blood samples, it may be useful for estimating the activity in tissues. This is especially the case if this method can be used where there is marked interference with the titration of remaining peroxide.

Summary. A method is described for estimating catalase activity by the amount of heat liberated. The latter is estimated from the temperature rise of the solution, the maximum temperature being conveniently recorded by a clinical thermometer. The average temperature rise of the solution to which 0.01 ml of human blood was added was found to be about 12°C, corresponding to a liberation of 0.4 M or 14 g of H_2O_2 by each ml of blood. Some comparisons are made of the time course of the liberation of heat with that of the evolution of O_2 and the disappearance of H_2O_2 as estimated by titration.

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Origin and Development of the Urogenital Union in the Chick.* (20546)

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The literature(1) on the origin of the rete in amniote embryos reveals 3 general viewpoints: (1) that the rete derives from the renal corpuscles of the mesonephros and joins the gonad secondarily; (2) that the rete arises from the germinal epithelium and only secondarily becomes associated with the mesonephros; (3) that the rete differentiates within the mesenchyme between the gonad and the mesonephros and connects secondarily with both. Torrey(2), in analyzing rete development in the albino rat, contended that the primordial rete differentiates from the gonadal blastema coincidentally with the sex cords, and only later becomes associated with the mesonephros. His position is thus somewhat unlike all the above, but is most closely allied with the second.

The present study on the chick embryo follows lines similar to those outlined by Torrey and is designed to resolve the conflicting opinions of this segment of avian development. It includes both a redescription of normal ontogeny of the rete and an experimental analysis.

For descriptive study, Barred Rock embryos and chicks were collected from the 96th hr of incubation to the 30th day after hatching. In the earlier stages, 4-9 days incubation, the embryos were collected at 8 hr intervals; from the 9th day of incubation to the 15th day after hatching, specimens were collected only at daily intervals; from the 15th-30th day after hatching, chicks were chosen at 2-3 day intervals. All of the material was fixed in Bouin's fluid, sectioned transversely at 10-15 μ, and stained either with Mallory's triple stain or Heidenhain's "Azan" modification of the Mallory method.

Normal ontogeny. The primordial, sexually undifferentiated rete first appears in embryos of 112 hr as strands of cells (Fig. 1) extending from the bases of the primary sex cords into the mesonephric stroma. From the beginning the rete is in structural continuity with and is interpreted as having a common origin with the primary sex cords. For the next 2 days there is little to distinguish males from females rete-wise, but in male embryos of 7 and 8 days the strands of rete testis will

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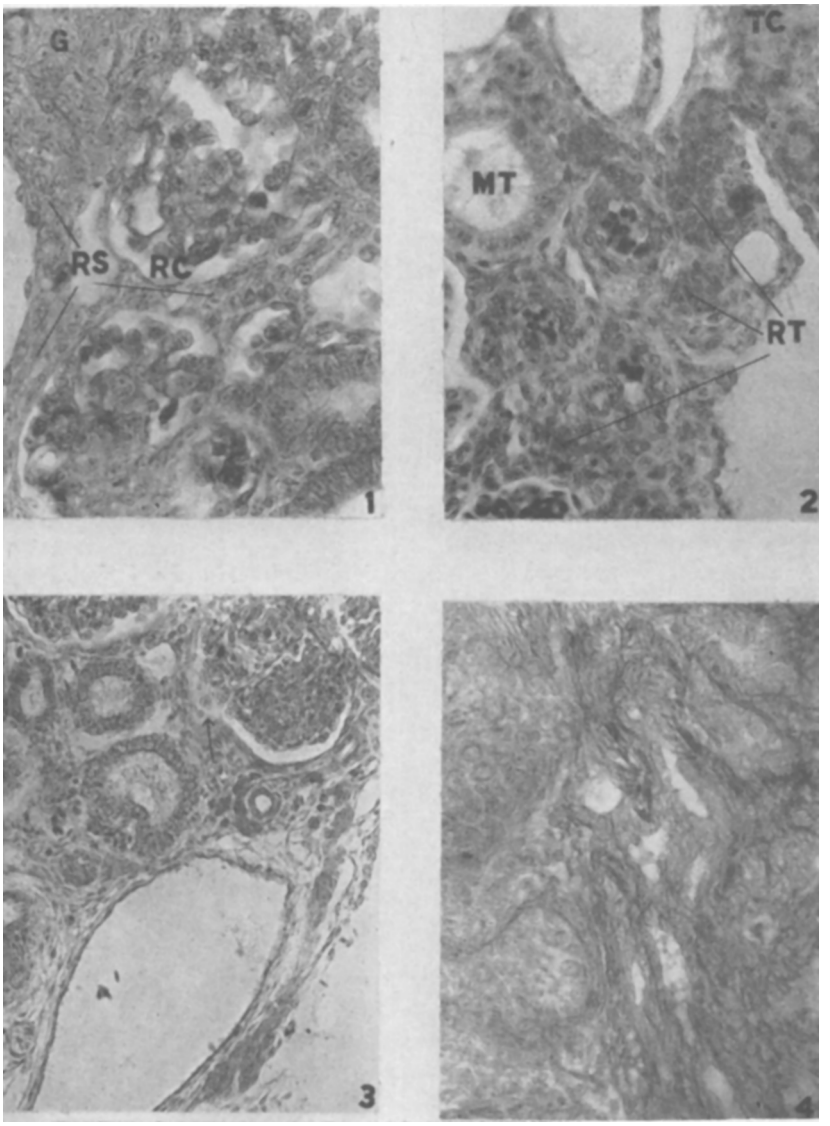

