Notes on the Development of the Suprarenal Bodies in the Mouse.

By

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With Plates XXX–XXXI.

It has long been known that the suprarenal bodies of the vertebrata consist of two substances, the medulla and the cortex. As to how these two substances arise and in what relations they stand to each other the opinions of previous investigators are divided. During the academic year, 1888-89, I studied the development of the organ in the common domesticated mouse, a variety of Mus musculus, and came to the conclusion that the cortical cells are derived, as Janosik stated, from the peritoneal epithelium, and the medullary substance arises, as described by Mitsukuri, from the sympathetic elements. The following is a brief account of my investigation. I must here express my sincere thanks to Profs. Mitsukuri and Ijima, for their constant encouragement and valuable suggestions, without which I could not have finished the work.

As to the method of investigation I preserved after Selenka the specimens, young and adult, in Kleinenberg's picro-sulphuric acid mixed with chromic acid in the ratio 8 : 1. Some of the adult specimens were also preserved in bichromate of potash, but as Gottschau justly remarked, it is not necessary to use the chromic acid, at least in

the case of the mouse, to demonstrate the distinction between the medullary and cortical elements. In the preparations of the chromo-picro-sulphuric acid the medulla is not coloured brown ; this seems to be due partly to the shortness of the interval during which the embryos were exposed to the action of the reagent ($1^1/_4$ hours) and partly to the presence of the picro-sulphuric acid. To stain embryos, I used a weak solution of Kleinenberg's hæmatoxylin, as it gives the clearest and most differentiated figures. With picrocarmine I also obtained good preparations of the suprarenal bodies of the young mouse. The objects were stained in *toto* before imbedding in the celloidin paraffin. In all cases I took pains to stain deeply and to cut sections as thin as possible.

I am not quite sure of the age of the embryo, since I could not observe any actual copulation. After the method of Selenka, I separated the individuals of two sexes for from ten to fifteen days, then put a pair together for a night, and separated them again the next morning. I counted the day of separation as the first day of gestation, the next the second day, and so forth. From a number of preserved embryos I determined the approximate size (from the tip of the head to the root of the tail) of the embryo in each stage as follows :

11th day	3–4.5 mm.
12th day	4.5–6 mm.
13th day	6–8 mm.
14th day	8–10 mm.
15th day	10–12 mm.

In cases of embryos older than this stage, I opened their abdomen as quickly as possible before immersing them into the killing fluid, and could not make any reliable measurement.

Suprarenal Bodies of the Mouse, from the new-born to the adult.—I commenced my study with the young mouse about

one month old. In these specimens, the two substances of the suprarenal bodies are already well marked. In cross sections, the organ is elliptical, consisting of two concentric zones (Pl. XXXI. fig. 21); the inner central zone (med.) stains somewhat less than the outer zone (cor.). Under a high power, the central zone is found to be composed of irregular cord-like cell-aggregates, each of which is bounded by strong connective tissue fibres. The cell-protoplasm is faintly stained; the nuclei are large (6 μ. on an average) and slightly granular. The nuclei of the cells of the outer zone are smaller in size (5 μ.) and highly granular. Their cells are smaller than those of the central zone; this is especially the case in the middle portion of the outer zone where the cell-protoplasm is stained deeper than in any other part, so that the outer zone is subdivided into these minor concentric zones. But these three zones gradually merge one into another without presenting any distinct limit. The transition from the outer (cor.) to the central zone (med.), on the other hand, is very sudden; the limiting line is distinct and tolerably even, forming an elliptical outline. Evidently the central zone is the medulla, and the outer the cortex.

Turning now to the mouse ten days old (Pl. XXXI. fig. 18), a considerable difference is observed in the structure of the medulla. The medullary substance (med.) projects irregularly into the cortex (cor.), and the boundary is not yet even, though its elliptical outline can already be made out. The cells and nuclei of the medulla are stained deeper than before, so that the distinction of it from the cortex is obscure in some parts where the former projects into the latter. The difficulty is further increased by the fact that the cord-like arrangement of the medulla is as yet very weakly developed, and the respective sizes of the nuclei in the two substances are approximately equal. But tracing carefully the margin of the medulla, we can find here and

there the distinct groupings of its cells into cords (fig. 19), where the nuclei are larger and the protoplasm is less stained, than in the adjoining cortical cells. This stage seems to be the formation of the medullary cords. The three minor zones of the cortex are already to be found, though less distinct than in the stage described before.

In the mouse three days old (fig. 16), the medulla is very irregular in its outline. Along its margin the cells are greatly mingled with the cortical cells, but the distinction is clear, the cells and nuclei of the medulla being stained more deeply and packed more closely, than in the cortex. The three minor cortical zones are not yet distinguishable.

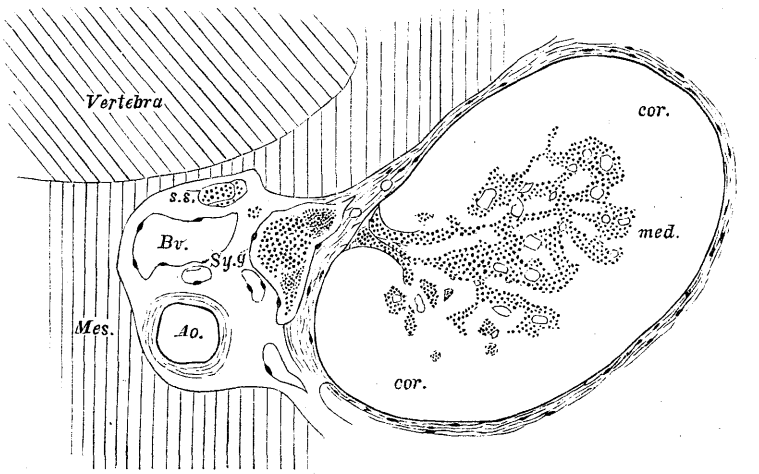
In the newly-born mouse (wood-cut 1 and Pl. XXXI. fig. 15), the medulla no longer forms any compact mass, but has cortical cells, intermixed throughout its substance. The distinctions between the two substances can however be easily made out as before.

The relative size of the nuclei in the two substances is interesting. In figs. 15 and 16 (Pl. XXXI.), the nuclei of the medullary cells are evidently smaller than those of the cortical cells, while in fig. 21, the case is reversed. I measured the nuclei of cells in the two substances near their boundary line at various stages. The following gives the average size (in μ) of those nuclei.

	1 day old.	3 days.	10 days.	29 days.	adult.
Medulla	5.2—	5.6—	5.6+	6—	6—
Cortex	6.5—	6.—	5.4—	5—	5+

It will be seen from the table that for about a month after birth, the cortical nuclei are gradually decreasing in size ; at the same time the medullary nuclei are growing though very slightly. This is, I believe, due to the formation of the cord-like arrangement on the part of the medulla, and of the zona reticulata on the part of the cortex.

Woodcut 1.



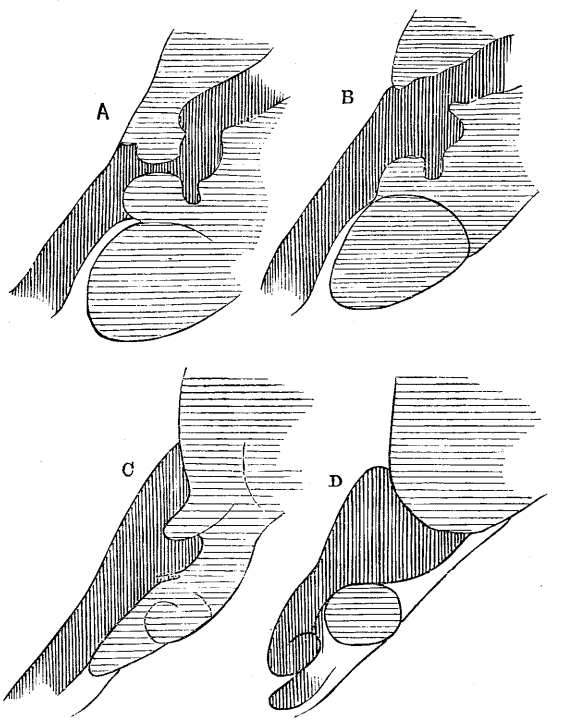
From a mouse one day old. The left suprarenal body is represented. Ao=Aorta, Bv.=Veins, Cor.=cortex, Med.=Medulla, Mes.=Mesentery, s. s.=Main mass of Sympathetic ganglia, sy. g.=ganglion of sympathetic origin. 2×BB.

