes of the blinded animals (group 2) were involuted; however, the reproductive organs in the other 5 groups of hamsters were normal on gross and microscopic examination. Neither melatonin nor serotonin caused degenerative changes in the reproductive organs; in fact, the largest testes were found in animals that had melatonin-cholesterol implants.

F. Relationship of Sympathetic Innervation and Pineal Function in Hamsters.

A number of studies indicate that pineal activity apparently is not influenced by the normal feedback mechanisms that govern the secretory activity of most endocrine organs. Rather, the control of melatonin synthesis in the rat pineal gland is photic and depends on intact sympathetic fibers to the parenchymal cells of the gland.[42, 43] The synthesis of melatonin is normally high in dark-exposed animals and low in rats kept in the light.[44, 45] Interruption of the sympathetic innervation to the pineal gland interferes with the inhibitory action of light on the pineal synthetic activity; i.e., in rats in which the superior cervical ganglion has been removed, melatonin synthesis proceeds independent of the LD schedule in which the animals are kept.[42] To test what effect removal of the superior cervical ganglia would have on the response of the gonads of blinded hamsters, the following experiments were carried out.

Groups of adult male and female hamsters were wither left untreated or subjected to one or a combination of operations, including pinealectomy, bilateral optic enucleation, bilateral superior cervical ganglionectomy, and removal of the eyelids. All animals were killed 8 wk after treatment. The data from both male (table 29) and female (table 30) hamsters show that ganglionectomy, like pinealectomy, prevents gonadal involution in blinded hamsters. These findings indicate that the sympathetic innervation of the pineal gland must be intact for the synthesis of the antigonadotropic principle, at least in blinded hamsters.[4]

The pineal gland of the rat had been transplanted under the kidney capsule,[46] the hamstring muscles of the hind leg,[47] and to the anterior chamber of the eye.[48,49] Such grafts grew and had a normal cellular structure. When Gittes and Chu[47] transplanted multiple pineal glands into the dorsal musculature of the hind leg of rats, the effects of pinealectomy were reversed. To test whether transplanted pineal glands of hamsters retain their antigonadotropic potential, the following experiment was carried out.

Pineal glands were implanted under the capsule of the right kidney of blinded, pinealectomized male hamsters. In each case, two pineal glands were grafted under the capsule, the animal receiving its own pineal gland and that of another adult male hamster. Since the transfer of the pineal gland from its intracranial position to the kidney results in loss of its sympathetic innervation, two groups of ganglionectomized animals were included as controls (table 31). Fourteen weeks after the operations, the hamsters were necropsied and the endocrine organs were weighed. Although intact pineal glands of blinded hamsters caused gonadal involution, the transplanted glands did not. It is surmised that the loss of sympathetic innervation of the grafted glands was the reason for their inability to affect reproduction, since ganglionectomy was as effective as pinealectomy in preventing involution of the testes and seminal vesicles of blinded animals.* Histologically, transplants were indistinguishable from those of normal, intact pineal glands. The apparent difference in the activity of transplanted rat and hamster pineal glands has not been resolved.

G. Photoperiod-Pineal-Endocrine Relationships in Prepubertal Hamsters, Rats, and Mice.

The literature abounds with contradiction concerning the role of the pineal gland in influencing the prepubertal and postpubertal growth of the reproductive and endocrine organs of animals.[50-52] The following series of investigations demonstrates the influence of the photoperiod and the pineal gland on the growth and development of the glands of internal secretion in three species of rodents.

* Reiter, R. J. The Effects of Pineal Grafts, Pinealectomy, and Denervation of the Pineal Gland on the Reproductive Organs of Male Hamsters. Neuroendocrinology. In press.

Agouti hamsters, albino rats, and albino mice of both sexes were used for these investigations. At the beginning of the experiment, hamsters and rats varied between 23 and 28 days of age, whereas mice were approximately 40 days old. The animals were subjected to either unilateral or bilateral optic enucleation and were either pinealectomized or sham pinealectomized. These combinations of operations resulted in four groups of animals of each sex and of each species, as follows: (1) one eye removed, sham pinealectomized; (2) one eye removed, pinealectomized; (3) both eyes removed, sham pinealectomized; and (4) both eyes removed, pinealectomized. Some animals of each species of the four groups were killed at 25-day intervals after the operations; i. e., the rats and hamsters were killed at approximately 50, 75, 100, etc. days of age and mice at 65, 90, 115, etc. days of age. At necropsy, individual body weights as well as endocrine and reproductive organ weights were recorded.

In both male and female rats, blinding caused a significant lag in the growth of the animals (tables 32 and 33). By 100 days postoperatively, however, the body weights of the bilaterally blinded animals with intact pineal glands were similar to those of the other three groups. With the exception of the thyroid gland, all the endocrine organs studied in both sexes of blinded rats exhibited a similar sluggishness in development (tables 34-43). The overall impression was one of panhypopituitarism (except for the thyroid gland) in which the pineal gland, activated in darkness, secreted a substance that retarded the growth of the endocrine and reproductive organs. With time, however, the organs of blinded rats matured and were then morphologically similar to those of control animals. In all cases, if animals were both bilaterally blinded and pinealectomized, the organs grew at a rate similar to those of unilaterally blinded rats.

Optic enucleation or pinealectomy had little effect on the body size of hamsters. The response of the endocrine organs of male and female hamsters to darkness (tables 44-53) was not like that of albino rats. Blinding failed to delay development of the endocrine organs, but after these animals reached the adult condition, the reproductive organs of both sexes rapidly regressed to an infantile condition (tables 46, 48 and 49). The weight of the ovaries of blinded hamsters (table 47) actually increased over those of control animals; however, histological examination of these enlarged ovaries showed that they were atrophic; i. e., there were few antral or preantral follicles and only rare corpora lutea. Moreover, as judged by the size of the uteri, these ovaries were secreting either little or no estrogen. Thus, the effect of darkness on the development of the endocrine system is different in albino rats and agouti hamsters. The hamsters mature normally but then, rapidly regress (especially the reproductive organs) whereas in rats, blinding retards maturation of the endocrine system. Despite the different types of responses, both are prevented by removal of the pineal gland.

Neither optic enucleation of either type nor pinealectomy affected the body size or the rate of growth of endocrine organs of albino mice of either sex (tables 54-63). The failure of darkness to influence organ growth possibly was caused by the relatively advanced age of the animals at the beginning of the experiment; i.e., 40 days of age for mice versus 25 days of age for rats and hamsters. It was necessary to use older mice because weanling animals were so small that pinealectomy (with the technique used) was difficult without damaging the surrounding nervous structures. Similarly, Chase[53] reported that congenital eyelessness does not impair the development of the reproductive systems in albino mice.

H. Photoperiod-Pineal-Endocrine Relationships in Adult Rats and Gerbils.

The demonstration of the strong inhibitory effect of darkness on the reproductive system of agouti golden hamsters led us to investigate photoperiod-gonadal relationships in other animals. Adult male black NIH rats were wither pinealectomized or sham pinealectomized and kept in LD cycles of 1:23 (table 64). Adult female black NIH rats received either sham or real pinealectomy, but rather than being kept in short daily photoperiods, the eyes of both groups of females were bilaterally enucleated (table 65). Because the number of animals available was limited, only four groups of black rats (two groups of males and two groups of females) were used.[54] For comparison, four groups each of adult male albino (table 66) and adult female albino (table 67) rats were included in the experiment.

Both black and albino male rats were killed after 18 wk of treatment. The accessory organs, adrenal glands, and pituitary glands of the dark-exposed black rats with intact pineal glands exhibited significant regression when compared with the same organs of pinealectomized black rats (table 64). In contrast, the organs of all groups of albino males were similar in weight and histological appearance regardless of photoperiod or surgical treatment.

The female rats (black and albino) were killed 12 wk after the beginning of the experiment. As in black males, a number of endocrine organs of black females exhibited a decrease in size, which was prevented by pinealectomy (table 65). In albino females, optic enucleation in combination with real or sham pinealectomy did not affect organ size (table 67).

A second series of investigations on pineal-endocrine interrelationships involved the Mongolian gerbil. Adult male gerbils were obtained from the West Foundation, Brant Lake, New York. Limited physiological studies indicate that the gerbil may resemble the rat more than it resembles the

hamster.[55, 56] Although the gerbil has been bred successfully in captivity for a number of years, comparatively little is known of its reproductive habits or cycles in the wild.[57, 58]

Adult male gerbils were subjected to either unilateral or bilateral optic enucleation and either sham or real pinealectomy. Animals were kept six per cage at 22° ±2°C and in light (LD 16:8) controlled rooms. A few animals were killed 8 and 12 wk after the operations. The rest were necropsied 16 wk after the beginning of the experiment. The data (table 68) show that the pineal gland of blinded gerbils is not as effective in causing gonadal regression as it is in hamsters. The accessory organs of blinded gerbils with intact pineal glands, were, however, significantly smaller than those of the other groups. The findings show that, in this regard, the gerbil resembles the rat more than it resembles the hamster, i.e., in adult gerbils and rats, the pineal gland has little effect in altering gonadal size or function.

I. Miscellaneous Pineal Studies in Hamsters and Rats.

1. Follicle Stimulating Hormone (FSH)-Luteinizing Hormone (LH) Treatment of Blinded Hamsters.

The specific level at which the pineal substance interferes with the normal functioning of the endocrine system has not been established. Some conjecture regarding the level of interaction, however, has been advanced, and it is generally conceded that, at least in part, the inhibitory effects of the active pineal substance are manifested at the neuroendocrine level.[3, 59, 60, *] To determine if the active pineal gland (of blinded hamsters) would prevent the action of gonadotropins on the ovaries, adult female hamsters were blinded to induce regression of the reproductive organs, and approximately 8 wk later they were given injections of FSH and LH for 10 consecutive days; then they were killed. The dose of each hormone was 0.5 mg/day. Three groups of control animals were used (table 69).

The reproductive organs of the FSH-LH treated hamsters responded, as evidenced by the stimulation of uterine growth, with the secretion of estrogen.[61] The mean uterine weight of the gonadotropin-stimulated hamsters was significantly more than the mean uterine weight of animals that were blinded but not given FSH-LH (table 69). Similarly, the size of the ovaries of the hamsters given FSH-LH increased markedly. The inability of the active pineal

* Reiter, R. J., and Hester, R. J. Metabolic Regulation of Physiological Activity. III. Neuroendocrinological Interrelationships. pp 12-18. Medical Research Laboratory, Edgewood Arsenal, Maryland. 1966. Unpublished Report.

gland to prevent the action of gonadotropins on the ovaries and the action of estrogen on the uterus indirectly suggest that the pituitary gland or tropic hormone-regulating "centers" within the hypothalamus may be the sites at which pineal inhibitory substances act. This is not unequivocal evidence in support of a neuroendocrine level of action of the pineal substances since relatively large doses of exogenous gonodatropins were used and there was no way to ascertain whether a partial inhibition occurred.

2. Pineal Gland and Induced Hypertrophy of Endocrine Organs.

Earlier experiments indicated that dark exposure, and thus apparently pineal substances, in addition to altering pituitary-gonadal relationships also restricts, or that light stimulates, growth of the pituitary gland.[2,4] It is known that various peripheral glandectomies, for example, castration, adrenalectomy, or thyroidectomy, evoke hypophyseal hypertrophy because of the increased demand for specific tropic principles.[62] To test whether the activated pineal gland would limit or prevent hypophyseal growth after castration, the following experiments were conducted on male albino rats and male golden hamsters. Four groups of each species were prepared as follows: (1) untreated animals; (2) castrated animals; (3) castrated, blinded animals; and (4) castrated, blinded, pinealectomized animals. Animals of both species were necropsied 30 days after the surgical procedures. The pituitary glands of both rats and hamsters hypertrophied following castration and in neither species was the hypertrophy prevented by blinding (tables 70 and 71).

Removal of one of a pair of endocrine organs (e.g., one adrenal gland or one ovary) is followed by a compensatory hypertrophy and hyperplasia of the contralateral organ in rats but apparently only hyperplasia in hamsters.[2,*] Theoretically, the compensatory growth is a consequence of the augmented secretion of specific adenohypophyseal tropic hormones.[63] The following investigation shows that the pineal gland of dark-exposed albino rats affects compensatory ovarian growth. Young adult female rats were subjected to either sham or real pinealectomy and maintained in one of three LD cycles (16:8; 24:0; 1:23) for the next 6 mo. Two weeks prior to necropsy, all rats were unilaterally ovariectomized; the ovary removed was weighed, and the mean ovarian weight for a group was recorded as the initial ovarian weight (table 72). When the animals were killed 2 wk later, the remaining ovaries were weighed and the mean ovarian weight was recorded (remaining ovarian weight, table 72). The percentage increase in ovarian weight was calculated for all groups.

* Reiter, R. J., and Hoffman, R. A. Adrenocortical Cytogenesis in the Adult Male Golden Hamster. A Radioautographic Study Using Tritiated-Thymidine. J. Anat. In press.

In pinealectomized and sham-operated rats exposed to LD cycles of 16:8, the percentage increase in ovarian growth was the same (table 70). Althouth continuous (24:0) light caused an absolute decrease in the size of the ovaries, the percentage of enlargement after unilateral ovariectomy was similar in both groups of rats (sham-operated and pinealectomized) and equal to that of animals kept in LD cycles of 16:8. When sham-operated and pinealectomized rats were kept on an LD cycle of 1:23 (groups 5 and 6, table 72), there was no significant change in the size of the first ovaries removed; however, the percentage ovarian enlargement after unilateral castration of rats with pineal glands (group 5) was significantly less than in pinealectomized animals (group 6). Since compensatory ovarian enlargement in rats is a sequel to the increased secretion of hypophyseal gonadotropins, the data suggest that darkness, because of the loss of the inhibitary action of light on the pineal gland, inhibited the production or release of FSH, LH, or both.

III. DISCUSSION.

A summary of the responses of the gonads of male and female golden hamsters to various combinations of treatment is shown below.