PLATE 1

FIG. 1. Strands of primordial rete (RS) projecting from gonad (G) and in contact with renal capsules (RC). 112-hr embryo. Mallory, × 200.

FIG. 2. Rete testis (RT) of 11-day embryo. Mesonephric tubule (MT); testis cord (TC). Note interruption of rete tissues by blood vessels. Mallory, × 200.

FIG. 3. Fusion of rete testis and walls of renal capsules. Arrow points to an area of fusion. 12-day embryo. Mallory, × 100.

FIG. 4. Initial cavitation of rete testis. 3-day chick. Mallory, × 200.

have become more bulky and by the 11th day subjected to considerable vascular invasion (Fig. 2). Fusion of rete testis and renal corpuscles is inaugurated by the 12th day and continues through hatching (Fig. 3). While morphological continuity from the potential tubuli recti of the testis through the rete to the potential epididymis is established by this fusion, at this time the rete and sex cords are solid. A few of the rete cords appear to blend with the nearby adrenal cortex rather than the renal corpuscles. Cavitation of the rete testis usually begins near the third day after hatching (Fig. 4), although sometimes

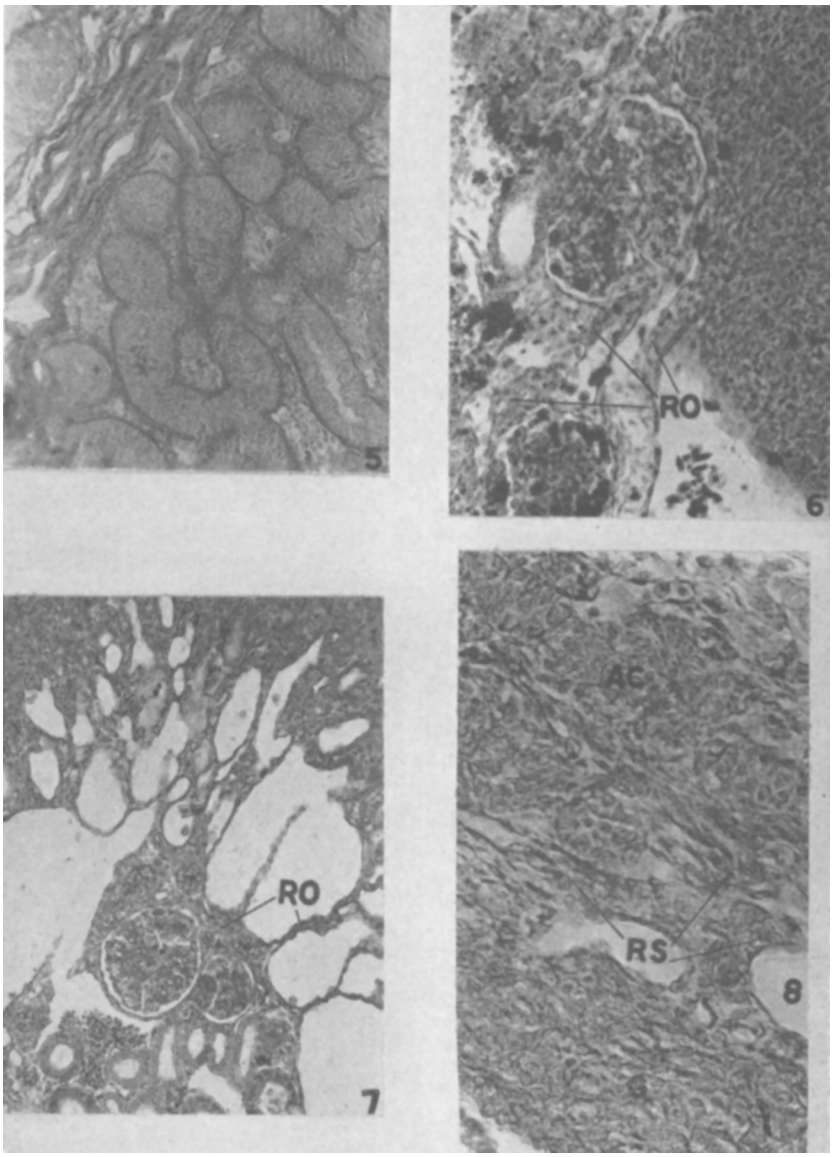

PLATE 2

FIG. 5. Rete testis of 3-week-old chick. Note continuity of rete tubule and sex cord. Mallory, × 100.

FIG. 6. Rete ovarii (RO) of a 7-day embryo. Mallory, × 100.

FIG. 7. " " " " " " " " × 100.

FIG. 8. Strands of primordial rete (RS) passing from gonad (G) towards adrenal cortex (AC). Mesonephros absent as result of block of wolffian duct. Mallory, × 100.