So far as traced, the medulla is always distinct from the cortex, and its origin cannot be decided. But some interesting (and evidently a little abnormal) cases were met with. In one mouse just born (woodcut 1), the roughly elliptical medulla (med.) situated in the centre of the organ sends off an offshoot at one place toward the medial side, actually reaching the connective tissue capsule. Outside the organ lies a large ganglion (sy. g.), which is found on tracing sections to be continuous with the main sympathetic system (s. s.). The medullary cells of the suprarenal body and the true ganglion cells are very similar in their size and colouration. This condition was observed only on the left suprarenal.

In a three-day old mouse (woodcut 2), again on the left side, I observed an actual connection of the medulla with the ganglion. In fig. 17 (Pl. XXXI.), which is a more magnified figure of the woodcut 2 B, a mass of cells with small and deeply stained nuclei (med.) eads out of the organ, and directly joins the ganglion cell mass (sy. g.)

lying close to it. In another mouse at the same stage, a similar condition was observed; the ganglion besides being joined by a nerve coming from the neighbourhood of the kidney.

Woodcut 2.



4 successive sections (not consecutive) from the posterior end of the left suprarenal, a 3-day old mouse. Horizontally shaded part=Cortex. Vertically shaded part= Medulla.

Guided by these facts, I examined again the ten-days old mouse, and found in one case the medulla projecting on its medial side and actually touching the connective tissue capsule (Pl. XXXI. fig. 20.), but it was not traced to the sympathetic ganglion. These facts plainly show that the medulla is derived from the ganglion cells. When and how the nervous elements enter the organ, will be described below.

In passing, it may be remarked that in woodcut 2, a small portion of the cortical substance is projecting far posteriorly and is separated from the main mass by the sympathetic ganglion. In fig. 17, the part (ac. cor.) is distinctly separated from the main mass by strong connective tissue cells. This is the so-called accessory suprarenal body. From the mode of the entrance of the nerve into the organ, as seen in this and other cases, I am inclined to believe that the introduction of the nervous elements into the organ greatly influences the formation of the accessory suprarenal body, though it may not be the sole cause.

Of the adult suprarenal body (Pl. XXX. fig. 22), I have little to say, as it does not differ much from that of the one month old mouse (fig. 21). One feature interesting from the embryological point of view is the occasional presence of the ganglionic remnants. In one specimen (fig. 23), I found at the margin of the medulla on its medial side, a mass (sy. g.) of indistinct cells, highly granular and deeply stained. Their nuclei are smaller than those of the medulla or cortex cells but decidedly larger than those of the connective tissue cells. By tracing sections, I found the mass to project pyramidally into the cortex and finally reach the capsule. In comparison with the ten-days old suprarenal body (fig. 20) this mass may be considered as a part of the nervous elements, which has not been transformed into the true medulla. Of the large ganglion cells such as seen outside the adult suprarenal body, I could find none present within the adult organ.

Development of the Medullary Substance, in the 13th-18th day Embryos.—Balfour[1] remarked in his monograph on elasmobranch fishes that the suprarenal bodies of

1. Older erature I had not access to.

Vertebrates consist of two substances distinct in their origin. This Braun [2] has confirmed in Reptiles, and Mitsukuri [3] in Mammalia. Mitsukuri says that in the 16th day embryo rabbit the medullary substance is already distinct; sympathetic nerve cells closely applied to the inner side of the suprarenal blastema send in a process partly composed of nerve fibres into the ventral end of the suprarenal; the cells thus carried in become gradually transformed into the medulla. Gottschau [4] and Janosik [5] dispute this statement. Though these authors do not deny the entrance of the nerve fibres into the suprarenal, they state that the two parts of the suprarenal substance cannot be distinguished at the time of the entrance, and the medullary substance is gradually differentiated from the cortical substance at a considerably later stage. Gottschau even states that in some mammals the medulla is developed only after birth. Yet from the descriptions of the two authors, the exact mode of the formation of the medulla is not yet clear, and it is also necessary to trace the ultimate fate of the nervous fibres sent into the suprarenal blastema.

The suprarenal blastema is already distinct in the 13th day embryo. It is a somewhat elongated mass of cells lying between the 16th and 17th body-segments, just behind the lobes of the lungs. The anterior end of the blastema lies on about the same level as the 2nd tubule of the mesonephros, while the 3rd segmental tubule lies on about the middle portion of the suprarenal. In cross sections (woodcut 3 and Pl. XXX. fig. 8), the blastema

2. Bau und Entwicklung der Nebennieren bei Reptilien. Arb. aus dem Zool. Zoot. Inst. in Würzburg. Bd. V. 1882.

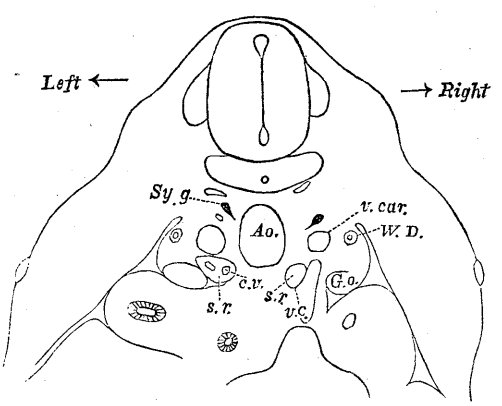
3. On the Development of the Suprarenal Bodies in Mammalia. Quart. Journ. of Microscop. Science. XXII. 1882.

4. Structur und embryonale Entwicklung der Nebennieren bei Säugethieren. Arch. f. Anat. u. Physiol. 1883.

5. Bemerkungen über die Entwicklung der Nebenniere. Arch. f. Mikr. Anat. XXII. 1883.

(s. r.) is seen as a rounded mass (about $\frac{1}{4}$ mm. thick) of cells lying between the aorta (Ao.) and the mesonephros (st.), immediately below the cardinal veins (v. car.). Already at this stage, a blood vessel (c. v.) is seen in the posterior portion of the blastema, coming from the cardinal vein; this vein is ultimately transformed into the central vein of the adult suprarenal. The suprarenal blastema (s. r.) is distinguished from all neighbouring tissue cells by the densely packed state of its large and faintly granular cells. Cell boundaries within the blastema are only faintly indicated, but a careful observation shows that cells are collected into irregular groups, separated by scanty connective tissue cells. The cell nuclei are slightly granular and their size varies between 5-7 μ. These characters of the cortical cells are retained during the subsequent developmental phases and are useful in distinguishing them from the medullary cells.

Woodcut 3.

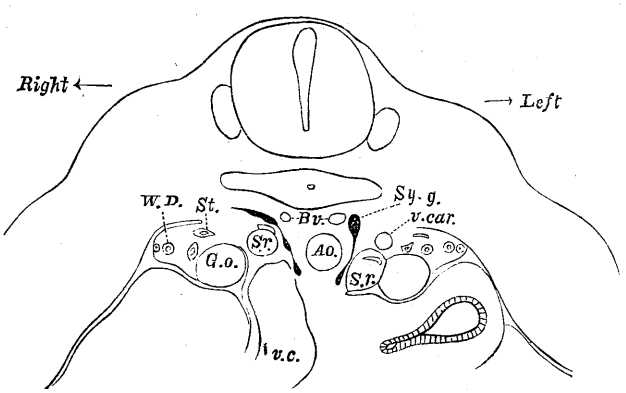


A cross section taken near the posterior end of the suprarenal bodies.—13th day embryo. Ao.=aorta, c. v.=central vein of the suprarenal, G. O.=generative organ, s. r.=suprarenal blastema, sy. g. =sympathetic ganglia, v. c.=vena cava, v. car = cardinal vein. 2×aa.