	Pinealectomy	Superior Cervical Ganglionectomy	Blinding	Darkness (22 Hr/Day)	Light (14-16 Hr/Day)	Olfactoriectomy	Low Temperature (5-6°)
Pinealectomy	O	O	O	O	O	O	R
Superior Cervical Ganglionectomy	O	O	O	NT	O	NT	NT
Blinding	O	O	R	R	R	NT	NT
Darkness (22 Hr/Day)	O	NT	R	R	NT	NT	R
Light (14-16 Hr/Day)	O	O	R	NT	O	R*	R
Olfactoriectomy	O	NT	NT	NT	R*	R*	NT
Low Temperature (5-6°C)	R	NT	NT	R	R	NT	R

O = no change in gonadal function
R = regression of the gonads
NT = not tested
* = females only

The functional control of the pineal gland is interesting in that it apparently is not governed by normal endocrine feedback mechanisms.[4] Gonadectomy in rodents is followed normally by pituitary hypertrophy within a relatively short period of time. The hypertrophic response is a sequel to the low level of testosterone in the blood, which is detected by specific hypothalamic regulatory neurons; they, in turn, stimulate gonadotropic hormone secretion and pituitary growth. In light-deprived hamsters with involuted gonads, the androgen levels in the blood are also low, as indicated by the marked reduction in the size of the seminal vesicles and coagulating glands. Yet the pituitary gland does not hypertrophy; i. e., the pituitary (or hypothalamus) is not released from the inhibition which the pineal substance has imposed on it. Thus, the hypothalamus is either unable to detect the low serum levels of testosterone or the pituitary is unable to respond to the hypothalamic signal.

The regulatory control of pineal synthetic activity appears to be a function of the photoperiod in which the animals are kept. These impulses are transmitted to the pineal gland by as yet unidentified central nervous system (CNS) pathways and by postganglionic sympathetic fibers that have their cell bodies within the superior cervical ganglia. The cue for the inhibition of the production of the pineal antigonadotropin is light and in darkness the pineal gland is released from this inhibition. The effect of bilateral superior cervical ganglionectomy on the regulation of pineal hormone synthesis varies with the animal used. Wurtman and colleagues,[42, 43] using melatonin synthesis as an index of the activity in the rat pineal, found that ganglionectomy prevented the inhibitory action of light on melatonin synthesis; thus, in the pineal glands of rats that have had their superior cervical ganglia removed, melatonin synthesis proceeds unabated even in rats exposed to light. In rats, then, ganglionectomy is equivalent to dark-exposure in activating the pineal gland. These workers have postulated further that melatonin may be the pineal antigonadotropic substance, but its effect on reproductive functions is disputed.[64, 65]

Since in the rat ganglionectomy activates the pineal gland (or, more accurately, prevents its inhibition by light), and if melatonin is the important pineal hormone, then one would expect that bilateral superior cervical ganglionectomy alone would cause gonadal regression in hamsters. This is not the case however; in hamsters superior cervical ganglionectomy has no effect on the growth of the reproductive organs; in fact, ganglionectomy prevents the production or release of gonadal inhibitory substances, as evidenced by the failure of the gonads of blinded, ganglionectomized hamsters to atrophy; i. e., in hamsters, ganglionectomy is equivalent to pinealectomy (tables 29 and 30). These findings suggest that either melatonin is not the pineal antigonadotropic factor in the hamster or this compound is not synthesized (or released) in the denervated hamster pineal gland. This is supported by other experimental data.

Gittes and Chu[47] found that pineal glands transplanted to the hamstring muscles or under the kidney capsule reversed the effects of pinealectomy in rats. In hamsters, pineal glands grafted under the kidney capsules of blinded, pinealectomized hamsters do not modify pituitary-gonadal relationships (table 31). Again, unavoidable sympathetic denervation of the transplants must be considered as an explanation for failure of the grafts to alter reproduction in hamsters. Based on morphological evidence, the grafts grew well under the capsule and were morphologically similar to intact pineal glands.* Whether pineal glands transplanted into specific diencephalic endocrine regulatory "centers" would modify hypothalamo-hypophyseal-target organ relationships remains to be demonstrated.

Regeneration of the testes of light-deprived hamsters after long periods of darkness (about 25 wk) presents interesting data for speculation. The recrudescent testes are grossly and morphologically indistinguishable from testes of normal hamsters. This spontaneous recovery of gonads of blinded hamsters has not been explained. Either the inhibited hypothalamic "centers" (assuming the inhibition is in the hypothalamus) become refractory to pineal substances or the pineal gland discontinues secretion of antigonadotropic principles. Whether the regenerated gonads undergo a second decline in size and function is presently being investigated. The period (about 20 wk) during which the testes remain atrophic corresponds to the average length of the "winter" period as well as the average duration of hibernation of some animals; e.g., the 13-lined ground squirrel.[19,20] Many investigations suggest that, in their natural habitat, golden hamsters are also hibernators.[18,19] Interestingly, ground squirrels breed very early (in a matter of days) after they leave their underground burrows in the spring. It is known that these animals enter hibernation with atrophic gonads and that during the late stages of hibernation the testes enlarge and become functionally active, even though the ground squirrels are confined to the darkness of their underground dwellings. Hence, they have functional gonads upon emerging from their lightless burrows.

The findings of Mogler[18] are also noteworthy in this regard. He reported that when hamsters were kept in outside cages for a 12-mo period, the endocrine organs exhibited marked seasonal variations in size and activity. Based on morphological evidence, Mogler speculated that the endocrine organs were minimally functional during the winter months and maximally functional during the summer months. There was one exception to this general rule, however, the pineal gland. Again using morphological appearance as a criterion, Mogler judged the pineal gland to be functioning maximally during the winter and minimally during the summer season. This inverse relation between the pineal gland and other endocrine organs is interesting and deserves

* Reiter, R. J. The Effects of Pineal Grafts, Pinealectomy, and Denervation of the Pineal Gland on the Reproductive Organs of Male Hamsters. Neuroendocrinology. In press.

more extensive investigation, expecially in seasonal breeders. Whether the pineal gland has any function as an impeller of seasonal breeding remains to be established; however, its photoperiodic nature makes it a curious organ in this regard. The gonadal involution because of lack of light can possibly be explained on the basis of the pineal gland, but it is also necessary to account for decreases in environmental temperature which, like light-deprivation, are capable of forcing regression of the reproductive organs of hamsters regardless of whether the animals are pinealectomized (tables 26 and 27).

A seasonal decline in fertility of hamsters during certain months of the year, even when animals are kept in light- and temperature-controlled rooms, has been reported.[16, 17] At least one group of investigators found that increasing the daily increment of light improved the breeding ability of the hamsters.[17] It appears that the possible importance of the pineal gland in such processes should not be overlooked.

Most vertebrates are equipped with sensors to detect visual, olfactory, and auditory stimuli. The degree to which animals rely on different senses for contact with their external environment varies widely. Olfaction seems to be an important exteroceptive sense that mammals especially rely on for sexual attraction and behavior.[21] The early work of Whitten and subsequent reports of many investigators describe the important influence of olfaction and odor on the integrity of the reproductive organs, estrous cycles, pregnancy, and reproduction in general.[22-27] In 1956, Whitten reported[28] that removal of the olfactory bulbs from adult virgin female mice led, within 6 wk, to a marked reduction in uterine and ovarian weights. In contrast, male mice suffered little apparent adverse effect from anosmia. In the present experiments, we found that female hamsters experience a similar decline in uterine size after olfactoriectomy. The effect was detected only when animals were killed 8 wk after the operations (tables 22 and 23); if anosmic hamsters were maintained for 12 wk, uterine weights were not significantly different from those of control animals (table 24). It is interesting that the apparent transient inhibitory effect of anosmia was prevented if animals were pinealectomized. The experiment was repeated three times with similar results. Undoubtedly, olfactory-pineal-gonadal relationships warrant closer scrutiny before any profound statements concerning such interactions can be made.

Cellular changes within the adenohypophysis of olfactory-deprived rats have been reported by Balboni;[66] there were marked alterations in the basophilic gonadotropes. Recently Orbach and Kling[67] found that the production of anosmia in 6- to 10-day-old female rats resulted in significant delay in vaginal introitus; however, they did not attempt to determine the effect of pinealectomy on the response. They also discussed the significance of olfactory input in the

maturation of the centers within the diencephalon that produce gonadotropin-releasing factor. In a recent review, Relkin[68] recounts the possible interrelationships of olfaction, the limbic system, and the epiphysis cerebri.

The innervation of the azygous epiphysis cerebri has been especially well studied in the rat,[69-71] and the innervation of the vertebrate pineal gland in general has been very ably reviewed by Kappers.[72-73] The neural input to the hamster pineal gland has not been described in any great detail, but it is generally assumed to be similar to that of the rat. The physiological data presented in this report reveals that the autonomic component, arising from the superior cervical ganglia, is of primary importance in regulating the incretionary activity of the organ. The CNS pathways which conduct photic stimuli (see specific neural pathways, figure) from the optic nerves to the upper thoracic cord have escaped identification thus far. Attempts to elucidate the central pathways involved have been carried out by Axelrod and colleagues,[74, 75] and they report that bilateral electrolytic lesions of the medial forebrain bundle (specifically the inferior accessory optic tract) in the lateral hypothalamus of rats block the usual effects of altered environmental illumination on the weight of the pineal gland as well as on the concentration of HIOMT, which is the rate-limiting enzyme concerned with melatonin synthesis within pineal tissue. Conversely, interruption of the primary optic tract or the superior accessory optic tract is ineffectual in altering the response of the pineal gland to changes in environmental illumination. Retinohypothalamic fibers, if in fact they do exist,[76, 77] do not appear to be involved in the transmission of photic stimuli from the retina to the pineal gland. The role of the medial forebrain bundle in mediating the effects of light and darkness on the reproductive systems of hamsters is currently under investigation in this laboratory. Even if this major fiber bundle is involved, it would supply only part of the answer since it extends caudally only to the level of the midbrain tegmentum (at least in rats).[78]

The site at which the pineal principle acts to modulate endocrine and reproductive activity is also unknown. The pineal substances may interfere with the normal functioning of the hypothalamo-pituitary axis (A, figure), with the action of specific tropic hormones at the target organ level (B, figure), at the level of the peripheral end organs (C, figure), or with a combination of these. A neuroendocrine action of the pineal principle has been postulated by two groups of workers; however, the definitive proof of this suggestion awaits further investigation.

A number of enzymes and other compounds have been identified within pineal glands of various species, including man.[40, 79-87,*] At least two of these substances, melatonin and 5-methoxytryptophol, have antigonadotropic effects in albino rats. A single report mentions the presence of melatonin

* Penney, D. P., and Reiter, R. J. Fine Structural Localization of a Possible Acyl Transferase in the Pineal Gland of the Male Golden Hamster. J. Histochem. Cytochem. In press.

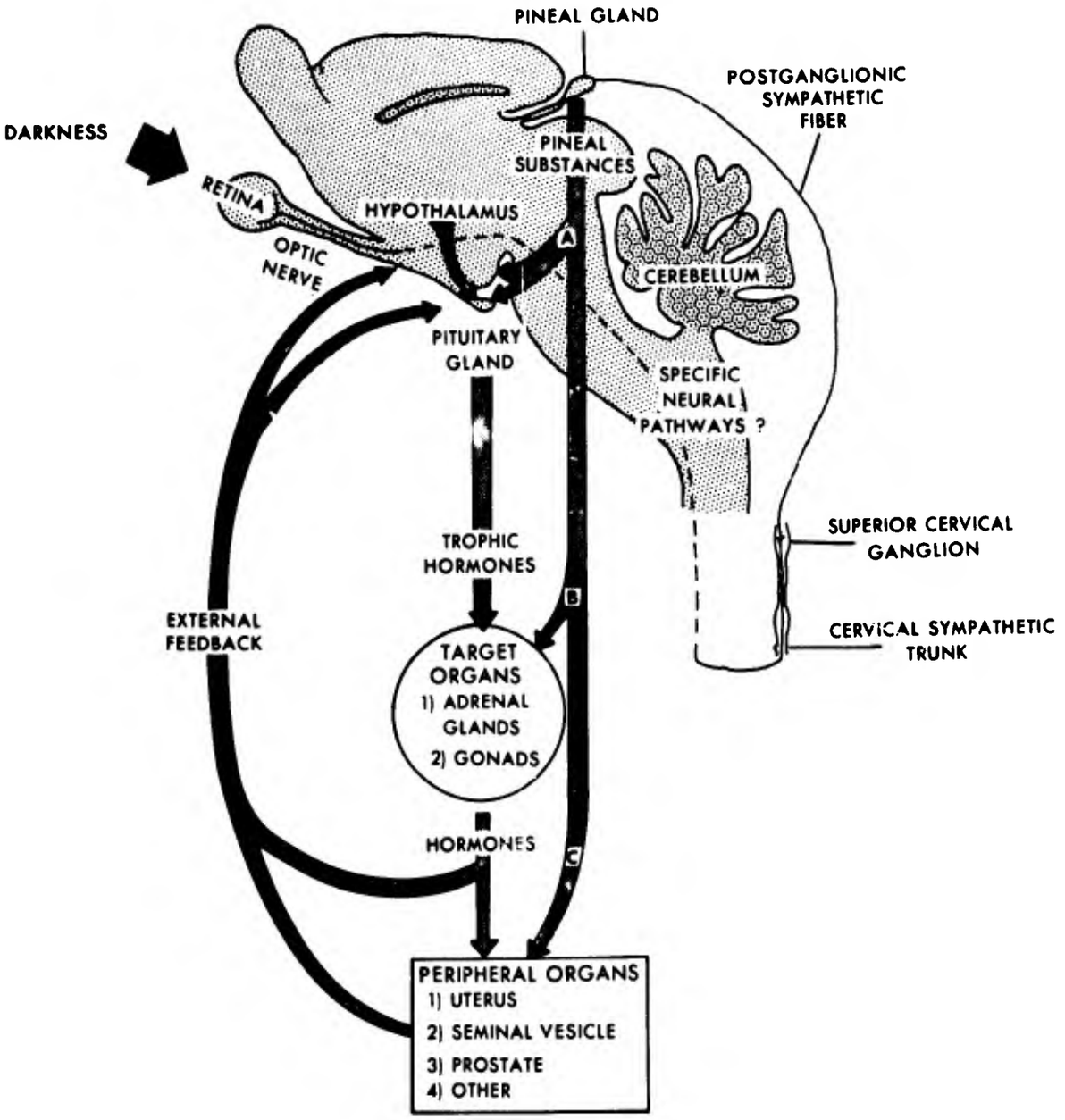

Figure. Apparent Neural Connection of the Central Nervous System and the Pineal Gland in the Hamster and Possible Sites of Action of Pineal Substances.

A - Hypothalamo-pituitary axis

B - Specific target organs

C - Peripheral end organs

in cult[illegible]d hamster pineal glands, the concentration being lower than that report[illegible] rat pineal glands.[85] At this time, it appears that the pineal-derive[illegible]otropin antagonist in the hamster remains to be identified.

IV. CONCLUSIONS.

Removal of the eyes (optic enucleation) of adult male hamsters (Mesocricetus auratus) is followed, within 5 to 7 wk, by involution of the gonads. If eyeless hamsters with atrophic testes are pinealectomized, the gonads regenerate within 8 to 10 wk. Even though the testes of blinded hamsters regress, the spermatogonia remain mitotically active, as evidenced by their uptake of exogenously administered H^3-thymidine.