earlier; cavitation of the sex cords by the end of the third week after hatching. In the meantime the rete testis has become a system of broad, branching tubules with clean cavernous lumina (Fig. 5). With the establishment of the seminiferous tubules, the "open" system from the testis via the rete to the epididymis is complete. While the strands of cells constituting the rete ovarii are in 7-day embryos (Fig. 6) essentially like those of the rete testis, they are more tenuous and never become so bulky as in males. Shortly (176 hr), too, the ovary is characterized by degeneration and vacuolation among those medul-

lary cords which are adjacent to the mesonephros. This vacuolation of the medullary cords is accompanied by a further thinning and reticulation of the rete tissues. By the 9th day vacuolation of the deeper medullary cords has progressed so that at many points their walls are reduced to thin strings of cells. These in turn are continuous with the tenuous rete strands which pass into the mesonephros and fuse with the capsules of the renal corpuscles (Fig. 7). While the rete ovarii increases in bulk for the next few days and clearly blends with the renal corpuscles, it is never at any time so voluminous as in male embryos of corresponding age. Ultimately, too, the rete system will become virtually isolated in the mesovarium, for from the 12th day the connection of medullary and rete cords becomes more and more tenuous and within a day or two after hatching the junctions of rete and renal corpuscles have begun to break down as well. By the 15th day after hatching the vacuolated medullary cords will have disappeared almost entirely, and with their mesonephric connections now scanty, the rete cords, some showing incipient lumina since the 3rd day, are essentially isolated.