The sympathetic ganglia (woodcut 3 sy. g.) are well developed on the upper lateral corner of the aorta, and a strong branch from

the spinal nerve enters each ganglion. The ganglia send out branches downwards between the aorta and the cardinal vein, but they are very fine, often consisting of a single row of cells and cannot be clearly traced. Yet on the medial side of the suprarenal blastema, closely applied to it, there is seen a small irregular group of deeply stained cells (fig. 8, sy′. g′.), whose nuclei are a little smaller and more granular than those of the suprarenal, and similar to the cells of the sympathetic ganglia. Probably these cells are of the nervous nature.

Woodcut 4.



A cross section taken near the posterior end of the suprarenal bodies.—Later stage of the 13th day. Ao.=aorta, Bv.=veins, G. O.=generative organ, s. r.=suprarenal blastema, s. t.=segmental tubulus, sy. g.=sympathetic ganglia, v. c.=vena cava, v. car.=cardinal veins, W. D.=Wolffian duct. 2×aa.

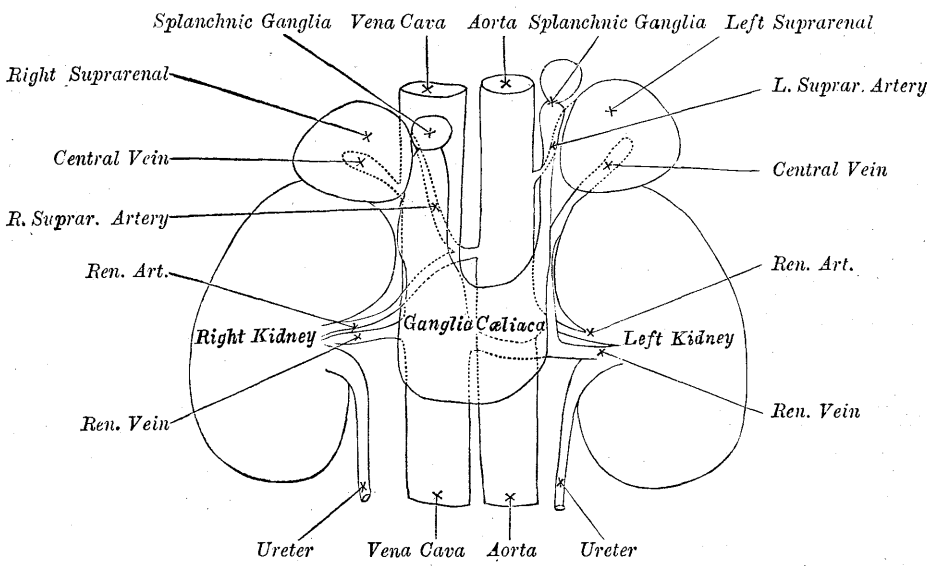
Towards the close of the 13th day (woodcut 4), the cardinal veins greatly retrograde, on the right side almost completely. Thus the central vein of the right suprarenal becomes now the direct continuation of the vena cava, and the left central vein becomes a side branch from the great vein. The suprarenal blastemas of the two sides are now placed not ventrally, but laterally to the aorta. The mesonephros is pushed laterally and Müller's duct is distinct. In

the 14th day embryo, the blastemas have a considerable size, a little projecting into the coelom cavity. The kidneys appear at the posterior and dorsal side of the suprarenal. By dissecting the embryo, the suprarenals are seen as a pair of oval shaped bodies, flattened antero-posteriorly as if pressed by the developing kidney. The inner end of each suprarenal is attenuated and thus overlaps the anterior inner corner of each kidney,—a state of things retained and more distinctly seen in later stages. In the 15th day embryo (woodcut 8), the suprarenal bodies have shifted their position, further dorsalward, being now placed just laterally to the vertebral body and dorsally to the aorta. Thus at no stage, are the suprarenals of the two sides connected together as some writers state. As Mitsukuri and Gottschau well remarked, it is the ganglion placed inside of each suprarenal, which is posteriorly joined to its fellow by a cross bar.

The nerves sent out from the sympathetic ganglia are distinct in the later stage of the 13th day (woodcut 4). Two or three branches are successively given out from the ganglia and all are united into the splanchnic plexus lying inside of, and closely applied to, each suprarenal. A branch is further sent downwards from the plexus to the front of the aorta, where it is connected (in the next day) with its fellow of the other side. From the 14th day onward (woodcut 5), we can distinguish in each splanchnic plexus at least two ganglia, the larger anterior and the smaller posterior ones. The posterior ganglion on the right side is elongated and becomes continuous with the cæliac ganglion, so that the latter may be said to be the direct continuation of the right splanchnic plexus. From the ganglion closely applied to each suprarenal (that is the second ganglion of the plexus), some fibres enter the organ. Though very fine, these fibres can be traced for a certain distance within the organ. Woodcut 6 and fig. 9, taken from the 14th day embryo, repre-

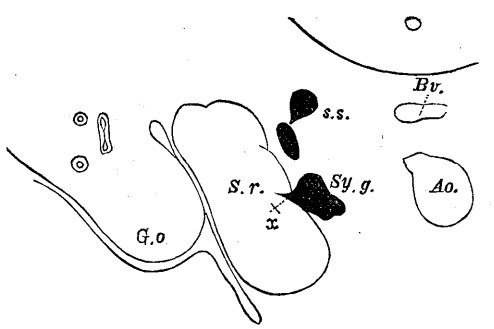
sent the state of things, when the nervous elements are just entering the organ. It is seen only for one section.

Woodcut 5.



Semi-diagramatic figure, showing relations of suprarenals to ganglia and bloodvessels.

Woodcut 6.



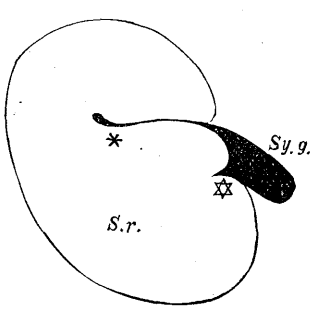
From a 14th day embryo, representing the right suprarenal. The place marked × is more magnified in fig. 9. (Pl. XXX.). Ao.=aorta, Bv.=veins, G. O.=generative organ, s. r.=suprarenal blastema, s. s.=main mass of sympathetic ganglia, sy. g.=ganglion of the sympathetic origin.

In the 15th day embryo, the nerve fibres within the organ are stronger and more easily to be ascertained. These branches are

tolerably constant in number. Generally into the left suprarenal (woodcut 8), one very strong bundle enters at about the middle and ventral portion of its inner margin. At the corresponding point of the right suprarenal (woodcuts 7 and 9 A) a strong bundle (but more slender than that of the left side) is seen ; on the same level and somewhat dorsal to the one just mentioned another smaller bundle runs in from the same ganglion. Besides these, a small bundle may sometimes be seen entering the organ at its posterior end (woodcut 9 B). All these bundles are very delicate, and can be seen only for three or four consecutive sections.

It will be necessary here to describe the characters of the nervous cells to distinguish them from the cortical cells. The protoplasm in these cells is not so rich as in the cortical cells, and is very granular ; their nuclei are comparatively small (4.5 μ on an average), thickly packed, and deeply stained due to the presence of many granules.

Woodcut 7.

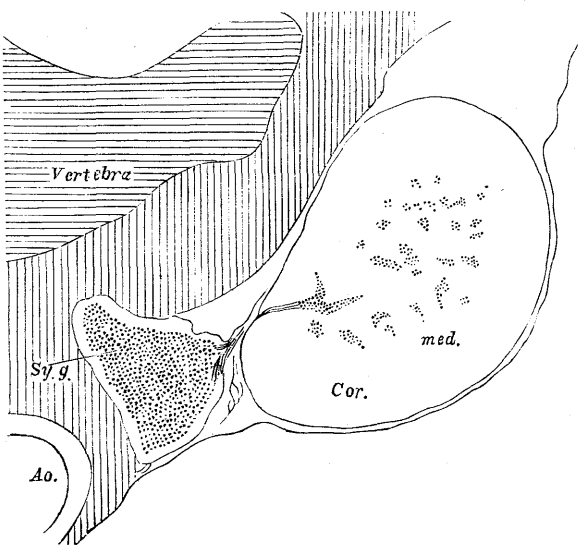


A cross section taken from a 15th day embryo, right suprarenal. S. r. = suprarenal blastema, Sy. g. = ganglion of sympathetic origin. 2 × B.
The place marked ✡ is more magnified in fig. 10. A. (Pl. I.) The place marked * is more magnified in fig. 10. B.