If eyeless male hamsters are maintained for long periods of time (circa 20 to 25 wk), the testes, after a period of regression, undergo a spontaneous and total regeneration.

Involution of the gonads of eyeless male hamsters is not influenced either by the presence of other male hamsters, hysterotomized females, or ovariectomized females.

The season of the year seems to have little role in determining the rate of gonadal involution in either blinded male or female hamsters.

Bilateral removal of the olfactory bulbs (olfactoriectomy) of the female hamster is followed by regression of the uterus, which is manifested 8 wk after the operation. If both the olfactory bulbs and the pineal gland are removed, the uterus does not regress.

Subjecting adult female hamsters to either optic enucleation or cold exposure causes gonadal involution. When blinded animals are placed in the cold, the effects of the two insults are additive. Pinealectomy prevents only the involution caused by enucleation.

The subcutaneous implantation of melatonin (a pineal substance) or serotonin pellets does not affect the size of the reproductive organs of male hamsters.

The pineal gland depends on an intact autonomic innervation for its autacoidal effects since bilateral superior cervical ganglionectomy, like pinealectomy, prevents the gonads of blinded hamsters from regressing. The transplantation of pineal glands to kidneys of blinded, pinealectomized hamsters does not influence reproductive organ size, probably because of the loss of the sympathetic innervation of the grafted pineal glands.

Removal of the eyes from weanling (25-day-old) male and female albino rats results in a retardation of the development of the endocrine system in both sexes; the pinealectomy negates the effects of optic enucleation. Optic enucleation of weanling (25-day-old) male and female hamsters does not retard maturation of the reproductive system, but once the adult condition is reached, the gonads regress, a response that is counteracted by removal of the pineal gland. Optic enucleation alone or combined with pinealectomy (at 40 days of age) has no effect on growth of the endocrine or reproductive organs of albino mice.

The endocrine response to blinding or short daily photoperiods differs for adult black and albino rats. In eyeless or dark-exposed black rats, some endocrine organs exhibit a significant decrease in weight; if the pineal glands are removed, no changes in organ weights are detected. The size of the endocrine organs of adult albino rats is not greatly changed by blinding or short daily increments of light. Male gerbils respond to darkness with only moderate decreases in the weight of the accessory sex organs (seminal vesicles and coagulating glands).

The ovaries of blinded female hamsters respond to the exogenous administration of follicle stimulating hormone and luteinizing hormone, as evidenced by a marked increase in ovarian weights, an increase in the number of corpora lutea, and a significant rise in uterine weights.

The pineal gland is incapable of preventing pituitary hypertrophy following castration of either blinded male albino rats or blinded male golden hamsters. The pineal gland does inhibit significantly the degree of compensatory ovarian hypertrophy after unilateral ovariectomy of dark-exposed [light-dark (LD) 1:23] adult albino rats.

LITERATURE CITED

1. Hoffman, R. A., and Reiter, R. J. Pineal Gland: Influence on Gonads of Male Hamsters. Science 148, 1609-1611 (1965).

2. Reiter, Russel J., Hoffman, Roger A., and Hester, Ralph J. EATR 4032. The Role of the Pineal Gland and of Environmental Lighting in the Regulation of the Endocrine and Reproductive Systems of Rodents. October 1966. UNCLASSIFIED Report

3. Reiter, R. J., and Hoffman, R. A. The Endocrine System In the Golden Hamster: Its Biology and Use in Medical Research. Hoffman, R. A., Robinson, P. F., and Magalhaes, H., eds. Iowa State University Press. Ames, Iowa. 1967.

4. Reiter, R. J., and Hester, R. J. Interrelationships of the Pineal Gland, the Superior Cervical Ganglia and the Photoperiod in the Regulation of the Endocrine Systems of Hamsters. Endocrinology 79, 1168-1170 (1966).

5. Hoffman, R. A., and Reiter, R. J. Rapid Pinealectomy in Hamsters and Other Small Rodents. Anat. Rec. 153, 19-22 (1965).

6. Movat, H. Z. Demonstration of All Connective Tissue Elements in a Single Section. Arch. Pathol. 55, 289-295 (1955).

7. Messier, B., and Leblond, C. P. Preparation of Coated Radioautographs by Dipping Sections in Fluid Emulsion. Proc. Soc. Exptl. Biol. Med. 96, 7-11 (1957).

8. Hoffman, R. A., and Reiter, R. J. Responses of Some Endocrine Organs of Female Hamsters to Pinealectomy and Light. Life Sciences 5, 1147-1151 (1966).

9. Reiter, R. J., Hoffman, R. A., and Hester, R. J. The Effects of Thiourea, Photoperiod and the Pineal Gland on the Thyroid, Adrenals and Reproductive Organs of Female Hamsters. J. Exptl. Zool. 162, 263-268 (1966).

10. Hoffman, R. A., Hester, R. J., and Townes, C. Effect of Light and Temperature on the Endocrine System of the Golden Hamster (Mesocricetus auratus Waterhouse). Comp. Biochem. Physiol. 15, 525-533 (1965).

11. Hoffman, R. A., and Reiter, R. J. Influence of Compensatory Mechanisms and the Pineal Gland on Dark-Induced Gonadal Atrophy in Male Hamsters. Nature 203, 658-659 (1965).

12. Steinbach, E. Zur Geschichte des maennlichen Sexualhormon and seiner Wirkung beim Säugetiere und beim Menschen. Wien. Klin. Wschr. 49, 161-182 (1936).

13. Burger, J. W. The Effect of Photic and Psychic Stimuli on the Reproductive Cycle of the Male Starling, Sturnus vulgaris. J. Exptl. Zool. 124, 227-240 (1953).

14. Drori, D., and Folman, Y. Effects of Cohabitation on the Reproductive System, Kidneys and Body Consumption of Male Rats. J. Reprod. Fertil. 8, 351-359 (1964).

15. Folman, Y., and Drori, D. Effects of Social Isolation and of Female Odours on the Reproductive System, Kidneys and Adrenals of Unmated Male Rats. J. Reprod. Fertil. 11, 43-50 (1966).

16. Bruce, H. M., and Hindle, E. The Golden Hamster, Cricetus (Mesocricetus) auratus Waterhouse. Notes on Its Breeding and Growth. Proc. Zool. Soc., London, 2, 361-366 (1934).

17. Cusick, F. J., and Cole, H. An Improved Method of Breeding Golden Hamsters. Texas Repts. Biol. & Med. 17, 201-204 (1959).

18. Mogler, R. K.-H. Das Endokrine System das Syrischen Goldhamster unter Berücksichtigung des Natürlichen Winterschlafs. Zeit. Fur Morphol. und Oekol. der Tiere. 47, 267-308 (1958).

19. Hoffman, R. A. Terrestrial Animals in Cold: Hibernators. In Handbook of Physiology - Section IV, Environment. Chap. 24, 379-403 (1964).

20. Hoffman, R. A. Speculations on the Regulation of Hibernation. Ann. Acad. Sci. Fenn. A. Biol. 71, 201-214 (1964).

21. Parkes, A. S., and Bruce, H. M. Olfactory Stimuli in Mammalian Reproduction. Science 134, 1049-1054 (1961).

22. Whitten, W. K. Effect of Exteroceptive Factors on the Oestrous Cycle of Mice. Nature 180, 1436 (1957).

23. Whitten, W. K. Modification of the Oestrous Cycle of the Mouse by External Stimuli Associated With the Male. Changes in the Oestrous Cycle Determined by Vaginal Smears. J. Endocrin. 17, 307-313 (1958).

24. Lamond, D. R. Effect of Stimulation Derived From Other Animals of the Same Species on Oestrous Cycles in Mice. J. Endocrin. 18, 343-349 (1959).

25. Marsden, H. M., and Bronson, F. H. Estrous Synchrony in Mice: Alteration by Exposure to Male Urine. Science 144, 1469 (1964).

26. Marsden, H. M., and Bronson, F. H. The Synchrony of Oestrus in Mice: Relative Roles of the Male and Female Environments. J. Endocrin. 32, 313-319 (1965).

27. Chipman, R. K., and Fox, K. A. Oestrous Synchronization and Pregnancy Blocking in Wild House Mice (Mus Musculus). J. Reprod. Fertil. 12, 233-236 (1966).

28. Whitten, W. K. The Effect of Removal of the Olfactory Bulbs on the Gonads of Mice. J. Endocrin. 14, 160-163 (1956).

29. Lerner, A. B., Case, J. D., Takahashi, Y., Lee, T. H., and Mori, W. Isolation of Melatonin, The Pineal Gland Factor That Lightens Melanocytes. J. Am. Chem. Soc. 80, 2587 (1958).

30. Lerner, A. B., Case, J. D., and Heinzelman, R. V. Structure of Melatonin. J. Am. Chem. Soc. 81, 6084, 6085 (1959).

31. Lerner, A. B., Case, J. D., and Takahashi, Y. Isolation of Melatonin and 5-Methoxyindole-3-acetic Acid From Bovine Pineal Glands. J. Biol. Chem. 235, 1992-1997 (1960).

32. Wurtman, R. J., Axelrod, J., and Chu, E. W. Melatonin, a Pineal Substance: Effect on the Rat Ovary. Science 141, 277-278 (1963).

33. Wurtman, R. J., and Axelrod, J. The Formation, Metabolism, and Physiologic Effects of Melatonin in Mammals. Vol. 10, Progress in Brain Research. pp 520-529. Kappers, J. Ariëns, and Schade, J. P., eds. Elsevier Publishing Co. Amsterdam, The Netherlands. 1965.

34. Prop, N., and Kappers, J. Ariëns. Demonstration of Some Compounds Present in the Pineal Organ of the Albino Rat by Histochemical Methods and Paper Chromatography. Acta Anat. 45, 90-109 (1961).

35. Baschieri, L., DeLuca, F., Cramarossa, L., DeMartino, C., Ollivero, A., and Negri, M. Modification of Thyroid Activity by Melatonin. Experientia 19, 15-17 (1963).

36. Franchimont, P. Action de la Melatonin et de la Glomerulotrophine sur les Fonctions Genitale et Surrenalienne du Rat. Arch. Intl. Physiol. Biochem. 72, 735-740 (1964).

37. Cabassa, N., and Sciascia, R. Effect of Melatonin on the Erythrocyte Uptake of Triiodothyronine-^{131}I in the Rat. Radiobiol. Radioterap., Fis. Med. 20, 17-27 (1965).

38. Reiter, R. J., Hoffman, R. A., and Hester, R. J. Inhibition of I^{131} Uptake by Thyroid Glands of Male Rats Treated With Melatonin and Pineal Extract. Amer. Zoologist 5, 727-728 (1965).

39. Hertzl-Eshel, M., and Rahamimoff, R. Effect of Melatonin on Uterine Contractility. Life Sciences 4, 1367-1372 (1965).

40. Axelrod, J., and Weissbach, H. Enzymatic O-Methylation of N-Acetyl-serotonin to Melatonin. Science 131, 1312 (1960).

41. Weissbach, H., Redfield, B. G., and Axelrod, J. Biosynthesis of Melatonin: Enzymic Conversion of Serotonin to N-Acetyl-serotonin. Biochem. Biophys. Acta 43, 352-353 (1960).

42. Wurtman, R. J., Axelrod, J., and Fischer, J. E. Melatonin Synthesis in the Pineal Gland: Effect of Light Mediated by the Sympathetic Nervous System. Science 143, 1328-1330 (1964).

43. Wurtman, R. J., Axelrod, J., Chu, E. W., and Fischer, J. E. Mediation of Some Effects of Illumination on the Rat Estrous Cycle by the Sympathetic Nervous System. Endocrinology 75, 266-272 (1964).

44. Wurtman, R. J., Axelrod, J., and Phillips, L. S. Melatonin Synthesis in the Pineal Gland: Control by Light. Science 142, 1071-1073 (1963).

45. Wurtman, R. J., Axelrod, J., and Chu, E. W. The Relation Between Melatonin, a Pineal Substance, and the Effects of Light on the Rat Gonad. Ann. N. Y. Acad. Sci. 117, 228-230 (1964).

46. Ifft, J. D. Effects of Pinealectomy, a Pineal Extract and Pineal Grafts on Light-Induced Prolonged Estrus in Rats. Endocrinology 71, 181-182 (1962).

47. Gittes, R. F., and Chu, E. W. Reversal of the Effect of Pinealectomy in Female Rats by Multiple Isogenic Pineal Transplants. Endocrinology 77, 1061-1067 (1965).

48. Holmes, R. L. Iris Reactions to Homo- and Autografts of Pineal Tissue in Rats and Rabbits. Anat. Rec. 127, 173-186 (1957).

49. Wragg, L. E., Conceicao, R., Machado, S., Snyder, S. H., and Axelrod, J. Anterior Chamber Pineal Transplants: Their Metabolic Activity and Independence of Environmental Lighting. Life Sciences 6, 31-38 (1967).

50. Kitay, J. I., and Altschule, M. D. The Pineal Gland. Harvard University Press. Cambridge, Massachusetts. 1954.

51. Kelly, D. Pineal Organs: Photoreception, Secretion, and Development. Amer. Scientist 50, 597-625 (1962).

52. Kincl, F. A., and Benagiano, G. The Failure of the Pineal Gland Removal in Neonatal Animals to Influence Reproduction. Acta Endocrinologica 54, 189-192 (1967).

53. Chase, E. B. Studies on an Anophthalmic Strain of Mice. II. Effect of Congenital Eyelessness on Reproductive Phenomena. Anat. Rec. 80, 33-36 (1941).

54. Reiter, R. J., and Hester, R. J. Regulation of Endocrine Functions of Black Rats by Light and the Pineal Gland. Amer. Zoologist 6, 313 (1966).

55. Oliver, J. T., and Peron, F. G. 19-Hydroxy-11-Deoxycortisol, a Major Steroid Secreted by the Adrenal Gland of the Mongolian Gerbil. Steroids 4, 351-363 (1964).

56. Robinson, P. F., and Reiter, R. J. The Adrenal Response of Hamsters, Gerbils and Rats to Exogenous Corticotrophin or Unilateral Adrenalectomy. Acta Endocrinologica 54, 257-262 (1967).

57. Schwentker, V. The Gerbil. A New Laboratory Animal. III. Vet. 6, 5-9 (1963).

58. Marston, J. H., and Chang, M. C. The Breeding, Management and Reproductive Physiology of the Mongolian Gerbil (Meriones unguiculatus). Lab. Animal Care 15, 34-48 (1965).