Experimental analysis. The experimental method used by Torrey(2) on the albino rat in which he cultivated separately the primordia of the gonad and of the mesonephros in the anterior chamber of the adult rat eye is not feasible for the chick embryo. In the chick, the association of the primordial gonad and mesonephros is too intimate to permit such a separation. However, several investigators have reported an operation in chicks which provides an excellent tool for this problem. Gruenwald(3) found, in agreement with Boyden(4) and substantiated by Waddington(5), that the differentiation of nephrogenic tissue into mesonephros took place only where that tissue was in contact with the wolffian duct. If a block or injury were made in such manner as to interrupt the backward growth of the wolffian duct, mesonephric tubules failed to appear, but, in the absence of a wolffian duct and mesonephros, the gonad developed normally. This is obviously highly significant, for if, in the absence of the mesonephros, it were found that the rete develops in association with the gonad, then the rete is shown to be gonadal in origin. On the other hand, if the rete does not appear, it may mean one of two things: either the rete is mesonephric in origin, or, is gonadal in origin but requires an inductive stimulus provided by the mesonephric tubules. Thirty-hour embryos of Barred Rock chickens were exposed via an opening sawed through the shell. An extremely fine glass needle was inserted to a depth of approximately one millimeter immediately caudal to the last distinctly formed somite on the left side of the embryo. When the needle was withdrawn, some yolk was allowed to extrude. This plug of yolk served as the block for the excretory duct. When the operation was completed, the opening was closed by an egg-shell cap. Because of a high mortality rate, experimentals were not recovered beyond the 6th day of incubation. This appeared to reflect a critical period of embryonic physiology at about the 96th hr of incubation, wherein any interference with the excretory system is especially deleterious. Recovered embryos were prepared for microscopical study in conventional fashion.

The experimental results fall into 2 groups: one set of 12 embryos which show a complete absence of one mesonephros, and a second set of 22 embryos which show a variably incomplete block of one mesonephros. Although the latter group does not provide a critical test for the problem at hand, it does give results worth discussion. Only typically illustrative cases will be described and analyzed.

A. *Complete block of mesonephros.* The first embryo selected for illustration was sacrificed after 112 hr of incubation, at which stage the rete normally appears. A well developed mesonephros with a normally developing gonad occurs on the right side of the embryo. By contrast, there is a large empty space on the left side. The left mesonephric body is entirely lacking; in fact, even the potential mesonephros, *i.e.*, nephrogenic tissue, is very much reduced. In spite of this lack of nephrogenic material, a well developed and normal gonad appears on the operated side. This gonad has an extensive and nor-

mally developed germinal epithelium sharply delimited by a basement membrane. Centrally small, cordlike masses of cells, the primary sex cords, appear, and from the bases of the latter, several distinct strands of cells (the incipient rete strands) pass out between the intervening blood vessels toward the developing adrenal cortex (Fig. 8).

Similar conditions are found in a slightly older embryo (120 hr). The left gonad projects as an ovoid mass and is clearly much larger than at 112 hr. The greater bulk of this gonad has resulted from proliferation of the primary sex cords in its central portion. From the bases of these cords and clearly continuous with them, rete strands flare outward to meet and blend with the cells and cordlike processes of the adrenal.

In a 6-day experimental embryo, the gonad is still larger and definitely spherical in shape. It has a well defined germinal epithelium which contains a number of germ cells. In the deeper portions of the gonad there are numerous, spherical and elongated primary sex cords, with an occasional germ cell present therein. Rete strands are present and project from the sex gland. They unite as before with the tissues of the adrenal bodies.

It is clear, then, that even in the absence of the mesonephros a normal gonad makes its appearance at the usual time and in the usual place, and that from the medullary cords of these "isolated" gonads rete strands project toward the adrenal cortex. It will be recalled that in the normal ontogeny of the rete a similar association between some of the rete cords and the adrenal cortex prevails. But whereas the bulk of the rete normally joins the mesonephric capsules, in these cases experimentally deprived of their mesonephroi all the rete strands run to the adrenal. The significance of this is difficult to assess, although one might speculate that the rete cords have a predilection for attachment to other bodies and in the absence of their normal attachment site, *i.e.*, the mesonephric capsules, seek out the nearby adrenal cortex instead. In this connection it is interesting that adrenocortical material has been described in association with the rete and epoophoron in the ovaries of such mammals as moles and squirrels(6) and pikas(7).

B. *Incomplete block of mesonephros.* In this series, the mechanical block of the wolffian duct was successful only in varying degrees; thus, all of these embryos show some traces of mesonephric differentiation. Since the amount and the particular location of the mesonephros varies greatly, separate descriptions of the differing situations are necessary before a general evaluation of the results can be made.