In fig. 10 A (which represents a portion of the woodcut 7 under a higher power) taken from a 15th day embryo, a mass of

nervous cells is seen insinuating itself into the cortex. The other smaller bundle (marked in the woodcut with a *) is interesting. It is very delicate and scarcely visible, running deeply into the cortex, and finally ending in a small cluster of cells, which are distinctly of nervous nature (Pl. XXX. fig. 10 B).

Woodcut 8.

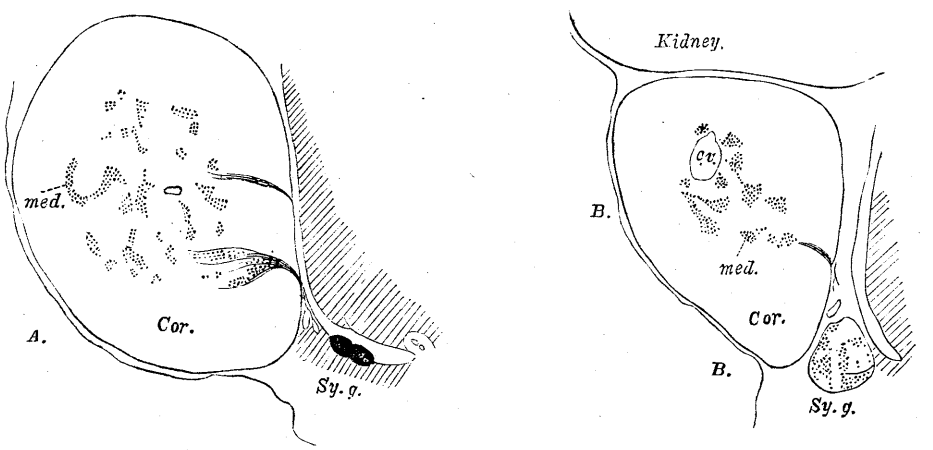


A cross section of a 16th day embryo, left side. Ao.=aorta, cor.=cortical substance, med.=medullary substance, Sy. g.=ganglion of sympathetic origin. 2×BB.

In the 16th day embryo, the nervous elements carried in the organ are considerable (woodcuts 8 and 9). They form now a reticulated network imbedded between the cortical cells, appearing in sections as small scattered groups of cells. Though the main mass of the nerve cells is clustered in the centre, some cell groups (Pl. XXXI. fig. 11) are found in the periphery of the organ at its medial side and send out their fibres, which actually piercing through the connective capsule become continuous with the ganglion near the organ. In others (fig. 12), although the fibres pierce through the capsule,

they can not be traced to the ganglion, but are lost on the way; in others again, they are lost in the connective tissue capsule of the organ. From this stage onward we can call the nervous elements within the suprarenal more appropriately the medulla. I believe this and the previous stage are sufficient to show the nature of the medullary substance. Probably these two stages were not observed by Gottschau and Janosik, who thus concluded that the medulla is differentiated gradually from the cortical substance.

Woodcut 9.



Cross section taken from a 16th day embryo, right side suprarenal.
A, at the middle of the organ. B. near the posterior end.
c. v.=central vein, cor.=cortex, med.=medulla, sy. g.=ganglion of sympathetic origin. 2×BB.

As to the further growth of the medulla, I have little to describe. It consists merely in the increase of the medullary cells which gradually form a compact mass in the centre of the organ, the cortical substance becoming in consequence scanty in the centre and pushed to the periphery. (Pl. XXXI. 14)

The severance of the nervous connection commenced in the previous stage is usually complete in the 18th day embryo, which

was the oldest one I investigated. The process takes place simply by the growth of the connective tissue capsule around the piercing nerve which is consequently reduced to a narrow neck and finally cut off (fig. 13). Still the direct connection of the medulla with the sympathetic ganglion is retained in some cases, especially on the left side. In all such cases observed, the connective link which persists is enormously strong, so much so that sometimes the ganglion itself may be immersed in the organ. This is one reason why the connection persists longer. Further as before stated, on the left side the nervous fibres enter the organ mostly as a single conspicuous bundle, while on the right side they are usually divided into several smaller clusters, which will more easily be cut off. Hence the connection when it persists in the newly born mouse is always found on the left suprarenal as before described.

As to the general appearance of the histological elements of the suprarenal bodies in this stage, it does not much differ from those of the newly born animal.

Development of the Cortical Substance in the 11th-12th day Embryos.—As regards the origin of the cortical substance the attention of earlier writers has been principally directed to the indifferent mesoblast. Kölliker[6] stated that the suprarenal bodies in the rabbit first appear in the 12th or 13th day embryo as masses of somewhat large round cells on each side of, and ventral to the aorta, on the inner side of the Wolffian bodies and dorsal to the mesentery. Mitsukuri confirmed this and added that dorsally this mass is tolerably distinct from the other mesoblastic cells, but ventrally its termination is indefinite. Brunn[7], Braun, and more recently Gottschau derived

6. Entwicklungsgeschichte des Menschen und der höheren Thiere. 1879.

7. Ein Beitrage zur Kentniss des feineren Baues und der Entwicklungsgeschichte der Nebennieren. Arch. f. Mikros. Anat. VIII. 1872.

the cortical cells from the mesoblast, but in connection with the walls of the blood vessels (aorta, cardinal veins, vena cava, or vena renalis).

Recently for the first time Janosik stated that the suprarenal body takes its origin from the peritoneal epithelium, and it is in fact in the closest connection with the beginning of the sexual organ: this connection persists for a tolerably long time until it is cut off by the entrance of blood vessels, especially the vena vertebralis posteriori and other veins emptying into the same from the Wolffian bodies. Weldon,[8] on the other hand, derived the blastema from the Wolffian bodies. According to his statement, a cell-mass proliferates from the walls of the glomerulus and separates into two masses: the one travelling backwards becomes the suprarenal body, the other growing downwards and entering the sexual organ becomes the tubuli seminiferi (in the male). Mihalcovics[9] also affirmed like Weldon the connection of the suprarenal blastema with the sexual "strang" (=segmental "strang" of Braun), which he derives, however, from the germinal epithelium. At this point he agrees with Janosik, but differs in the statement that the suprarenal body is only the undifferentiated anterior continuation of the sexual organ. In front of the anterior end of the generative ridge the suprarenal cells are said to be directly proliferated from the peritoneal epithelium, and posteriorly they are said to be continuous with the sexual strang but not in direct connection with the peritoneal epithelium. In birds and mammals, the direct proliferation of the peritoneal epithelium to form the suprarenal blastema is said to be confined to a very small tract, so that it might be overlooked if series of sections were not studied.

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8. Suprarenal Bodies of Vertebrates. Quart. Jour. of Micros. Science XXV. 1885.

9. Untersuchungen über die Entwicklung des Harn- und Geschlechts-apparates der Amnioten. Inter. Monatschr. f. Anat. u. Hist. II. 1885.

To trace the origin of the cortical substance is in fact extremely difficult, as its cells are faintly distinguished from the other tissue cells. The cortical blastema in the mouse is tolerably well seen in the early stage of the 12th day of gestation. The mesonephros in the mouse is very weakly developed. Only the anterior two or three segmental tubules actually open to the Wolffian duct; following these can be traced five or six blind tubules, which lessen in size one after another, until finally no tubular structure is seen beyond the 8th or 9th one, the cells being merely clustered in proper places. The suprarenal blastema extends from about the middle of the anterior two segmental tubules to about the 6th or 7th tubule. In cross section, it is large anteriorly and gradually lessens in size posteriorly. It is placed just at the angle of the mesentery (Pl. XXX. figs. 5 and 6), occupying the space enclosed by the aorta and the cardinal vein on the medial and dorsal side, and by the mesonephros and the generative organ on the lateral size. Medially the blastema is distinctly bounded by connective tissue cells. Where the S-shaped segmental tubules are projected in medial direction, they approach the dorsal end of the suprarenal blastema; in other cases they are far removed from the suprarenal. In no cases do the tubules send out cells medially. The walls of the cardinal vein show no signs of proliferation. Branches of the vein to the suprarenal are not yet developed.