59. Moszkowska, A. L'Antagonisme Epiphyso-Hypophysaire. Ann. Endocr. (Paris) 24, 215-226 (1963).

60. Moszkowska, A. Contribution a L'Etude du Mecanisme de L'Antagonisme Epiphyso-Hypophysaire. Vol. 10, Progress in Brain Research. pp 564-576. Kappers, J. Ariëns, and Schade, J. P. eds. Elsevier Publishing Co. Amsterdam, The Netherlands. 1965.

61. Reiter, R. J., Hester, R. J., and Muller, M. A. Action of FSH and LH on the Reproductive Organs of Blinded Female Hamsters. Amer. Zoologist 6, 599 (1966).

62. Schreiber, V., and Kmentova, V. Trophic Reactions of the Adenohypophysis to Adrenalectomy, Castration and Thyroidectomy in Male Rats. Folia Biologica 11, 222-232 (1965).

63. Edgren, R. A., Parlow, A. F., Peterson, D. L., and Jones, R. A. On the Mechanism of Ovarian Hypertrophy Following Hemicastration in the Rat. Endocrinology 76, 97-102 (1965).

64. Chu, E. W., Wurtman, R. J., and Axelrod, J. An Inhibitory Effect of Melatonin on the Estrous Phase of the Estrous Cycle of the Rodent. Endocrinology 75, 238-242 (1964).

65. Ebels, I., Prop, N. A Study of the Effect of Melatonin on the Gonads, the Oestrous Cycle and the Pineal Organ of the Rat. Acta Endocrinologica 49, 567-577 (1965).

66. Balboni, G. C. Modificazioni Citologiche Dell Ipofisi Anteriore in Seguito All'Ablazione dei Bulbi Olfattivi nel Ratto. Boll. Soc. Ital. Biol. Sperm. 41, 1527-1528 (1965).

67. Orbach, J., and Kling, A. Effect of Sensory Deprivation on Onset of Puberty, Mating, Fertility and Gonadal Weights in Rats. Brain Res. 3, 141-149 (1966).

68. Relkin, R. The Pineal Gland. New Engl. J. Med. 274, 944-950 (1966).

69. Hartman, F. Über die Innervation der Epiphysis Cerebri einiger Säugetiere. Z. Zellforsch. 46, 416-429 (1957).

70. Kappers, J. Ariëns, The Development, Topographical Relations and Innervation of the Epiphysis Cerebri in the Albino Rat. Z. Zellfrosch. 52, 163-215 (1960).

71. Kappers, J. Ariëns, Die Innervation der Epiphysi Cerebri der Albinoratte. Acta Neuroveg. 23, 111-114 (1961).

72. Kappers, J. Ariëns, Survey on the Innervation of the Pineal Organ in Vertebrates. Amer. Zoologist 4, 47-51 (1964).

73. Kappers, J. Ariëns, Survey of the Innervation of the Epiphysis Cerebri and the Accessory Pineal Organs of Vertebrates. Vol. 10, Progress in Brain Research. pp 87-153. Kappers, J. Ariëns and Schade, J. P., eds. Elsevier Publishing Co. Amsterdam, The Netherlands. 1965.

74. Axelrod, J., Snyder, S. H., Heller, A., and Moore, R. Y. Light-Induced Changes in Pineal Hydroxyindole-O-Methyltransferase: Abolition by Lateral Hypothalamic Lesions. Science 154, 898-899 (1966).

75. Moore, R. Y., Heller, A., Wurtman, R. J., and Axelrod, J. Visual Pathway Mediating Pineal Response to Environmental Light. Science 155, 220-223 (1967).

76 Krieg, W. J. S. The Hypothalamus of the Albino Rat. J. Com. Neurol. 55, 19-89 (1932).

77. Knoche, H. Die retino-hypothalamische Bahn von Mensch, Hund und Kaninchen. Z. Mikroskip. Anat. Forsch. 63, 461-486 (1957).

78. Hayhow, W. R., Webb, C., and Jervie, A. The Accessory Optic System in the Rat. J. Comp. Neurol. 115, 187-215 (1960).

79. Giarman, N. J., and Day, M. Presence of Biogenic Amines in the Bovine Pineal Body. Biochem. Pharmacol. 1, 235 (1959).

80. Quay, W. B., and Halvey, A. Experimental Modification of the Rat Pineal's Content of Serotonin and Related Indole Amines. Physiol. Zool. 35, 1-7 (1962).

81. Quay, W. B. Differential Extractions for the Spectrophotofluorometric Measurement of Diverse 5-Hydroxy- and 5-Methoxy-Indoles. Anal. Biochem. 5, 51-59 (1963).

82. Bertler, A., Flack, B., and Owman, C. Cellular Localization of 5-Hydroxytryptamine in the Rat Pineal Gland. Kungl. Fysiogr. Sallsk. Lund Forhandl. 33, 13-16 (1963).

83. Wurtman, R. J., Axelrod, J., and Barchas, J. D. Age and Enzyme Activity in the Human Pineal. J. Clin. Endocr. Metab. 24, 299-301 (1964).

84. Quay, W. B. The Significance of Darkness and Monamine Oxidase in the Nocturnal Changes in 5-Hydroxytryptamine and Hydroxyindole-O-Methyltransferase Activity of the Macaque's Epiphysis Cerebri. Brain Res. 3, 277-286 (1967).

85. Wells, S. A., Wurtman, R. J., and Rabson, A.S. Viral Neoplastic Transformation of Hamster Pineal Cells in vitro: Retention of Enzymatic Function. Science 154, 278-279 (1966).

Table 1. Studies on the Rate of Atrophy of the Reproductive and Endocrine Organs of Blinded Male Hamsters

Group	Treatment	Time of sacrifice*	Number of animals	Body weight	Mean organ weights				
					Testes	Accessory organs	Adrenals	Thyroid	Pituitary
		wk		gm	mg/100 gm body wt				
1	None	8	5	108 ±5	2933 ±221	294 ±14	21.1 ±1.6	4.1 ±0.6	2.22 ±0.09
2	Bilateral optic enucleation; pinealectomy	4	5	101 ±3	2841 ±104	341 ±12	22.2 ±0.7	4.4 ±0.4	2.60 ±0.05
3	Bilateral optic enucleation; pinealectomy	8	5	114 ±3	2540 ±53	284 ±15	21.0 ±0.9	4.1 ±0.5	2.40 ±0.12
4	Bilateral optic enucleation	1	5	96 ±3	3179 ±246	290 ±33	18.6 ±0.8	4.0 ±0.2	2.60 ±0.08
5	Bilateral optic enucleation	2	5	107 ±2	2599 ±232	223 ±26	19.7 ±1.7	4.3 ±0.1	2.35 ±0.15
6	Bilateral optic enucleation	3	5	115 ±4	2602 ±118	243 ±12	18.7 ±0.9	4.1 ±0.2	2.11 ±0.24
7	Bilateral optic enucleation	4	5	119 ±4	1855 ±287**	195 ±14**	18.0 ±1.2	4.2 ±0.3	2.12 ±0.11
8	Bilateral optic enucleation	5	5	124 ±7	1493 ±361**	203 ±13**	18.0 ±0.9	4.0 ±0.3	2.20 ±0.14
9	Bilateral optic enucleation	6	5	144 ±9**	475 ±95**	139 ±16**	16.5 ±1.3**	3.5 ±0.4	1.77 ±0.11**
10	Bilateral optic enucleation	7	5	132 ±4**	436 ±97**	123 ±14**	19.8 ±1.1	3.5 ±0.3	2.00 ±0.08
11	Bilateral optic enucleation	8	5	140 ±8**	272 ±16**	92 ±8**	16.7 ±0.9**	4.0 ±0.3	1.82 ±0.05**
Least significant difference				15	558	49	3.3	1.0	0.35

* Time of killing in relation to surgical procedure.
** Significantly different from untreated (group 1) and pinealectomized (groups 2 and 3) controls.

Table 2. Regeneration of the Testes and Accessory Organs of Blinded Hamsters Following Pinealectomy

Group	Treatment	Time of sacrifice*	Number of animals	Body weight	Mean organ weights			
					Testes	Accessory organs	Adrenals	Pituitary
		wk		gm	mg/100 gm body wt			
1	None (beginning of experiment)		5	106 ±2	2205 ±212	412 ±29	22.7 ±0.7	3.04 ±0.21
2	Bilateral optic enucleation Pinealectomy	9 9	5	101 ±4	2161 ±90	388 ±34	21.9 ±0.4	2.84 ±0.08
3	Bilateral optic enucleation	9	5	132 ±5	243 ±37**	91 ±7**	17.4 ±1.0	2.47 ±0.07
4	Bilateral optic enucleation Pinealectomy	11 2	6	123 ±7	253 ±23**	92 ±13**	17.4 ±0.7	2.37 ±0.13
5	Bilateral optic enucleation Pinealectomy	13 4	5	122 ±6	560 ±103**	116 ±17**	16.1 ±0.4**	2.76 ±0.12
6	Bilateral optic enucleation Pinealectomy	15 6	7	127 ±6	1271 ±224**	160 ±30**	16.7 ±0.9	2.68 ±0.15
7	Bilateral optic enucleation Pinealectomy	17 8	14	131 ±5	1925 ±127	275 ±15**	17.0 ±0.6	2.59 ±0.11
8	Bilateral optic enucleation	17	5	111 ±7	398 ±41**	71 ±4**	14.5 ±0.9**	2.49 ±0.17
9	Bilateral optic enucleation Pinealectomy	17 17	5	111 ±9	2242 ±150	379 ±30	20.5 ±1.3	2.36 ±0.05
10	None (end of experiment)		4	129 ±4	2274 ±126	364 ±9	18.9 ±0.4	2.91 ±0.17
Least significant difference				21	485	69	2.6	0.49

* Time of killing in relation to surgical procedure.

** Significantly different from untreated (groups 1 and 10) and pinealectomized (group 2) controls.

Table 3. Influence of Blinding and of Pinealectomy on the Endocrine Organs of Male Hamsters After 12 wk

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy		111 ±4	2533 ±110	286 ±26	18.7 ±1.2	2.52 ±0.38
2	Unilateral optic enucleation; pinealectomy		118 ±6	2276 ±333	270 ±37	18.1 ±0.7	2.76 ±0.16
3	Bilateral optic enucleation; Sham pinealectomy	5	118 ±4	582 ±118*	79 ±5*	16.7 ±2.5	2.30 ±0.15
4	Bilateral optic enucleation; pinealectomy	6	109 ±7	2365 ±289	260 ±30	17.5 ±0.9	2.73 ±0.11
Least significant difference			18	758	87	4.0	0.74

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 4. Influence of Blinding and of the Pineal Gland on the Endocrine Organs of Male Hamsters After 24 wk

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	10	121 ±7	2116 ±174	285 ±35	18.5 ±0.8	2.69 ±0.18
2	Unilateral optic enucleation; pinealectomy	11	125 ±11	2401 ±220	261 ±29	17.8 ±1.5	2.55 ±0.14
3	Bilateral optic enucleation; Sham pinealectomy	9	116 ±6	2290 ±285	275 ±25	18.1 ±1.1	2.67 ±0.23
4	Bilateral optic enucleation; pinealectomy	27	129 ±5	2012 ±193	248 ±21	18.6 ±0.9	2.53 ±0.09
Least significant difference			19	659	80	3.6	0.51

Table 5. Failure of Cohabitation to Influence Gonadal Degeneration in Blinded Male Hamsters

Group	Treatment*	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	None	9	112 ±3	1680 ±278	199 ±35	21.4 ±0.9	2.26 ±0.04
2	Bilateral optic enucleation	6	121 ±4	600 ±172**	119 ±19**	18.2 ±1.2**	1.98 ±0.11
3	Bilateral optic enucleation; pinealectomy	6	110 ±5	2535 ±120	236 ±41	22.9 ±0.7	2.26 ±0.15
4	Bilateral optic enucleation; (caged with hysterotomized females)	11	133 ±4**	439 ±133**	103 ±15**	17.9 ±0.9**	1.75 ±0.66**
5	Bilateral optic enucleation; (caged with ovariectomized females)	10	135 ±5**	295 ±21**	99 ±12**	16.8 ±0.5**	1.66 ±0.99**
Least significant difference			12	500	73	2.3	0.25

* Animals were killed 8 wk after beginning of experiment.

** Significantly different from untreated (group 1) and pinealectomized (group 3) controls.

Table 6. Mean (± Standard Error) Body Weights and Organ Weights of Female Hamsters Killed During the Month of February 25 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Ovaries	Uterus	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	8	108 ±3	23.1 ±0.9	276 ±28	16.3 ±0.8	3.85 ±0.17
2	Unilateral optic enucleation; pinealectomy	7	108 ±2	25.0 ±2.1	335 ±25	17.5 ±0.8	4.17 ±0.24
3	Bilateral optic enucleation; Sham pinealectomy	6	128 ±8*	29.7 ±2.3*	273 ±47	18.0 ±0.8	3.85 ±0.24
4	Bilateral optic enucleation; pinealectomy	7	105 ±3	24.6 ±1.4	301 ±10	16.5 ±1.2	4.03 ±0.21
Least significant difference			12	4.9	85	2.7	0.63

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 7. Mean (± Standard Error) Body Weights and Organ Weights of Female Hamsters Killed During the Month of May 25 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Ovaries	Uterus	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	5	114 ±3	22.3 ±0.9	301 ±25	14.6 ±0.4	3.51 ±0.10
2	Unilateral optic enucleation; pinealectomy	5	117 ±5	21.8 ±0.7	305 ±29	15.8 ±0.4	3.55 ±0.08
3	Bilateral optic enucleation; Sham pinealectomy	5	119 ±9	23.8 ±2.6	155 ±25*	12.6 ±0.9	3.27 ±0.07
4	Bilateral optic enucleation; pinealectomy	5	119 ±5	22.9 ±0.6	289 ±36	14.4 ±1.0	3.41 ±0.05
Least significant difference			18	4.4	87	2.3	0.61

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 8. Mean (± Standard Error) Body Weights and Organ Weights of Female Hamsters Killed During the Month of August 25 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Ovaries	Uterus	Adrenals	Pituitary
		gm		mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	8	145 ±6	17.9 ±0.7	294 ±24	12.5 ±0.7	3.64 ±23
2	Unilateral optic enucleation; pinealectomy	8	136 ±8	19.5 ±0.8	288 ±24	13.0 ±0.6	2.32 ±0.17
3	Bilateral optic enucleation; Sham pinealectomy	9	136 ±3	19.2 ±1.2	282 ±26	12.0 ±0.8	3.17 ±0.22
4	Bilateral optic enucleation; pinealectomy	6	127 ±8	21.0 ±1.0	272 ±25	11.8 ±0.6	3.43 ±0.18
Least significant difference			18	2.8	74	2.1	0.61