1. Mesonephric differentiation anterior to the gonad: In 4 embryos (with incubation ages from 120 to 144 hours) only 3-5 mesonephric tubules differentiated; 3 others (incubated 120-136 hours) have 6-10 tubules present. No renal corpuscles appear on the operated side in any of these embryos. Most importantly, the mesonephric differentiation which occurs is so far anterior as to leave the gonads isolated. In these "isolated" gonads, rete strands flare out from the ends of the primary sex cords and join the adrenal bodies.

2. Mesonephric differentiation posterior to the gonad: Three embryos (120 hours) have 3-6 tubules and one (136 hours) has 6-10 tubules which develop posterior to the gonads leaving them isolated as in the previous instance. One embryo shows a few renal corpuscles on the operated side; the others have none. In all of these "isolated" gonads, rete strands flare out from the ends of the primary sex cords and join the adrenal bodies.

3. Mesonephric differentiation anterior to and flanking the gonad: Seven embryos (aged 120-144 hours) have 3-10 mesonephric tubules on the operated side; 3 of them also have 2-4 renal corpuscles present. In these cases, the mesonephric differentiation flanks the gonad to some extent. In spite of this, rete strands are to be noted projecting from the gonad toward the neighboring adrenal tissue.

4. Mesonephric differentiation alongside the gonad: Two embryos (126 hours) have 2-5 mesonephric tubules and one embryo (136 hours) has 6-10 mesonephric tubules which develop somewhat laterally to the gonad. There is no trace of renal corpuscles in any of these cases. Rete strands are clearly discernible in the gonads of these embryos; they pass

out from the gonad toward the neighboring adrenal tissue.

5. Mesonephric differentiation both anterior and posterior to the gonad: In one embryo (120 hours) 12-15 mesonephric tubules appear together with 2 renal corpuscles. As all of the mesonephric differentiation occurs anterior and posterior to the gonad, the sex gland is again "isolated". Rete strands are clearly present and project toward the adrenal cortex.

In assessing these 22 cases showing mesonephric differentiation on the operated side, it should be noted that in all, a normal gonad with a full complement of rate strands developed in conjunction with an extremely small number of mesonephric tubules. The number of mesonephric tubules varied from 1-15. Now, if the mesonephric tubules or the renal corpuscles are the material source of the rete, then quantitatively there should be a corresponding deficiency of the rete. On the contrary, the rete on the operated side is always comparable to its counterpart on the unoperated side. Further, only 6 of the 22 cases have any renal corpuscles whatsoever on the operated side, yet rete strands are seen to develop and differentiate at a normal rate in all. These results, therefore, militate against a tubular or capsular origin for the rete.

Summary. The primordial rete of the chick embryo is a product of the gonadal blastema. It differentiates coincidentally with the primary sex cords with which it is continuous from the beginning. The rete testis is elaborated into a well vascularized network which invades the anterior portion of the mesonephros. There the rete tissues invest and ultimately fuse with the capsules of renal corpuscles. Cavitation of the rete testis begins within the first 3 days after hatching and is well advanced by the end of the 3rd week, when lumina appear in the sex cords. The rete ovarii in general parallels the development of the rete testis. However, its bulk is always less and shows only incipient cavitation. As a result of breakdown of the medullary cords accompanied by a disintegration of the connection between rete and renal capsules, the rete ovarii ends up as a rudiment isolated in the mesovarium. In embryos where a complete block of one mesonephros is effected experimentally, rete cords make their appearance associated and continuous with the sex cords of a normally differentiating gonad. In these cases, rete differentiation is independent of mesonephric differentiation. Embryos with the mesonephros only partially blocked on one side give evidence less critical but favorable to the view of gonadal origin of the rete.

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A Comparison of Fungistatic Properties of Three Aromatic Diamidines. (20547)

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The introduction of the aromatic diamidines as hypoglycemia-producing agents and the demonstration of their chemotherapeutic activity in protozoal diseases has led to experimental studies on their activity in the fields of bacterial, mycological, and neoplastic diseases. Favorable clinical results in patients suffering from blastomycosis(1,2), actinomycosis(3), and nocardiosis(2) have been reported following treatment with stilbamidine.