The relation of the suprarenal blastema with the beginning of the generative organ is interesting. These two blastemas are placed side by side, their anterior extremities reaching about the same level, but posteriorly the generative blastema extends far beyond the end of the suprarenal. The cell elements of the two are very similar, consisting of large cells with large round nuclei, which are stained slightly deeper than those of the connective tissue cells. But the two blastemas are separated from each other in all places, except at

the anterior parts, by an intervening thin septum of connective tissue cells. This septum, consisting of the two or three rows of cells, runs from the peritoneal epithelium in dorsal direction, and finally separates itself into two branches, the one bending laterally and covering the generative organ, the other bending medially and covering the dorsal end of the suprarenal.

The cells of the peritoneal epithelium which touches the suprarenal blastema are arranged in a single row (fig. 6). But as we proceed anteriorly (fig. 5) the epithelium cells are evidently proliferating; they are actually pushed upwards and are even continuous with the suprarenal blastema. Tracing sections still anteriorly, the connection becomes more intimate, till near the anterior end of the suprarenal (Pl. XXX. fig. 4) the peritoneal epithelium cannot be distinguished from the suprarenal blastema itself. Here the septum no longer exists between the suprarenal and generative organs. The cells of the two blastema are laterally continuous with each other, the two being indicated only by the two rounded eminences projected dorsalward; ventrally they are both seen to be the proliferation of the peritoneal epithelium.

In a stage somewhat earlier than that above described, the suprarenal blastema is not yet so distinct. Figs. 1-3 were taken from an embryo in the later stage of the 11th day of gestation. Fig. 2 taken from near the anterior end of the left suprarenal blastema corresponds with fig. 4, and figs. 1 and 3 taken on both sides at the middle of the organs correspond with fig. 5. From the somewhat detailed description of the previous stage, any further remarks will not be needed. Only it may be added that the proliferating cells are very indistinctly bounded dorsally, but a careful study shows that they are proliferated from the epithelium. Why I do not consider these proliferating cells as the sole beginning of the generative organ

is simply that the position of that organ is always in the following stages a little removed from the angle of the mesentery. Further in figs. 1 and 3 the proliferation of the peritoneal epithelium can be roughly separated into two parts, the medial and lateral.

From the above description, I think that Janosik's statement as to the origin of the cortical cells is quite correct. My figure 1 corresponds with his figure 1. The only difference is that the mesonephros in the mouse is not so well developed as in the case of the pig. Thus Janosik stated that the cells proliferate in the medial direction to the aorta, which condition is observed in the mouse only on the right side. The mesentery in the mouse being shifted from the medial line a little to the right side, its angle on the left side is carried far to the medial line, so that on this side the suprarenal blastema is projected upwards and a little lateralwards in the direction of the mesonephros (compare figs. 1 and 3). I cannot determine whether the suprarenal body is really the anterior continuation of the generative ridge or not. The state of things as seen in the figure given by Mihalkovics from a sheep embryo (his fig. 167) I could not find at the corresponding point of the mouse. But from the fact that the peritoneum is proliferated and the suprarenal blastema is placed side by side with the generative organ in its entire length, it is more likely to be the lateral separation, and not the anterior continuation of the generative organ.

Further growth of the suprarenal blastema consists simply in its separation from the peritoneum and clustering into a more compact round mass, as will be seen in fig. 12. The proliferation of the peritoneum, though slight, is still observed towards the close of the 12th day. Beyond the anterior end of the suprarenal bodies, a slight proliferation of the peritoneum was sometimes observed (Pl. XXX. fig. 7). I think that the compact suprarenal blastema is formed

rom the main mass of the proliferated cells, while a small portion may be left behind, which seems finally to disappear without entering into the formation of the suprarenal bodies.

To sum up:

1. The Medulla and the cortex are distinct in their origin.

2. The cortical blastema appears in the later stage of the 11th day of gestation, as a proliferation of the peritoneum at the angle of the mesentery and laterally continuous with the beginning of the generative organ. The separation from this connection is complete on the 13th day.

3. The medulla is derived from the sympathetic elements, which enter the organ in the 14th day embryo. They increase and form a reticulated mass at the centre, from which the cortical cells are gradually pushed aside. The connection with the sympathetic system is usually cut toward the close of gestation, but in some may be retained until after birth.

Explanation of Figures.

ac. cor.=accessory suprarenal. Ao=Aorta. Art. c.=cœliac artery. Bv.=Veins. cor.=cortical cells. c. v.=central vein of Suprarenal bodies. Diag.=Diaphragm. G. o.=Generative organ. Kid.=kidney. Med.=Medullary cells. Mes.=Mesentery. S. r.=Suprarenal body. S. t.=Segmental tubules. Sy. f.=Sympathetic nerve fibres. Sy. g.=Sympathetic ganglion cells. v. car.=cardinal veins. v. c.=vena cava. W. D.=Wolffian duct.

Fig. 1. From the 11th day embryo. Right side. Taken from the level of the 2nd segmental tubule. 2×E.

Fig. 2. From the 11th day embryo. Left side. Taken from near the 1st segmental tubule. 2×E.

Fig. 3. From the 11th day embryo. Left side. Near the 2nd segmental tubule. 2×E.

Fig. 4. From the 12th day embryo, early stage. Left side. Near the anterior ends of the suprarenal and generative organs. 2×E.

Fig. 5. From the 12th day embryo, early stage. 10 sections behind. 2×E.

Fig. 6. From the 12th day embryo, early stage. About the level of anterior one third of the left suprarenal. 2×E.

Fig. 7. From the 12th day embryo, late stage. Left side. Beyond the anterior end of the suprarenal bodies 2×F.

Fig. 8. From the 13th day embryo, early stage. Right side. 2×E.

Fig. 9. From the 14th day embryo. Right side. The place marked × in woodcut 6. 2×F.

Fig. 10. From the 15th day embryo. Right side. A. the place marked ✡ in the woodcut 7. 2×E. B. the place marked *. 2×F.

Fig. 11. From the 16th day embryo. Left side. More magnified figure of woodcut 8. 3×DD.

Fig. 12. From the 16th day embryo. Right side. More magnified figure of woodcut 9 A. 3×DD.

Fig. 13. From the 18th day embryo. From the posterior part of the left suprarenal. 2×E.

Fig. 14. From the 18th day embryo. From another embryo. Central portion of a section, taken near the posterior end of the right suprarenal. 3×DD.

Fig. 15. From the 1 day old mouse. Right suprarenal. 3×D.

Fig. 16. From the 3 days old mouse. 2×E.

Fig. 17. From the 3 days old mouse. Another specimen. Posterior end of the left suprarenal. More magnified figure of woodcut 2. B.

Fig. 18. From a mouse about 10 days old. 2×E.

Fig. 19. From a mouse about 10 days old. Medulla is weakly developed. 2×F.

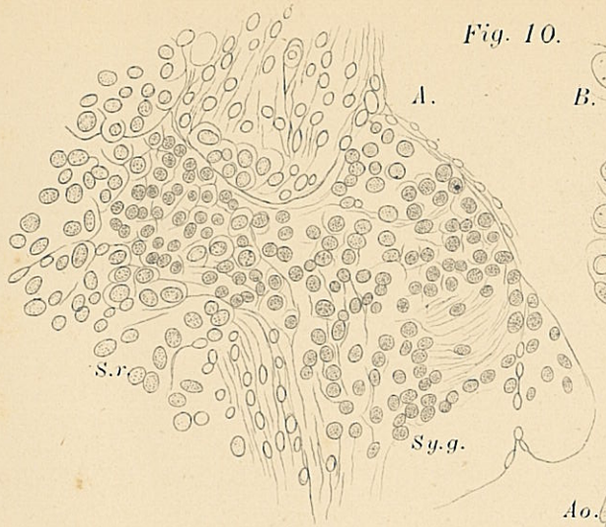
Fig. 20. From a mouse about 10 days old, another specimen. The remnant of the connection with the sympathetic. 2×E.