Table 9. Mean (± Standard Error) Body Weights and Organ Weights of Female Hamsters Killed During the Month of November 25 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Ovaries	Uterus	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	8	110 ±5	20.7 ±1.2	434 ±43	14.8 ±1.6	3.85 ±0.14
2	Unilateral optic enucleation; pinealectomy	8	110 ±8	22.1 ±1.5	382 ±25	14.1 ±0.7	3.56 ±0.34
3	Bilateral optic enucleation; Sham pinealectomy	9	117 ±5	21.9 ±1.5	223 ±30*	13.5 ±0.6	3.27 ±0.32
4	Bilateral optic enucleation; pinealectomy	9	112 ±4	20.3 ±1.2	427 ±28	13.4 ±0.7	3.49 ±0.10
Least significant difference			16	3.8	93	2.7	0.71

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 10. Mean (± Standard Error) Body Weights and Organ Weights of Female Hamsters Killed During the Month of February 50 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Ovaries	Uterus	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	8	121 ±4	25.5 ±0.9	304 ±15	14.0 ±0.6	3.73 ±0.14
2	Unilateral optic enucleation; pinealectomy	7	124 ±6	21.6 ±0.8	323 ±38	15.1 ±0.7	3.50 ±0.17
3	Bilateral optic enucleation; Sham pinealectomy	8	146 ±9	23.4 ±1.4	118 ±23*	12.8 ±1.4	2.66 ±0.18*
4	Bilateral optic enucleation; pinealectomy	6	129 ±10	23.9 ±1.6	286 ±25	13.8 ±0.9	3.59 ±0.32
Least significant difference			21	3.6	78	2.8	0.59

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 11. Mean (± Standard Error) Body Weights and Organ Weights of Female Hamsters Killed During the Month of May 50 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Ovaries	Uterus	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	7	147 ±5	23.5 ±2.2	232 ±36	13.0 ±0.6	2.92 ±0.26
2	Unilateral optic enucleation; pinealectomy	10	137 ±3	22.3 ±0.6	277 ±19	13.6 ±0.5	3.07 ±0.15
3	Bilateral optic enucleation; Sham pinealectomy	9	143 ±5	26.0 ±1.9	66 ±8*	10.5 ±0.4	2.[illegible] ±0.10*
4	Bilateral optic enucleation; pinealectomy	8	128 ±3	20.3 ±1.3	239 ±13	12.0 ±0.6	3.26 ±0.11
Least significant difference			12	4.4	57	1.5	0.46

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 12. Mean (± Standard Error) Body Weights and Organ Weights of Female Hamsters Killed During the Month of August 50 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Ovaries	Uterus	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	8	106 ±4	21.8 ±1.1	338 ±33	12.7 ±0.3	3.77 ±0.15
2	Unilateral optic enucleation; pinealectomy	9	120 ±6	21.9 ±1.2	277 ±16	12.9 ±0.8	3.54 ±0.12
3	Bilateral optic enucleation; Sham pinealectomy	9	123 ±8	25.7 ±2.5	159 ±37*	12.1 ±0.7	2.89 ±0.22*
4	Bilateral optic enucleation; pinealectomy	8	123 ±4	21.7 ±1.1	311 ±28	12.6 ±0.4	3.44 ±0.18
Least significant difference			17	6.5	85	1.7	0.49

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 13. Mean (± Standard Error) Body Weights and Organ Weights of Female Hamsters Killed During the Month of November 50 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Ovaries	Uterus	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	11	109 ±6	21.2 ±1.1	389 ±32	13.5 ±1.2	3.45 ±0.15
2	Unilateral optic enucleation; pinealectomy	10	118 ±6	21.1 ±1.4	323 ±27	11.6 ±0.6	3.01 ±0.16
3	Bilateral optic enucleation; Sham pinealectomy	16	120 ±6	26.0 ±0.9	114 ±9*	13.0 ±0.8	2.79 ±0.11
4	Bilateral optic enucleation; pinealectomy	14	124 ±6	20.6 ±1.3	318 ±18	12.3 ±0.7	2.99 ±0.15
Least significant difference			17	3.5	60	2.5	0.39

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 14. Mean (± Standard Error) Body Weights and Organ Weights of Male Hamsters Killed During the Month of February 25 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	8	105 ±3	2816 ±176	338 ±13	23.8 ±1.0	2.99 ±0.12
2	Unilateral optic enucleation; pinealectomy	6	106 ±3	2790 ±166	321 ±6	22.4 ±0.9	2.68 ±0.20
3	Bilateral optic enucleation; Sham pinealectomy	6	119 ±9	1795 ±344*	262 ±20	20.5 ±1.2	2.20 ±0.17
4	Bilateral optic enucleation; pinealectomy	6	106 ±4	2825 ±88	285 ±15	21.7 ±0.6	2.58 ±0.17
Least significant difference			15	622	43	2.9	0.48

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 15. Mean (± Standard Error) Body Weights and Organ Weights of Male Hamsters Killed During the Month of May 25 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	5	98 ±3	2654 ±181	273 ±58	22.8 ±1.2	3.04 ±0.07
2	Unilateral optic enucleation; pinealectomy	5	101 ±3	2430 ±275	282 ±63	23.8 ±0.7	3.05 ±0.10
3	Bilateral optic enucleation; Sham pinealectomy	5	104 ±4	2751 ±123	264 ±21	21.8 ±0.6	3.03 ±0.10
4	Bilateral optic enucleation; pinealectomy	5	100 ±7	2995 ±210	332 ±18	26.8 ±1.3	2.78 ±0.08
Least significant difference			13	614	136	3.0	0.41

Table 16. Mean (± Standard Error) Body Weights and Organ Weights of Male Hamsters Killed During the Month of August 25 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	5	104 ±7	2663 ±198	297 ±18	18.8 ±1.7	3.14 ±0.35
2	Unilateral optic enucleation; pinealectomy	6	98 ±4	2654 ±115	337 ±14	20.8 ±0.7	3.22 ±0.10
3	Bilateral optic enucleation; Sham pinealectomy	9	106 ±3	2609 ±119	294 ±12*	19.1 ±0.5	2.66 ±0.08*
4	Bilateral optic enucleation; pinealectomy	8	100 ±2	2729 ±30	357 ±13	20.8 ±0.5	3.20 ±0.09
Least significant difference			11	327	41	2.4	0.44

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 17. Mean (± Standard Error) Body Weights and Organ Weight of Male Hamsters Killed During the Month of November 25 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	6	103 ±6	2762 ±99	185 ±6	20.7 ±0.9	2.32 ±0.17
2	Unilateral optic enucleation; pinealectomy	6	106 ±14	2253 ±83	157 ±13	17.8 ±0.9	2.36 ±0.13
3	Bilateral optic enucleation; Sham pinealectomy	7	100 ±3	1104 ±262*	102 ±7*	16.9 ±1.2	2.33 ±0.14
4	Bilateral optic enucleation; pinealectomy	7	104 ±3	2575 ±164	161 ±9	20.3 ±0.9	2.88 ±0.21
Least significant difference			11	553	26	3.0	0.49

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 18. Mean (± Standard Error) Body Weights and Organ Weights of Male Hamsters Killed During the Month of February 50 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	10	119 ±3	2734 ±138	301 ±13	23.3 ±0.8	2.63 ±0.16
2	Unilateral optic enucleation; pinealectomy	10	113 ±5	2716 ±77	304 ±12	22.9 ±0.7	2.56 ±0.09
3	Bilateral optic enucleation; Sham pinealectomy	10	123 ±5	1026 ±225*	158 ±12*	18.2 ±0.6*	2.16 ±0.13*
4	Bilateral optic enucleation; pinealectomy	9	117 ±5	2624 ±95	278 ±14	21.4 ±1.0	2.68 ±0.12
Least significant difference			12	424	37	2.3	0.36

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 19. Mean (± Standard Error) Body Weights and Organ Weights of Male Hamsters Killed During the Month of May 50 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weight			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	5	104 ±7	2699 ±190	283 ±17	21.2 ±1.1	2.28 ±0.17
2	Unilateral optic enucleation; pinealectomy	10	113 ±4	2740 ±45	259 ±31	22.2 ±2.7	2.30 ±0.08
3	Bilateral optic enucleation; Sham pinealectomy	9	121 ±5	760 ±258*	171 ±19*	18.6 ±0.6	1.89 ±0.06
4	Bilateral optic enucleation; pinealectomy	7	113 ±3	2661 ±174	248 ±37	22.3 ±1.4	2.00 ±0.11
Least significant difference			14	549	96	2.8	0.28

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 20. Mean (± Standard Error) Body Weights and Organ Weights of Male Hamsters Killed During the Month of August 50 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	8	119 ±5	2454 ±79	327 ±12	19.2 ±1.4	2.40 ±0.14
2	Unilateral optic enucleation; pinealectomy	10	112 ±5	2100 ±216	338 ±24	20.5 ±0.7	2.62 ±0.14
3	Bilateral optic enucleation; Sham pinealectomy	10	116 ±4	821 ±264*	186 ±13*	17.5 ±0.7	2.27 ±0.12
4	Bilateral optic enucleation pinealectomy	11	115 ±4	1950 ±146	336 ±22	17.9 ±0.6	2.47 ±0.11
Least significant difference			13	568	56	2.4	0.36

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 21. Mean (± Standard Error) Body Weights and Organ Weights of Male Hamsters Killed During the Month of November 50 Days After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	10	125 ±10	2105 ±90	259 ±15	16.8 ±0.9	2.45 ±0.06
2	Unilateral optic enucleation; pinealectomy	16	109 ±3	2219 ±103	289 ±11	16.5 ±0.5	2.20 ±0.09
3	Bilateral optic enucleation; Sham pinealectomy	11	109 ±6	755 ±232*	161 ±15*	16.6 ±0.8	2.09 ±0.08
4	Bilateral optic enucleation; pinealectomy	14	111 ±3	2459 ±86	288 ±13	17.2 ±0.8	2.23 ±0.19
Least significant difference			15	385	38	2.2	0.25

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 22. Influence of Olfaction on the Endocrine and Reproductive Organs of Female Hamsters. Animals Killed 8 wk After Surgican Treatment

Group	Treatment	Number of animals	Body weight	Mean organ weights			
				Ovaries	Uterus	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Olfactoriectomy	21	118 ±4	21.8 ±0.9	217 ±18*	14.0 ±0.4	3.31 ±0.14
2	Olfactoriectomy; pinealectomy	14	110 ±3	23.3 ±1.5	333 ±24	15.7 ±0.9	3.88 ±0.17
Least significant difference		11	15	3.1	88	2.9	0.65

* Significantly different from pinealectomized (group 2) controls.

Table 23. Influence of Olfaction on the Endocrine and Reproductive Organs of Female Hamsters. Animals Killed 8 wk After Surgical Treatment

Group	Treatment	Number of animals	Body weight	Mean organ weights			
				Ovaries	Uterus	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	None	16	142 ±5	18.6 ±0.8	321 ±18	12.8 ±0.4	3.29 ±0.16
2	Olfactoriectomy	13	120 ±4	19.2 ±1.1	244 ±15*	13.7 ±0.4	3.45 ±0.17
3	Olfactoriectomy; pinealectomy	11	128 ±5	20.1 ±1.2	347 ±30	15.5 ±0.7	3.71 ±0.14
Least significant difference		11	14	2.9	60	1.4	0.46

* Signficantly different from untreated (group 1) and pinealectomized (group 3) controls

Table 24. Effect of Superior Cervical Ganglionectomy on Uterine Regression in Anosmic Female Hamsters. Animals Were Killed 12 wk After Surgical Treatment

Group	Treatment	Number of animals	Body weight	Mean organ weights			
				Ovaries	Uterus	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	None	15	108 ±2	24.5 ±0.8	334 ±20	11.9 ±0.4	4.14 ±0.10
2	Olfactoriectomy	13	120 ±4	23.6 ±0.8	273 ±21	12.6 ±0.4	4.31 ±0.18
3	Olfactoriectomy; pinealectomy	14	125 ±4	23.7 ±1.0	316 ±16	13.5 ±0.4	4.37 ±0.13
4	Olfactoriectomy; ganglionectomy	9	122 ±4	22.6 ±1.8	300 ±23	13.6 ±0.7	3.97 ±0.19
Least significant difference			10	3.1	58	1.3	0.43

Table 25. Influence of Olfaction on the Endocrine and Reproductive Organs of Male Hamsters. Animals Were Killed 12 wk After Surgical Treatment

Group	Treatment	Number of animals	Body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	None	10	110 ±4	2246 ±80	279 ±19	19.9 ±0.9	2.98 ±0.18
2	Pinealectomy	8	117 ±6	2390 ±79	284 ±14	21.8 ±0.9	3.00 ±0.24
3	Olfactoriectomy	9	119 ±5	2527 ±67	322 ±21	21.9 ±1.1	3.01 ±0.13
4	Olfactoriectomy; pinealectomy	9	118 ±4	2569 ±80	329 ±24	22.1 ±0.7	3.30 ±0.16
Least significant difference			15	350	69	2.9	0.43

Table 26. Interaction of Photoperiod and Temperature on the Regulation of the Endocrine Systems of Female Hamsters. Animals Were Killed 25 Days After Surgical Treatment

Group	Treatment	Environmental temperature	Number of animals	Final body weight	Mean organ weights			
					Ovaries	Uterus	Adrenals	Pituitary
		°C		gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	22	9	98 ±10	22.5 ±1.8	290 ±25	12.9 ±0.9	3.41 ±0.11
2	Unilateral optic enucleation; pinealectomy	22	9	101 ±5	20.1 ±1.2	311 ±26	14.2 ±0.7	3.62 ±0.12
3	Bilateral optic enucleation; Sham pinealectomy	22	8	100 ±3	23.6 ±1.1	212 ±38*	14.5 ±1.5	3.45 ±0.07
4	Bilateral optic enucleation; pinealectomy	22	10	96 ±4	22.3 ±1.5	286 ±30	14.0 ±0.7	3.93 ±0.21
5	Unilateral optic enucleation; Sham pinealectomy	6	8	109 ±6	23.0 ±2.1	259 ±22	13.9 ±0.9	3.54 ±0.21
6	Unilateral optic enucleation; pinealectomy	6	8	105 ±4	24.6 ±1.2	258 ±25	13.9 ±0.5	3.61 ±0.07
7	Bilateral optic enucleation; Sham pinealectomy	6	8	99 ±4	24.7 ±3.3	139 ±24*	12.8 ±0.5	3.14 ±0.09
8	Bilateral optic enucleation; pinealectomy	6	10	102 ±3	24.5 ±2.1	213 ±19	13.1 ±0.4	3.48 ±0.13
Least significant difference				15	5.2	73	2.4	0.51

* Significantly different from pinealectomized (groups 4 and 8) controls.