Fig. 21. From a mouse about 1 month old. 2×E.

Fig. 22. From an old wild mouse. 2×E.

Fig. 23. A part of the right suprarenal from an old mouse. 2×E.

Fig. 10.



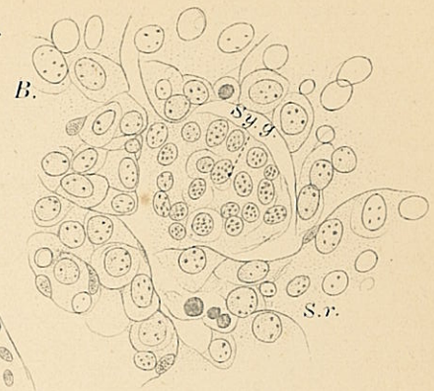
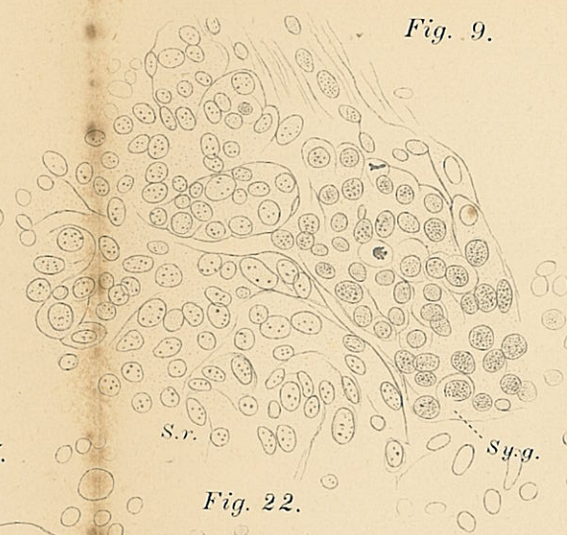


Fig. 9.



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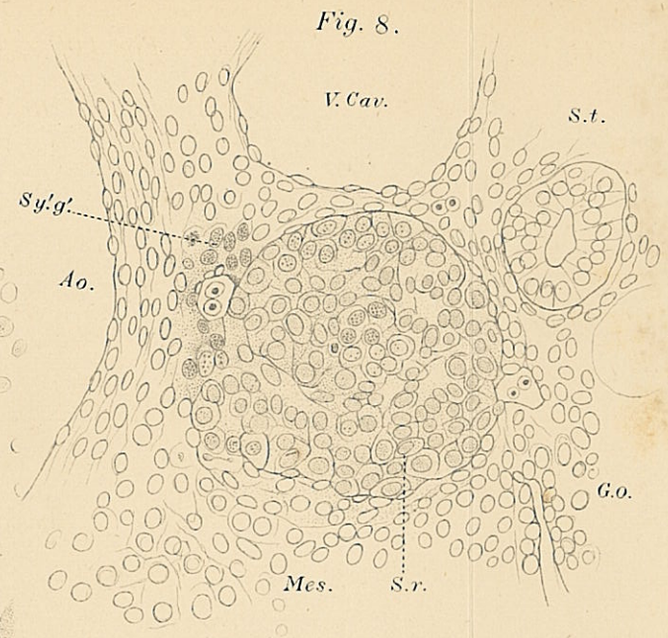

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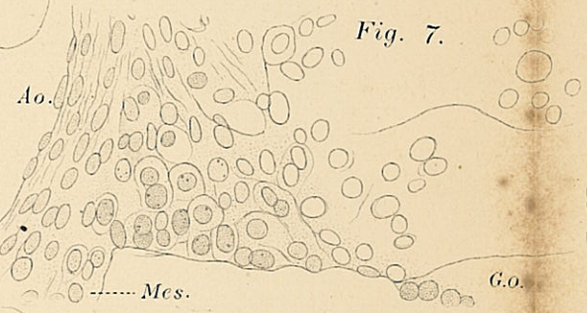

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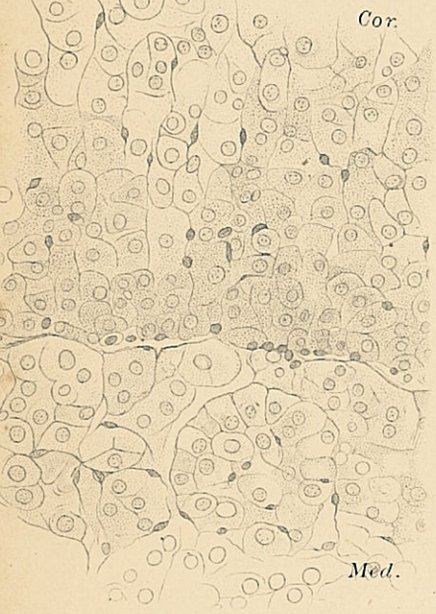

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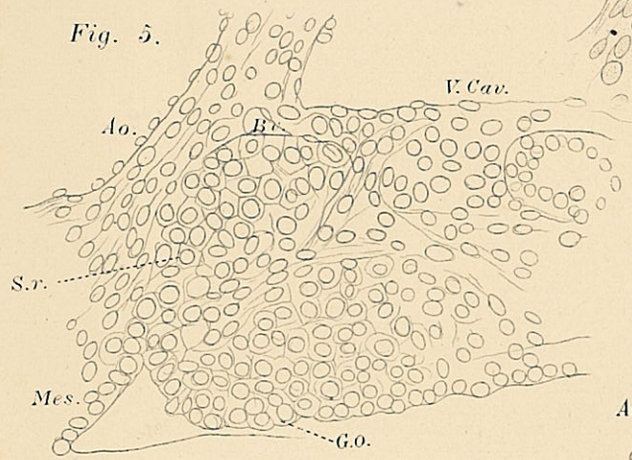


Fig. 1.

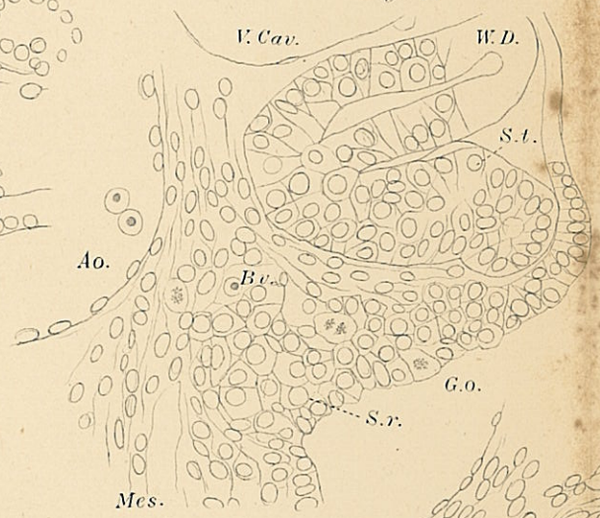
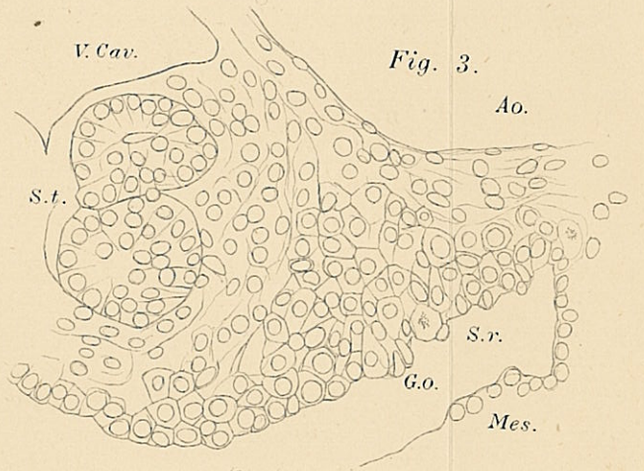


Fig. 3.