Table 27. Interaction of Photoperiod and Temperature on the Reproductive and Endocrine Systems of Female Hamsters. Animals Were Killed 50 days After Surgical Treatment

Group	Treatment	Environmental temperature	Number of animals	Final body weight	Mean organ weights			
					Ovaries	Uterus	Adrenals	Pituitary
		°C		gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	22	12	115 ±9	20.9 ±1.6	281 ±25	12.8 ±0.7	3.19 ±0.13
2	Unilateral optic enucleation; pinealectomy	22	15	124 ±11	19.3 ±0.9	276 ±19	13.2 ±0.6	3.05 ±0.15
3	Bilateral optic enucleation; Sham pinealectomy	22	9	115 ±8	19.0 ±2.2	90 ±8*	13.1 ±0.5	2.44 ±0.11*
4	Bilateral optic enucleation; pinealectomy	22	8	105 ±9	22.2 ±1.6	281 ±29	14.4 ±3.3	3.15 ±0.23
5	Unilateral optic enucleation; Sham pinealectomy	6	12	109 ±5	21.7 ±2.3	168 ±27	12.4 ±0.5	3.09 ±0.15
6	Unilateral optic enucleation; pinealectomy	6	8	129 ±8	19.9 ±1.6	178 ±29	13.1 ±0.9	3.14 ±0.28
7	Bilateral optic enucleation; Sham pinealectomy	6	13	137 ±12	21.3 ±1.7	96 ±11	13.9 ±1.2	2.71 ±0.07
8	Bilateral optic enucleation; pinealectomy	6	8	105 ±9	21.7 ±1.7	138 ±9	12.2 ±0.7	2.98 ±0.23
Least significant difference				26	5.1	65	3.2	0.47

* Significantly different from pinealectomized (group 4) controls.

Table 28. Influence of Melatonin and Serotonin on Reproductive and Endocrine Organs of Blinded, Pinealectomized Male Hamsters. Animals Were Killed 10 wk After Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	None	10	128 ±11	2116 ±241	261 ±12	18.8 ±0.7	2.01 ±0.05
2	Bilateral optic enucleation	12	151 ±3	219 ±27*	122 ±8*	17.6 ±0.7	1.69 ±0.07
3	Bilateral optic enucleation; pinealectomy	8	135 ±7	1876 ±236	253 ±19	19.1 ±0.5	1.87 ±0.10
4	Bilateral optic enucleation; pinealectomy; cholesterol pellet	8	123 ±17	1911 ±275	228 ±20	19.6 ±0.8	1.86 ±0.03
5	Bilateral optic enucleation; pinealectomy; serotonin pellet	5	140 ±6	1787 ±164	232 ±12	18.3 ±0.5	1.71 ±0.09
6	Bilateral optic enucleation; pinealectomy; melatonin pellet	9	120 ±8	2319 ±130	271 ±13	19.3 ±0.8	1.92 ±0.14
Least significant difference			17	513	43	2.2	0.28

* Significantly different from untreated (group 1) and pinealectomized (group 3) controls.

Table 29. Interaction of the Pineal Gland and of the Superior Cervical Ganglion on Gonadal Involution in Adult Male Golden Hamesters Following Removal of the Eyes. The Animals Were Killed 8 wks Surgical Treatment. Mean Weights ± Standard Errors

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	None	11	121 ±4	2655 ±148	292 ±15	23.0 ±0.8	2.56 ±0.14
2	Bilateral optic enucleation	11	124 ±4	826 ±161*	146 ±12*	18.0 ±0.6	2.17 ±0.10
3	Bilateral optic enucleation; pinealectomy	11	120 ±4	2514 ±107	270 ±13	21.0 ±0.9	2.64 ±0.10
4	Bilateral optic enucleation; ganglionectomy	16	131 ±4	2351 ±92	292 ±14	21.6 ±0.7	2.34 ±0.06
5	Bilateral optic enucleation; ganglionectomy; pinealectomy	17	123 ±5	2359 ±93	282 ±12	22.1 ±0.9	2.66 ±0.17
6	Ganglionectomy; pinealectomy	13	127 ±4	2405 ±76	288 ±10	21.5 ±1.1	2.54 ±0.10
7	Ganglionectomy; eyelids removed	20	130 ±3	2313 ±46	293 ±8	21.2 ±0.6	2.40 ±0.07
8	Ganglionectomy	10	124 ±5	2419 ±119	304 ±20	21.7 ±1.1	2.51 ±0.07
Least significant difference			11	389	28	2.4	0.33

* Significantly different from untreated (group 1), ganglionectomized (group 4) and pinealectomized (group 3) controls.

Table 30. Interaction of the Pineal Gland and of the Superior Cervical Ganglion on Gonadal Involution in Adult Female Golden Hamsters Following Removal of the Eyes. The Animals Were Killed 8 wk After Treatment. Mean Weights ± Standard Errors

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Uterus	Ovaries	Adrenal glands	Pituitary
			gm	mg/100 gm body wt			
1	None	10	107 ±3	212 ±33	23.9 ±2.4	12.5 ±0.7	3.06 ±0.17
2	Bilateral optic enucleation	8	116 ±7	101 ±13*	27.3 ±2.1	11.7 ±0.5	3.03 ±0.19
3	Bilateral optic enucleation; pinealectomy	8	113 ±6	218 ±18	20.6 ±1.3	12.3 ±0.7	3.10 ±0.15
4	Bilateral optic enucleation; ganglionectomy	11	119 ±5	227 ±30	20.9 ±2.5	12.9 ±0.4	3.51 ±0.12
5	Bilateral optic enucleation; ganglionectomy; pinealectomy	5	117 ±8	237 ±33	21.4 ±2.6	12.3 ±0.9	3.42 ±0.16
6	Ganglionectomy; pinealectomy	10	121 ±5	246 ±26	19.7 ±1.1	12.4 ±0.3	3.72 ±0.15
7	Ganglionectomy	6	107 ±4	222 ±21	20.7 ±1.7	12.6 ±0.7	3.42 ±0.17
Least significant difference			16	97	7.5	2.8	0.71

* Significantly different from untreated (group 1), ganglionectomized (group 4), and pinealectomized (group 3) controls.

Table 31. Response of the Endocrine Organs of Adult Male Hamsters to Blinding, Ganglionectomy, Pinealectomy, and theTransplantation of Pineal Glands to the Kidney. The Animals Were Killed 14 wk After Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	None	12	123 ±8	2020 ±155	233 ±12	18.6 ±0.9	2.6[illegible] ±0.18
2	Bilateral optic enucleation; Sham pinealectomy	16	109 ±7	313 ±25*	86 ±7*	16.6 ±0.8	2.6[illegible] ±0.17
3	Bilateral optic enucleation; pinealectomy; transplanted pineals	15	108 ±5	2234 ±.48	277 ±17	18.7 ±0.6	2.49 ±0.13
4	Bilateral optic enucleation; pinealectomy	11	111 ±5	1973 ±237	259 ±19	19.8 ±0.8	2.53 ±0.09
5	Bilateral optic enucleation; ganglionectomy	10	115 ±4	2116 ±161	268 ±15	18.9 ±0.5	2.5[illegible] ±0.07
6	Ganglionectomy	12	117 ±6	2219 ±108	231 ±14	18.7 ±0.7	2.5[illegible] ±0.16
7	Unilateral optic enucleation; Sham pinealectomy	10	110 ±7	2397 ±189	251 ±12	19.1 ±0.7	2.6[illegible] ±0.12
8	Unilateral optic enucleation; pinealectomy	10	114 ±5	2088 ±143	246 ±18	18.9 ±0.5	2.5[illegible] ±0.17
Least significant difference			17	490	45	2.1	0.24

* Significantly different from untreated (group 1), ganglionectomized (group 5), and pinealectomized (group 4) controls.

Table 32. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Albino Rats (8 to 12 per group). Mean Body Weight of 25-Day-Old Rats was 50 ±2 gm

Group	Treatment	Body weight				
		Days after operations				
		25	50	75	100	125
		gm				
1	Unilateral optic enucleation; Sham pinealectomy	205 ±8	271 ±7	328 ±12	351 ±10	398 ±21
2	Unilateral optic enucleation; pinealectomy	189 ±5	274 ±9	337 ±11	337 ±10	429 ±23
3	Bilateral optic enucleation; Sham pinealectomy	176 ±8*	238 ±12*	314 ±7*	337 ±8	385 ±18
4	Bilateral optic enucleation; pinealectomy	212 ±9	266 ±11	347 ±7	365 ±20	422 ±18
Least significant difference		21	25	30	40	56

* Significantly different from pinealectomized (group 2 and 4) controls.

Table 33. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Albino Rats (7 to 12 per group). Mean Body Weight of 25-Day-Old Rats was 45 ±2 gm

Group	Treatment	Body weight				
		Days after operations				
		25	50	75	100	125
		gm				
1	Unilateral optic enucleation; Sham pinealectomy	155 ±2	195 ±5	225 ±6	224 ±5	240 ±10
2	Unilateral optic enucleation; pinealectomy	156 ±4	189 ±4	220 ±4	232 ±5	241 ±4
3	Bilateral optic enucleation; Sham pinealectomy	150 ±4	166 ±5*	196 ±6*	221 ±7	223 ±13
4	Bilateral optic enucleation; pinealectomy	159 ±4	189 ±4	220 ±7	216 ±16	248 ±8
Least significant difference		11	13	17	16	26

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 34. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Albino Rats (8 to 12 per group). Mean Testicular Weight of 25-Day-Old Rats was 278 ±18 mg

Group	Treatment	Testicular weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; Sham pinealectomy	2305 ±136	2892 ±83	3004 ±93	3013 ±71	3043 ±229
2	Unilateral optic enucleation; pinealectomy	2109 ±128	2835 ±77	3002 ±65	2975 ±74	3229 ±202
3	Bilateral optic enucleation; Sham pinealectomy	2097 ±88	2486 ±142*	2670 ±64*	2833 ±83*	3000 ±90
4	Bilateral optic enucleation; pinealectomy	2419 ±89	2813 ±63	2955 ±52	3099 ±70	3399 ±125
Least significant difference		326	302	208	219	406

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 35. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Albino Rats (7 to 12 per group). Mean Ovarian Weight of 25-Day-Old Rats was 16.4 ±2.0 mg

Group	Treatment	Ovarian weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; Sham pinealectomy	47.9 ±2.8	64.3 ±3.7	65.9 ±3.3	65.9 ±4.6	62.6 ±3.5
2	Unilateral optic enucleation; pinealectomy	52.9 ±3.6	64.1 ±3.4	65.2 ±1.7	65.6 ±2.4	63.9 ±6.9
3	Bilateral optic enucleation; Sham pinealectomy	48.9 ±3.1	53.2 ±3.0*	54.2 ±5.2*	59.1 ±2.6	64.6 ±6.8
4	Bilateral optic enucleation; pinealectomy	47.7 ±2.4	66.9 ±2.5	64.7 ±2.7	62.3 ±1.4	65.7 ±3.8
Least significant difference		8.5	9.1	10.2	8.2	12.0

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 36. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Albino Rats (8 to 12 per Group). Mean Accessory Organ Weight of 25-Day-Old Rats was 8 ±1 mg

Group	Treatment	Accessory gland weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; Sham pinealectomy	292 ±23	357 ±24	567 ±33	633 ±54	653 ±27
2	Unilateral optic enucleation; pinealectomy	207 ±17	354 ±32	554 ±32	686 ±23	577 ±51
3	Bilateral optic enucleation; Sham pinealectomy	159 ±29*	206 ±26*	294 ±31*	526 ±45*	549 ±37
4	Bilateral optic enucleation; pinealectomy	244 ±22	353 ±31	595 ±27	654 ±19	638 ±58
Least significant difference		66	82	81	119	143

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 37. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Albino Rats (7 to 12 per group). Mean Uterine Weight of 25-Day-Old Rats was 23 ±3 mg

Group	Treatment	Uterine weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; Sham pinealectomy	228 ±14	314 ±17	366 ±35	403 ±33	457 ±40
2	Unilateral optic enucleation; pinealectomy	236 ±18	323 ±15	397 ±19	391 ±32	481 ±39
3	Bilateral optic enucleation; Sham pinealectomy	254 ±28	252 ±22*	342 ±26	413 ±40	439 ±65
4	Bilateral optic enucleation; pinealectomy	279 ±15.3	335 ±21	383 ±26	421 ±22	456 ±20
Least significant difference		56	56	76	101	112

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 38. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Albino Rats (8 to 12 per Group). Mean Adrenal Weight of 25-Day-Old Rats was 14.2 ±1.0 mg

Group	Treatment	Adrenal weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; Sham pinealectomy	33.7 ±1.7	37.1 ±2.5*	43.9 ±2.4	38.9 ±1.9	47.2 ±2.5
2	Unilateral optic enucleation; pinealectomy	32.5 ±1.8	43.8 ±1.8	44.9 ±1.5	39.1 ±2.8	47.6 ±2.9
3	Bilateral optic enucleation; Sham pinealectomy	31.6 ±1.4	32.2 ±1.4*	38.7 ±1.3	41.9 ±2.7	38.9 ±2.2
4	Bilateral optic enucleation; pinealectomy	33.9 ±1.7	40.2 ±2.0	41.5 ±1.4	43.6 ±2.9	42.1 ±2.2
Least significant difference		4.8	5.9	5.0	7.7	7.3

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 39. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Albino Rats (7 to 12 per Group). Mean Adrenal Weight of 25-Day-Old Rats was 13.1 ±0.7 mg

Group	Treatment	Adrenal weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; Sham pinealectomy	39.1 ±0.9	54.6 ±1.2	56.9 ±2.4	58.5 ±3.2	61.2 ±2.1
2	Unilateral optic enucleation; pinealectomy	42.6 ±2.2	56.4 ±2.5	60.0 ±2.9	58.5 ±2.5	58.4 ±2.2
3	Bilateral optic enucleation; Sham pinealectomy	42.0 ±3.1	46.9 ±4.0*	55.0 ±3.9	56.7 ±2.9	55.3 ±5.0
4	Bilateral optic enucleation; pinealectomy	42.8 ±1.2	56.9 ±2.2	56.8 ±1.5	54.7 ±1.8	55.1 ±3.0
Least significant difference		5.3	8.0	8.1	8.1	9.8

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 40. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Albino Rats (8 to 12 per Group). Mean Thyroid Weight of 25-Day-Old Rats was 5.2 ±0.5 mg

Group	Treatment	Thyroid weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; Sham pinealectomy	12.6 ±0.9	14.9 ±0.7	15.0 ±0.7	14.4 ±0.8	14.5 ±0.5
2	Unilateral optic encleation; pinealectomy	12.3 ±0.5	14.9 ±0.9	16.6 ±0.6	14.9 ±0.9	15.2 ±0.6
3	Bilateral optic enucleation; Sham pinealectomy	11.5 ±0.6	14.9 ±0.9	16.0 ±0.8	15.5 ±0.7	14.2 ±0.9
4	Bilateral optic enucleation; pinealectomy	13.7 ±0.5	15.7 ±0.8	16.1 ±0.9	15.9 ±0.9	14.3 ±0.7
Least significant difference		1.9	1.5	2.3	2.4	2.1

Table 41. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Albino Rats (7 to 12 per Group). Mean Thyroid Weight of 25-Day-Old Rats was 5.9 ±0.4 mg

Group	Treatment	Thyroid weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; Sham pinealectomy	10.9 ±0.5	14.2 ±0.7	13.4 ±0.5	14.2 ±0.7	13.3 ±0.9
2	Unilateral optic enucleation; pinealectomy	11.3 ±0.5	13.9 ±0.5	14.1 ±1.2	13.5 ±0.5	13.6 ±0.4
3	Bilateral optic enucleation; Sham pinealectomy	11.6 ±0.4	13.5 ±0.3	13.8 ±0.4	13.1 ±0.6	13.6 ±0.9
4	Bilateral optic enucleation; pinealectomy	10.5 ±0.5	14.4 ±0.5	13.5 ±0.3	13.4 ±0.7	14.6 ±0.6
Least significant difference		1.3	1.4	2.1	1.8	2.1

Table 42. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Albino Rats (8 to 12 per Group). Mean Pituitary Weight of 25-Day-Old Rats was 2.2 ±0.1 mg

Group	Treatment	Pituitary weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; Sham pinealectomy	6.2 ±0.4	7.7 ±0.3	8.8 ±0.4	9.1 ±0.4	10.7 ±0.6
2	Unilateral optic enucleation; pinealectomy	6.9 ±0.3	7.9 ±0.4	9.3 ±0.4	9.2 ±0.4	10.7 ±1.0
3	Bilateral optic enucleation; Sham pinealectomy	6.6 ±0.4	6.6 ±0.3*	7.3 ±0.3*	7.7 ±0.3*	8.5 ±0.4
4	Bilateral optic enucleation; pinealectomy	6.6 ±0.3	7.9 ±0.3	9.5 ±0.3	8.9 ±0.6	9.8 ±0.4
Least significant difference		1.1	1.0	1.0	1.2	1.9

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 43. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Albino Rats (7 to 12 per Group). Mean Pituitary Weight of 25-Day-Old Rats was 2.3 ±0.2 mg

Group	Treatment	Pituitary weights				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; Sham pinealectomy	7.0 ±0.2	9.9 ±0.3	10.8 ± 0.6	12.1 ±0.7	11.9 ±0.2
2	Unilateral optic enucleation; pinealectomy	6.3 ±0.3	9.7 ±0.5	10.8 ±0.5	10.9 ±0.4	11.5 ±0.4
3	Bilateral optic enucleation; Sham pinealectomy	6.6 ±0.4	7.3 ±0.4*	9.1 ±0.6*	10.1 ±0.7	9.9 ±1.1
4	Bilateral optic enucleation; pinealectomy	7.3 ±0.3	10.1 ±0.4	10.6 ±0.5	10.8 ±0.2	11.2 ±0.5
Least significant difference		0.9	1.1	1.4	1.6	2.4

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 44. Photoperiod-Pineal-Endrocrine Relationships in Prepubertal and Postpubertal Male Hamsters (7 to 12 per Group). Mean Body Weight of 25-Day-Old Hamsters was 42 ±3 gm

Group	Treatment	Body Weight		
		Days after operations		
		25	50	75
		gm		
1	Unilateral optic enucleation; sham pinealectomy	86 ±3	108 ±5	123 ±4
2	Unilateral optic enucleation; pinealectomy	86 ±5	111 ±4	114 ±5
3	Bilateral optic enucleation; sham pinealectomy	86 ±6	101 ±4	141 ±8*
4	Bilateral optic enucleation; pinealectomy	87 ±3	107 ±2	122 ±3
Least significant difference		13	11	14

* Significantly different from pinealectomized (groups 2 and 4) contols.

Table 45. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Hamsters (6 to 10 per Group). Mean Body Weight of 25-Day-Old Hamsters was 39 ±5 gm

Group	Treatment	Body weight		
		Days after operations		
		25	50	75
		gm		
1	Unilateral optic enucleation; sham pinealectomy	89 ±6	105 ±10	122 ±8
2	Unilateral optic enucleation; pinealectomy	84 ±6	113 ±8	122 ±7
3	Bilateral optic enucleation; sham pinealectomy	89 ±6	116 ±6	123 ±6
4	Bilateral optic enucleation; pinealectomy	92 ±4	123 ±8	112 ±5
Least significant difference		16	24	20

Table 46. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Hamsters (7 to 12 per group). Mean Testicular Weight of 25-Day-Old Hamsters was 604 ±73 mg

Group	Treatment	Testicular weight		
		Days after operations		
		25	50	75
		mg		
1	Unilateral optic enucleation; sham pinealectomy	2209 ±149	3283 ±112	3158 ±125
2	Unilateral optic enucleation; pinealectomy	2563 ±126	2979 ±143	3068 ±138
3	Bilateral optic enucleation; sham pinealectomy	2482 ±200	1581 ±339*	690 ±392*
4	Bilateral optic enucleation; pinealectomy	2861 ±156	2648 ±198	2886 ±241
Least significant difference		466	625	718

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 47. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Hamsters (6 to 10 per Group). Mean Ovarian Weight of 25-Day-Old Hamsters was 16.3 ±1.0 mg

Group	Treatment	Ovarian weight		
		Days after operations		
		25	50	75
		mg		
1	Unilateral optic enucleation; sham pinealectomy	21.3 ±0.8	22.9 ±2.0	25.6 ±3.3
2	Unilateral optic enucleation; pinealectomy	24.5 ±1.6	25.8 ±0.8	26.4 ±1.3
3	Bilateral optic enucleation; sham pinealectomy	23.4 ±1.1	30.3 ±2.3	34.1 ±2.9*
4	Bilateral optic enucleation; pinealectomy	20.4 ±0.7	26.6 ±3.5	25.9 ±0.9
Least significant difference		3.3	7.5	7.5

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 48. Photoperiod-Pineal-Endocrine Relationships in Prepubertal Male Hamsters (7 to 12 per Group). Mean Accessory Organ Weight of 25-Day-Old Hamsters was 41 ±11 mg

Group	Treatment	Accessory organ weight		
		Days after operations		
		25	50	75
		mg		
1	Unilateral optic enucleation; sham pinealectomy	214 ±12	314 ±15	323 ±40
2	Unilateral optic enucleation; pinealectomy	235 ±8	306 ±21	337 ±17
3	Bilateral optic enucleation; sham pinealectomy	250 ±17	121 ±37*	166 ±14*
4	Bilateral optic enucleation; pinealectomy	226 ±8	299 ±10	307 ±14
Least significant difference		35	102	72

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 49. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Hamsters (6 to 10 per Group). Mean Uterine Weight of 25-Day-Old Hamsters was 54 ±8 mg

Group	Treatment	Uterine weight		
		Days after operations		
		25	50	75
		mg		
1	Unilateral optic enucleation; sham pinealectomy	262 ±43	258 ±29	337 ±49
2	Unilateral optic enucleation; pinealectomy	247 ±16	288 ±40	391 ±34
3	Bilateral optic enucleation; sham pinealectomy	234 ±35	152 ±41*	89 ±7*
4	Bilateral optic enucleation; pinealectomy	248 ±28	264 ±32	312 ±29
Least significant difference		96	105	96

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 50. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Hamsters (7 to 12 per Group). Mean Adrenal Weight of 25-Day-Old Hamsters was 11.4 ±0.4 mg

Group	Treatment	Adrenal weight		
		Days after operations		
		25	50	75
		mg		
1	Unilateral optic enucleation; sham pinealectomy	17.0 ±1.2	22.5 ±1.2	26.5 ±1.1
2	Unilateral optic enucleation; pinealectomy	17.0 ±0.8	26.2 ±1.2	24.1 ±2.0
3	Bilateral optic enucleation; sham pinealectomy	15.8 ±1.2	19.4 ±1.1	22.8 ±0.7
4	Bilateral optic enucleation; pinealectomy	16.2 ±0.8	22.7 ±1.0	24.4 ±1.2
Least significant difference		3.1	3.4	3.8

Table 51. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Hamsters (6 to 10 per Group). Mean Adrenal Weight of 25-Day-Old Hamsters was 9.7 ±0.5 mg

Group	Treatment	Adrenal weight		
		Days after operations		
		25	50	75
		mg		
1	Unilateral optic enucleation; sham pinealectomy	12.3 ±0.9	14.0 ±1.3	14.7 ±0.6
2	Unilateral optic enucleation; pinealectomy	12.5 ±0.8	14.2 ±0.9	14.8 ±0.9
3	Bilateral optic enucleation; sham pinealectomy	13.5 ±0.7	14.2 ±0.9	13.5 ±0.5
4	Bilateral optic enucleation; pinealectomy	13.2 ±0.4	15.5 ±1.1	13.9 ±0.5
Least significant difference		2.2	3.1	2.0

Table 52. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Hamsters (7 to 12 per Group). Mean Pituitary Weight of 25-Day-Old Hamsters was 1.75 ±0.12 mg

Group	Treatment	Pituitary weight		
		Days after operations		
		25	50	75
		mg		
1	Unilateral optic enucleation; sham pinealectomy	2.58 ±0.12	2.82 ±0.15	2.58 ±0.12
2	Unilateral optic enucleation; pinealectomy	2.40 ±0.08	2.65 ±0.11	2.43 ±0.09
3	Bilateral optic enucleation; sham pinealectomy	2.52 ±0.16	2.28 ±0.09	2.33 ±0.18
4	Bilateral optic enucleation; pinealectomy	2.50 ±0.13	2.52 ±0.17	2.34 ±0.09
Least significant difference		0.36	0.39	0.36

Table 53. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Hamsters (6 to 10 per Group). Mean Pituitary Weight of 25-Day-Old Hamsters was 2.25 ±0.19 mg

Group	Treatment	Pituitary weight		
		Days after operations		
		25	50	75
		mg		
1	Unilateral optic enucleation; sham pinealectomy	3.28 ±0.23	3.28 ±0.21	3.50 ±0.18
2	Unilateral optic enucleation; pinealectomy	3.14 ±0.20	3.64 ±0.25	3.84 ±0.19
3	Bilateral optic enucleation; sham pinealectomy	3.26 ±0.23	3.50 ±0.43	2.68 ±0.06*
4	Bilateral optic enucleation; pinealectomy	3.54 ±0.16	3.08 ±0.16	3.58 ±0.27
Least significant difference		0.62	0.93	0.51

* Significantly different from pinealectomized (groups 2 and 4) controls.

Table 54. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal and Male Albino Mice (6 to 12 per Group). Mean Body Weight of 40-Day-Old Mice was 24.2 ±0.7 gm

Group	Treatment	Body weight				
		Days after operations				
		25	50	75	100	125
		gm				
1	Unilateral optic enucleation, sham pinealectomy	27.4 ±1.9	31.7 ±1.0	35.6 ±1.9	40.1 ±0.9	41.8 ±0.4
2	Unilateral optic enucleation, pinealectomy	27.4 ±0.7	30.6 ±0.6	36.2 ±0.9	41.1 ±1.2	40.7 ±1.1
3	Bilateral optic enucleation, Sham pinealectomy	26.2 ±1.1	31.4 ±1.1	36.1 ±1.1	41.0 ±0.9	40.2 ±0.7
4	Bilateral optic enucleation, pinealectomy	25.6 ±1.8	30.4 ±1.2	35.8 ±1.8	42.0 ±0.6	40.0 ±1.6
Least significant difference		2.3	2.9	2.7	2.6	2.9

Table 55. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Albino Mice (6 to 12 per Group). Mean Body Weight of 40-Day-Old Mice was 21.3 ±0.6 gm

Group	Treatment	Body weight				
		Days after operations				
		25	50	75	100	125
		gm				
1	Unilateral optic enucleation; sham pinealectomy	24.9 ±1.3	25.0 ±0.8	31.3 ±1.8	32.2 ±0.5	32.4 ±0.7
2	Unilateral optic enucleation; pinealectomy	24.2 ±1.4	24.6 ±0.6	29.3 ±0.9	31.3 ±0.6	30.6 ±1.4
3	Bilateral optic enucleation; sham pinealectomy	23.1 ±0.5	24.7 ±0.8	31.7 ±1.9	32.0 ±1.0	32.8 ±0.6
4	Bilateral optic enucleation; pinealectomy	24.3 ±1.5	25.2 ±0.9	29.8 ±0.9	32.0 ±1.1	31.5 ±0.9
Least significant difference		3.3	2.3	3.8	2.4	2.8

Table 56. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Albino Mice (6 to 12 per Group). Mean Testicular Weight of 40-Day-Old Mice was 152 ±12 mg

Group	Treatment	Testicular weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; sham pinealectomy	205 ±4	216 ±10	242 ±11	268 ±8	254 ±21
2	Unilateral optic enucleation; pinealectomy	185 ±2	214 ±8	244 ±8	249 ±9	251 ±11
3	Bilateral optic enucleation; sham pinealectomy	181 ±8	240 ±6	266 ±9	263 ±7	259 ±15
4	Bilateral optic enucleation; pinealectomy	197 ±6	228 ±20	259 ±5	272 ±10	241 ±11
Least significant difference		29	33	27	24	48

Table 57. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Albino Mice (6 to 12 per Group). Mean Ovarian Weight of 40-Day-Old Mice was 6.4 ±0.7 mg

Group	Treatment	Ovarian weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; sham pinealectomy	8.9 ±0.9	8.7 ±0.4	15.1 ±1.4	19.8 ±0.8	24.3 ±1.8
2	Unilateral optic enucleation; pinealectomy	8.1 ±0.9	10.2 ±0.7	14.4 ±1.4	21.4 ±1.2	20.8 ±1.6
3	Bilateral optic enucleation; sham pinealectomy	7.3 ±0.6	9.8 ±0.7	16.7 ±1.7	23.1 ±1.5	25.2 ±0.9
4	Bilateral optic enucleation; pinealectomy	7.0 ±1.5	9.0 ±0.5	13.3 ±0.9	17.8 ±1.4	24.1 ±1.3
Least significant difference		2.4	1.9	3.8	3.8	4.3