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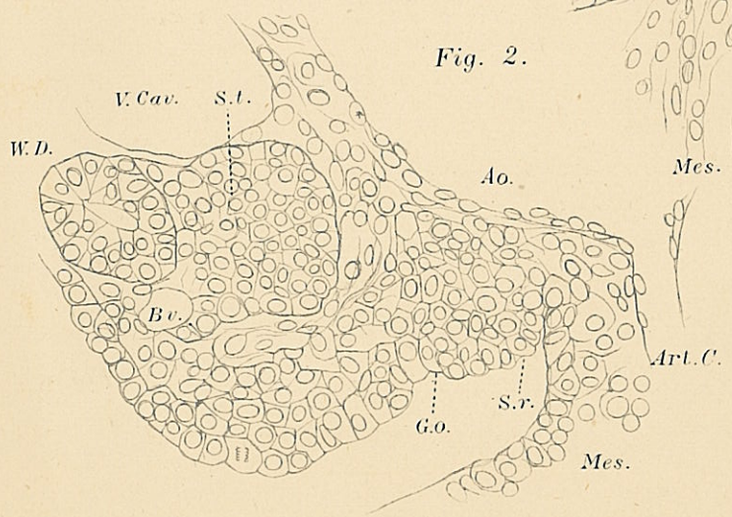

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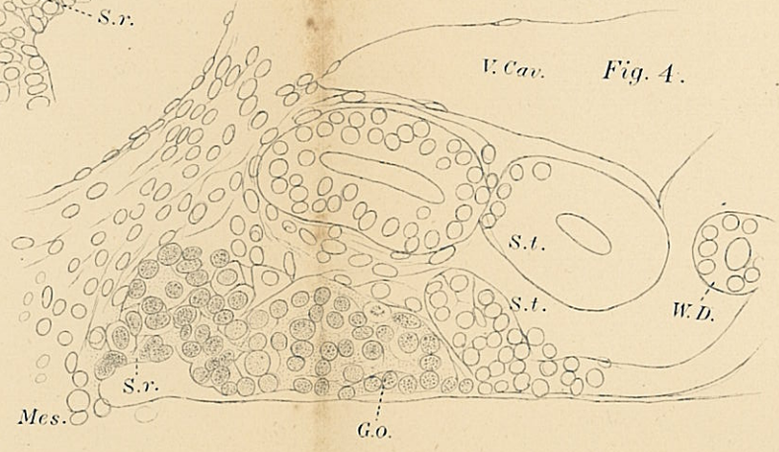

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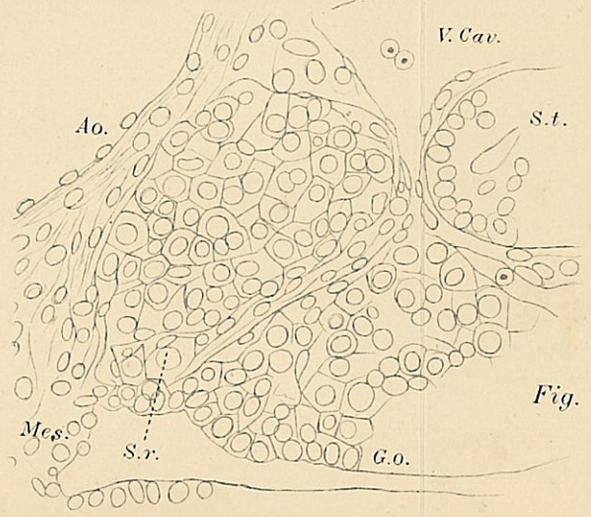

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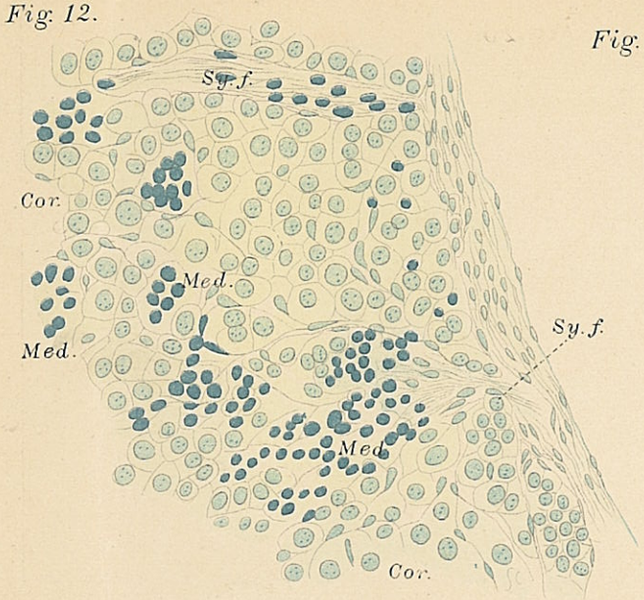
Fig. 12.



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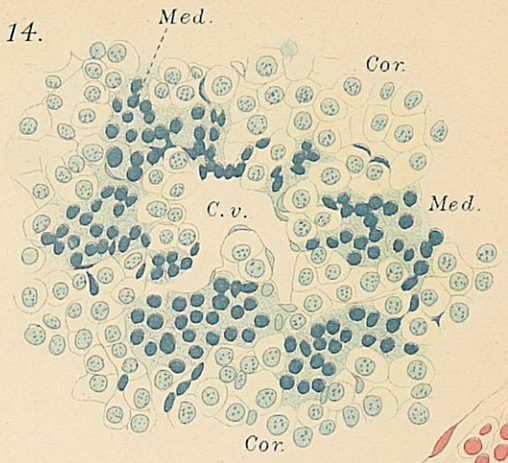

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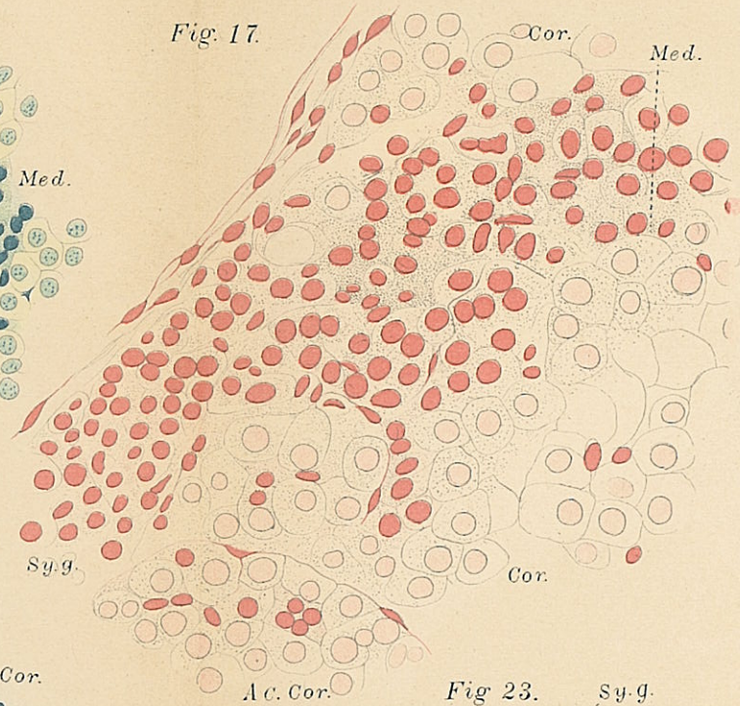

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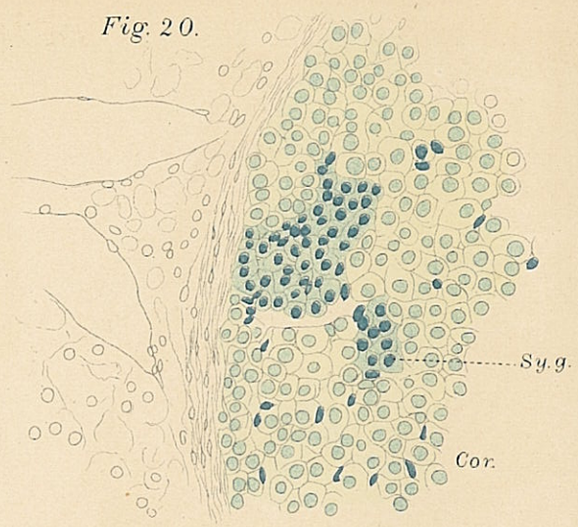