Table 58. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Albino Mice (6 to 12 per Group). Mean Accessory Organ Weight of 40-Day-Old Mice was 31 ±8 mg

Group	Treatment	Accessory organ weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; sham pinealectomy	66 ±12	74 ±5	93 ±10	116 ±8	118 ±7
2	Unilateral optic enucleation; pinealectomy	55 ±4	84 ±5	100 ±5	118 ±9	114 ±11
3	Bilateral optic enucleation; sham pinealectomy	59 ±4	86 ±4	113 ±9	104 ±5	121 ±8
4	Bilateral optic enucleation; pinealectomy	61 ±10	84 ±5	104 ±10	106 ±4	123 ±6
Least significant difference		19	18	23	18	14

Table 59. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Albino Mice (6 to 12 per Group). Mean Uterine Weight of 40-Day-Old Mice was 36 ±8 mg

Group	Treatment	Uterine weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; sham pinealectomy	58 ±11	66 ±7	134 ±26	151 ±26	145 ±17
2	Unilateral optic enucleation; pinealectomy	55 ±15	79 ±15	136 ±14	141 ±25	205 ±26
3	Bilateral optic enucleation; sham pinealectomy	79 ±11	83 ±16	91 ±10	163 ±13	171 ±19
4	Bilateral optic enucleation; pinealectomy	53 ±10	88 ±21	126 ±15	148 ±21	166 ±16
Least significant difference		35	44	50	64	64

Table 60. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Albino Mice (6 to 12 per Group). Mean Adrenal Weight of 40-Day-Old Mice was 3.6 ±0.3 mg

Group	Treatment	Adrenal weights				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; sham pinealectomy	4.0 ±0.5	4.2 ±0.2	4.1 ±0.2	4.8 ±0.3	4.6 ±0.2
2	Unilateral optic enucleation; pinealectomy	4.5 ±0.5	3.8 ±0.2	3.7 ±0.4	4.9 ±0.1	4.5 ±0.1
3	Bilateral optic enucleation; sham pinealectomy	4.3 ±0.2	3.8 ±0.3	4.3 ±0.2	4.5 ±0.1	4.3 ±0.4
4	Bilateral optic enucleation; pinealectomy	4.5 ±0.1	4.2 ±0.3	4.0 ±0.4	4.6 ±0.2	4.0 ±0.3
Least significant difference		1.1	0.7	1.0	0.5	0.8

Table 61. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Albino Mice (6 to 12 per Group). Mean Adrenal Weight of 40-Day-Old Mice was 6.3 ±0.5 mg

Group	Treatment	Adrenal weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; sham pinealectomy	7.5 ±0.3	5.7 ±0.4	7.9 ±0.1	7.9 ±0.4	8.9 ±1.0
2	Unilateral optic enucleation; pinealectomy	7.6 ±0.4	6.1 ±0.3	8.5 ±0.8	8.4 ±0.4	7.6 ±0.4
3	Bilateral optic enucleation; sham pinealectomy	6.9 ±0.6	6.6 ±0.6	8.6 ±0.4	8.3 ±0.4	8.5 ±0.4
4	Bilateral optic enucleation; pinealectomy	7.1 ±0.5	7.4 ±0.5	7.7 ±0.3	8.5 ±0.6	8.1 ±1.3
Least significant difference		1.6	1.4	1.4	1.4	2.2

Table 62. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Male Albino Mice (6 to 12 per Group). Mean Pituitary Weight of 40-Day-Old Mice was 7.38 ±0.08 mg

Group	Treatment	Pituitary weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; sham pinealectomy	1.56 ±0.12	1.74 ±0.09	1.93 ±0.11	2.24 ±0.09	2.84 ±0.08
2	Unilateral optic enucleation; pinealectomy	1.50 ±0.05	1.90 ±0.11	1.98 ±0.09	2.08 ±0.14	2.61 ±0.21
3	Bilateral optic enucleation; sham pinealectomy	1.50 ±0.11	1.72 ±0.10	2.13 ±0.14	2.09 ±0.06	2.80 ±0.14
4	Bilateral optic enucleation; pinealectomy	1.42 ±0.03	1.68 ±0.12	2.03 ±0.12	2.16 ±0.12	2.56 ±0.06
Least significant difference		0.31	0.32	0.31	0.29	0.32

Table 63. Photoperiod-Pineal-Endocrine Relationships in Prepubertal and Postpubertal Female Albino Mice (6 to 12 per Group). Mean Pituitary Weight of 40-Day-Old Mice was 1.34 ±0.12 mg

Group	Treatment	Pituitary weight				
		Days after operations				
		25	50	75	100	125
		mg				
1	Unilateral optic enucleation; sham pinealectomy	1.59 ±0.15	1.52 ±0.07	2.60 ±0.25	2.42 ±0.09	2.90 ±0.42
2	Unilateral optic enucleation; pinealectomy	1.43 ±0.14	1.51 ±0.08	2.40 ±0.18	2.30 ±0.13	2.63 ±0.21
3	Bilateral optic enucleation; sham pinealectomy	1.54 ±0.08	1.68 ±0.11	2.88 ±0.29	2.36 ±0.08	2.81 ±0.22
4	Bilateral optic enucleation; pinealectomy	1.62 ±0.18	1.76 ±0.17	2.39 ±0.13	2.24 ±0.10	2.54 ±0.13
Least significant difference		0.39	0.44	0.56	0.37	0.57

Table 64. Influence of Photoperiod and Pineal Gland on Some Endocrine Organs of NIH Male Black Rats LD Cycle was 1:23, and Animals Were Necropsied 18 wk After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights				
				Testes	Accessory organs	Adrenals	Thyroid	Pituitary
			gm	mg/100gm body weight				
1	Sham pinealectomy	10	292 ±7	879 ±51	146 ±10*	15.4 ±0.5*	5.9 ±0.2	2.21 ±0.11*
2	Pinealectomy	13	298 ±9	981 ±28	180 ±11	17.5 ±0.6*	5.9 ±0.3	2.53 ±0.22
Least significant difference			26	114	31	1.7	0.8	0.24

* Significantly different from pinealectomized (group 2) controls.

Table 65. Influence of Blinding and Pineal Gland on Some Endocrine Organs of NIH Female Black Rats. Animals Were Necropsied 12 wk After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights				
				Ovaries	Uterus	Adrenals	Thyroid	Pituitary
			gm	mg/100gm body weight				
1	Bilateral optic enucleation; Sham pinealectomy	19	200 ±7	17.6 ±1.2	144 ±21*	25.1 ±1.6	6.7 ±0.4	4.94 ±0.18*
2	Bilateral optic enucleation; pinealectomy	8	210 ±6	20.5 ±1.0	239 ±11	27.5 ±0.9	6.2 ±0.2	6.15 ±0.27
Least significant difference			24	4.0	69	4.2	1.4	0.69

* Significantly different from pinealectomized (group 2) controls.

Table 66. Influence of Photoperiod and Pineal Gland on the Endocrine and Reproductive Organs of Adult Male Albino Rats. Animals Were Necropsied 18 wk After Surgical Treatment

Group	Treatment	LD cycle	Number of animals	Body weight	Mean organ weights				
					Testes	Accessory organs	Adrenals	Thyroid	Pituitary
				gm	mg/100gm body wt				
1	Sham pinealectomy	16:8	8	483 ±14	779 ±18	126 ±9	9.9 ±0.7	4.4 ±0.3	2.37 ±0.09
2	Pinealectomy	16:8	10	487 ±10	761 ±31	134 ±11	9.7 ±0.6	4.2 ±0.2	2.49 ±0.09
3	Sham pinealectomy	1:23	11	451 ±12	789 ±44	116 ±9	11.2 ±0.5	4.6 ±0.2	2.28 ±0.11
4	Pinealectomy	1:23	12	461 ±15	824 ±17	119 ±4	10.4 ±0.3	4.1 ±0.2	2.39 ±0.03
Least significant difference				38	88	24	1.4	0.6	0.23

Table 67. Influence of Blinding and Pineal Gland on the Endocrine and Reproductive Organs of Adult Female Albino Rats. Animals Were Necropsied 12 wk After Surgical Treatment

Group	Treatment	Number of animals	Body weight	Mean organ weights				
				Ovaries	Uterus	Adrenals	Thyroid	Pituitary
			gm	mg/100gm body wt				
1	Unilateral optic enucleation; sham pinealectomy	13	273 ±7	27.9 ±1.1	162 ±11	19.9 ±0.6	5.8 ±0.3	4.5 ±0.1
2	Unilateral optic enucleation; pinealectomy	9	273 ±9	25.1 ±1.7	147 ±10	20.4 ±1.0	5.7 ±0.1	4.2 ±0.2
3	Bilateral optic enucleation; sham pinealectomy	9	255 ±5	25.7 ±1.3	174 ±15	21.6 ±1.1	6.2 ±0.4	4.1 ±0.2
4	Bilateral optic enucleation; pinealectomy	11	262 ±8	26.9 ±2.0	170 ±8	21.5 ±1.1	6.0 ±0.3	4.2 ±0.1
Least significant difference			20	4.5	31	2.4	0.8	0.4

Table 68. Influence of Blinding and of the Pineal Gland on Some Endocrine Organs of Male Gerbils. Animals were Killed 10 wk After Operations.

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Testes	Accessory organs	Adrenals	Pituitary
			gm	mg/100 gm body wt			
1	Unilateral optic enucleation; Sham pinealectomy	11	87 ±4	1313 ±59	213 ±11	41.2 ±2.6	3.33 ±0.16
2	Unilateral optic enucleation; pinealectomy	13	85 ±2	1381 ±35	230 ±8	41.5 ±1.2	3.43 ±0.40
3	Bilateral optic enucleation; Sham pinealectomy	20	91 ±3	1337 ±31	184 ±10*	40.5 ±0.9	3.01 ±0.11
4	Bilateral optic enucleation; pinealectomy	16	88 ±3	1389 ±31	216 ±7	41.7 ±1.1	3.27 ±0.16
Least significant difference			8	108	27	4.0	0.39

* Significantly different from pinealectomized (group 4) controls.

Table 69. Influence of Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH) on the Reproductive Organs of Blinded Female Hamsters. Animals Were Necropsied About 9 wk After Surgical Treatment

Group	Treatment	Number of animals	Final body weight	Mean organ weights			
				Uterus	Ovaries	Adrenals	Pituitary
			gm	mg/100 gm final body wt			
1	None	6	127 ±5	272 ±30	18.9 ±0.5	9.9 ±0.3	3.21 ±0.21
2	Bilateral optic enucleation	10	171 ±6	63 ±3*	20.4 ±1.5	10.9 ±0.5	2.43 ±0.14*
3	Bilateral optic enucleation; pinealectomy	6	135 ±7	283 ±33	20.3 ±1.9	11.8 ±1.0	3.47 ±0.26
4	Bilateral optic enucleation; FSH-LH treatment**	8	154 ±5	123 ±14*	46.1 ±2.1*	12.5 ±0.5	2.37 ±0.11*
Least significant difference			19	56	5.1	1.8	0.50

* Significantly different from untreated (group 1) and pinealectomized (group 3) controls.

** 0.5 mg/day of each hormone for 10 consecutive days, beginning about 8 wk after surgical treatment.

Table 70. Influence of Blinding and Pinealectomy on Pituitary Hypertrophy Following Castration of Male Hamsters. All Animals Were Killed 30 Days After the Operations.

Group	Treatment	Number of animals	Body weight	Absolute pituitary weight
			gm	mg
1	None	10	122 ±2	4.02 ±0.24
2	Castration	13	136 ±6*	4.68 ±0.18*
3	Castration; Bilateral optic enucleation;	15	130 ±2*	4.58 ±0.14*
4	Castration; Bilateral optic enucleation; pinealectomy	15	120 ±3	4.53 ±0.15*
Least significant difference			11	0.50

* Significantly different from untreated (group 1) controls.

Table 71. Influence of Blinding and Pinealectomy on Pituitary Hypertrophy Following Castration of Male Albino Rats. All Animals Were Killed 30 Days After the Operations

Group	Treatment	Number of animals	Body weight	Absolute pituitary weight
			gm	mg
1	None	18	374 ±7	9.94 ±0.20
2	Castration	21	330 ±5*	12.43 ±0.31*
3	Castration; bilateral optic enucleation	18	342 ±5	12.69 ±0.28*
4	Castration; bilateral optic enucleation; pinealectomy	20	316 ±7*	12.13 ±0.41*
Least significant difference			30	1.13

* Significantly different from untreated (group 1) controls.

Table 72. The Role of the Light-Dark (LD) Cycle and of the Pineal Gland in the Regulation of Compensatory Ovarian Enlargement Following Unilateral Ovariectomy in Adult Female Albino Rats. Pineal Operations Were Performed and all Animals Were Kept in the Various LD Regimens Indicated for 6 mo Prior to Unilateral Ovariectomy. The Rats Were Killed 14 Days After Removal of One Ovary

Group	Treatment	LD cycle	Number of animals	Initial ovarian weight	Remaining ovarian weight	Percentage increase in ovarian weight after ovariectomy
				mg	mg	
1	Unilateral ovariectomy; Sham pinealectomy	16:8	17	33.4 ±1.9	43.2 ±3.1	29
2	Unilateral ovariectomy; pinealectomy	16:8	12	31.5 ±2.0	40.5 ±2.6	29
3	Unilateral ovariectomy; Sham pinealectomy	24:0	15	19.2 ±1.4	24.5 ±1.9	28
4	Unilateral ovariectomy; pinealectomy	24:0	14	20.2 ±1.5	25.9 ±2.1	28
5	Unilateral ovariectomy; Sham pinealectomy	1:23	11	35.3 ±2.5	42.9 ±2.8	22*
6	Unilateral ovariectomy; pinealectomy	1:23	11	33.7 ±1.4	44.4 ±2.9	31
Least significant difference				8.2	9.7	4

* Significantly different from pinealectomized (group 6) controls.

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Investigations were conducted to determine the role of the pineal gland in influencing the endocrine systems of hamsters, rats, mice, and gerbils. It is concluded that the gonadal involution in hamsters attendant upon darkness is prevented by pinealectomy or bilateral superior cervical ganglionectomy. Removal of the olfactory bulbs from adult female hamsters causes regression of the uteri; this response is also prevented by pineal removal. Darkness retards the development of the endocrine systems of albino rats but if the pineal gland is ren oved the endocrine organs develop at the normal rate. The pineal gland in mice and gerbils appears to play a less marked role in regulating endocrine organ size.

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