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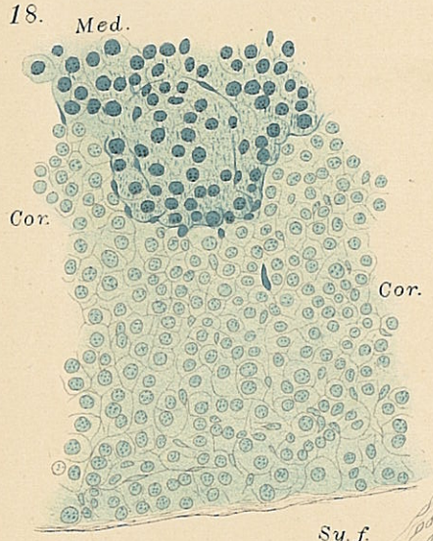


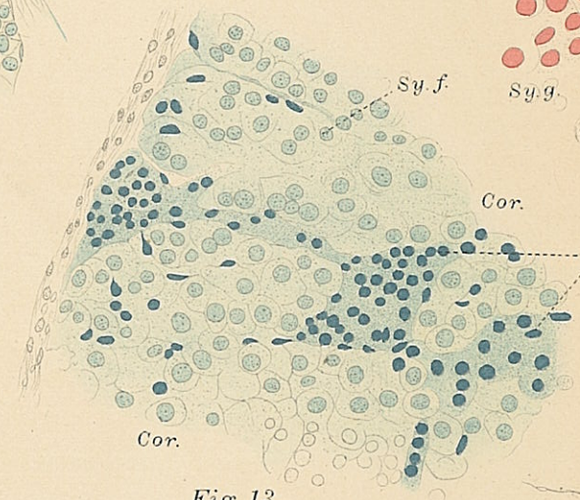
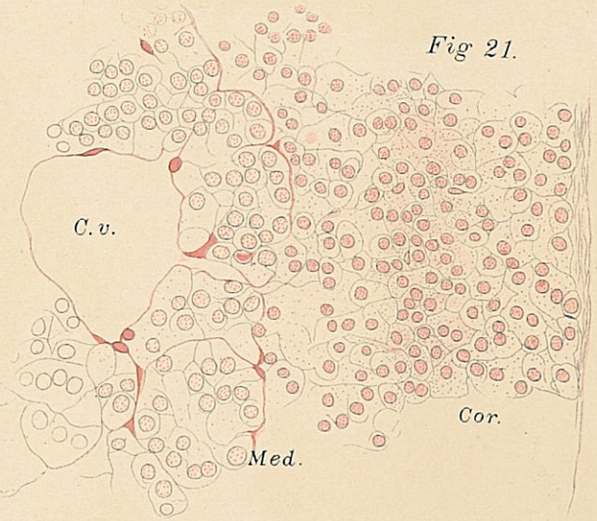


Fig 13.

Fig 21.



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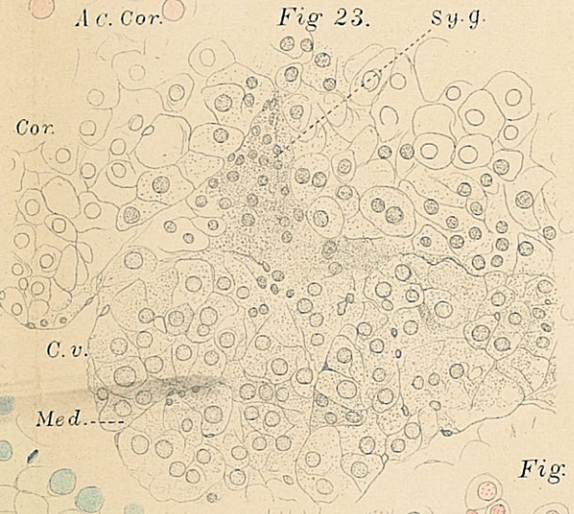

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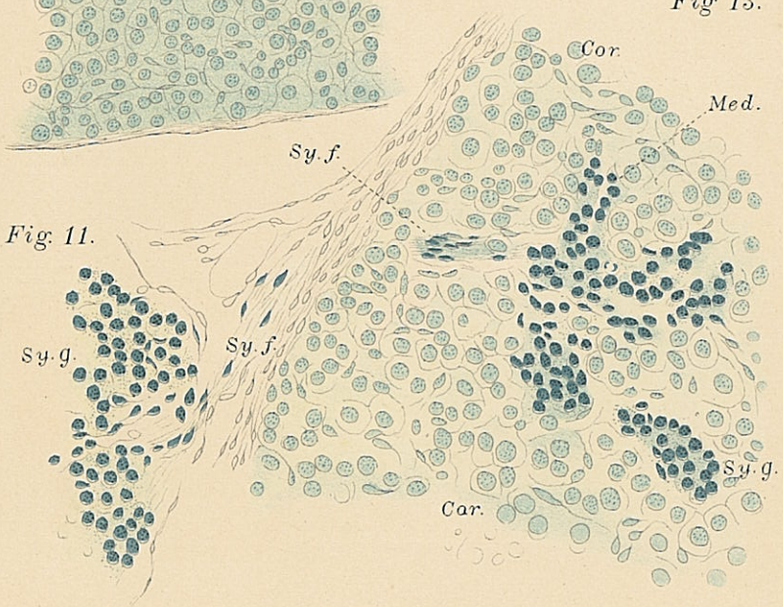

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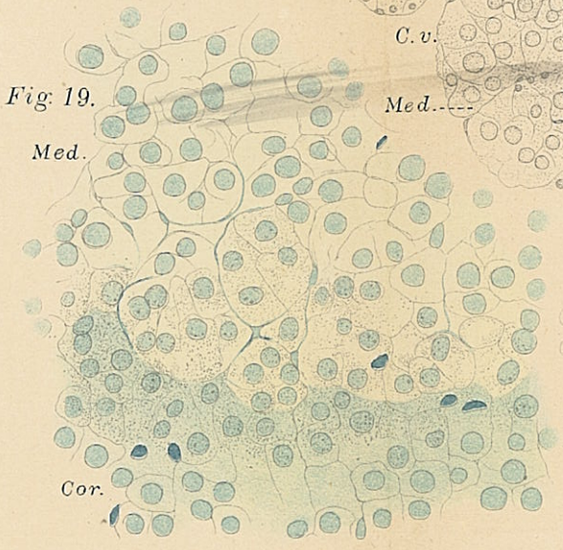

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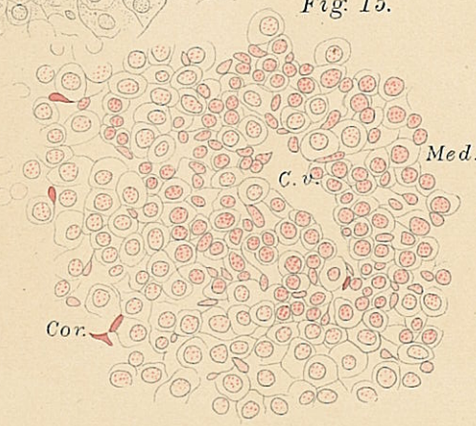

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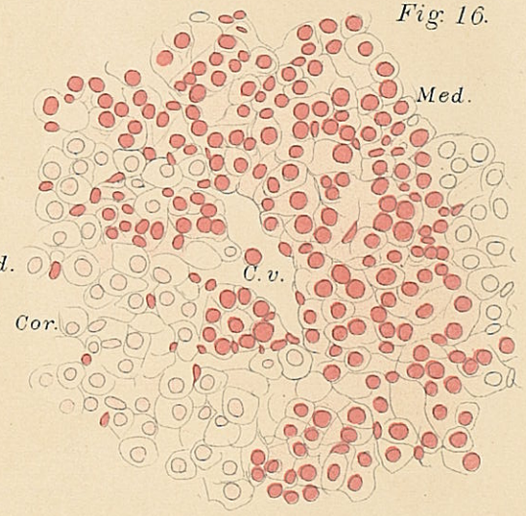

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