ABSTRACTS.*

FUSION OF THE SEMILUNAR AND CUNEIFORM BONES (OS LUNATUM AND OS TRIQUETRUM) IN BOTH WRISTS OF AN ADULT MALE NEGRO—SHOWN BY THE X-RAY. By EUGENE R. CORSON. *Savannah, Ga.*

While examining by X-ray a negro's wrist for a Colles' fracture, the semilunar and cuneiform bones were seen to be fused. An examination of the uninjured hand showed a similar condition. There was no external evidence of the fusion and the normal movements of the wrist were in no way impaired.

Although I have taken many X-rays of the wrist among both white and colored, I have never before found an anomaly of any kind in the carpus. While anomalies of the wrist are rare, this fusion of the semilunar and cuneiform bones has been occasionally observed. In an analysis of the twenty-six cases already reported, Thomas Dwight shows in his "Atlas of the variations of the bones of the hands and feet" that at least twelve of the twenty-six were in blacks. See also his discussion in Piersol's Human Anatomy.

A careful study of many skiagraphs of the wrist has shown me a remarkable uniformity in the position of the carpal bones, and especially of those of the first row, in their relations with the radius and ulna. The semilunar bridges the radio-ulnar articulation. This was first brought out by a study of Colles' fracture, where a weakening or rupture of the internal lateral ligament allows the hand to drop to the radial side. In this movement to the radial side the articulation between the semilunar and cuneiform is brought nearly in line with the radio-ulnar joint. In the accompanying cut (Fig. 2) of the uninjured wrist it is seen that the semilunar portion of the fused bones is in the usual position.

In my paper (An X-ray study of the normal movements of the carpal bones and wrist) I pointed out the almost ball and socket arrangement of the first and second row—of the head of the os magnum in the socket made by the semilunar and scaphoid, one of the most inter-

*Abstracts of some of the papers read at the twenty-third session of the Association of American Anatomists, Chicago, January 1, 2 and 3, 1908.

FIG. 1. X-ray picture of a normal wrist of a male negro.

esting features in the anatomy of the wrist. It was also brought out that the carpal bones move as two rows and not as a cluster. The most important movement, of course, is at the radio-carpal joint; next in importance is the movement between the first and second rows, while

FIG. 2. X-ray picture of the wrist of a male negro showing fusion of the semi-lunar and cuneiform bones (*Os. lunatum* and *O. triquetrum*). Compare with the normal wrist in Fig. 1.

the movement between the second row and the metacarpals is practically nil.

To apply this knowledge of the normal movements of the bones of the hand to the fusions which occur, independent of disease, it will be seen, as one might expect, that those bones between which much motion

exists rarely if ever fuse, while with those between which there is little or no motion fusion occasionally occurs. That is, there is fusion between bones in the same row, as in the present case with the semilunar and cuneiform bones, or between the second row and the metacarpals, as pointed out by Professor Dwight in the case of the fusion of the second metacarpal with the trapezoid, or the congenital fusion of the proximal parts of the fourth and fifth metacarpals, or in the tarsus, of the external cuneiform and the third metatarsal.

THE FIBROGLIA FIBRILS OF NECTURUS. By CAROLINE MCGILL. *From the Department of Anatomy, University of Missouri.*

In the intestine of *Necturus*, forming a basement membrane for the lining epithelium and scattered throughout the subepithelial connective tissue, are fibrils which closely resemble the fibroglia fibrils described by Mallory. These fibrils always, at some point in their course, are in connection with the granular protoplasm of the cells from which they arise. In some places, throughout their entire length, they are surrounded by granular protoplasm.

With all stains used the fibrils stain just as do myofibrils. Throughout, the similarity to myofibrils, not only in staining, but also in size and general arrangement, is so close that it seems unnecessary to consider them other than a type of myofibril. Some evidence that they are contractile lends further support to this view.

HISTOGENESIS OF GASTRIC GLANDS. By EDWIN G. KIRK. *From the Laboratory of Anatomy, University of Chicago.*

The development of the cardiac, fundic and pyloric glands of the pig was traced from the stage of the 2 cm. embryo to the time of birth. At about 3 cm. short intra-epithelial ridges appear in the stomach. These intersect in all directions, thus enclosing depressions which are the primary gland tubules. The basement membrane is yet a level plane, the ridges thus simply representing the line of cells which have increased more rapidly in height than those of the intervening areas or depressions. Very soon, however (4 cm.), the ridges are reinforced by the upgrowth from below of mesoblastic ridges. (This essentially confirms Salvoli's work on rabbit.) The simple tubules deepen rapidly through continued upgrowth of the lamina propria. Growth occurs more rapidly at the nodal points of the ridges, so that a villoid appearance results. This observation seems to explain the two apparently antagonistic

views as to the nature of the first irregularities; namely, that they are ridges, or, on the other hand, papillæ, whose bases later fuse. In the later stages, by a lagging of growth at the nodal points, the definitive condition is reached. In the later stages mesoblastic processes push up into the bottom of the simple tubules. At first these grow clear to the surface, thus increasing the number of tubules. The later ones grow up only part way, thus giving rise to compound tubules; this compounding occurs in the pylorus of about 17 cm., fundus 20 cm., and cardia 22 cm.

All developmental processes—both form development and cyto differentiation—are most precocious along the greater curve and in the pylorus and adjacent fundus.

The parietal type is the first to differentiate. These cells appear in the fundus tubules of 4 cm. From the first, they are in line with the general epithelium, rather than appearing between the bases of the epithelial cells, as sometimes described. As the tubules deepen, new parietals appear, always at the bottom; later they differentiate in the middle third of the tubule (future cervix). After 7-9 cm., they increase both by differentiation of new ones and by karyokinesis of the old.

Mucous cells, both chief and goblet, appear first along the lesser curve, at 6 cm. After 9 cm. the pyloric cyto differentiation is practically complete. In the fundus, the mucous cells of foveola and cervix differentiate at 12-16 cm. Up to 19 cm. the cells lining the deeper part of the fundic tubules—aside from the scattered parietals—are yet of the embryonic type. At 19 cm. zymogen granules appear in their distal ends. Thus it is seen that the serous chief cells pass through no mucous stage.

After 20 cm. the main increase in length of the tubules is in the deeper part or fundic segment.

The form development of the cardiac tubules is essentially identical with that of the fundic up to the 14 cm. stage, after which the growth of the cardiac tubules is retarded. At 17 cm. all the cardiac cells are differentiated, three types being present—goblet, mucous chief and parietal. The parietals are the first to appear, just as in the fundus. A few zymogenic cells appear in the depths of the cardiac tubules at about the 21 cm. stage. Later these disappear, probably being converted into mucous chief cells. As in the adult pig, there is in all stages of development a broad zone between fundus and cardia, transitional as to form and size of tubules and as to cytologic characters. At birth the parietals are very abundant in the cardiac tubules. As the adult tubules

have practically none, the cells must either degenerate or transform into mucous chief cells—probably the latter. Their exact fate is now being investigated. The cardiac glands are not primitive, but rather retrogressive. They represent fundic glands undergoing a process of involution. It is of interest that the first cell type to differentiate from the primitive embryonic cells—namely, the parietals—are younger phylogenetically than the mucous or the zymogenic cells. The early appearance of the ductules suggests a functional explanation of this apparent anomaly.

Development in the cæcal pouch is so erratic and complicated that reference must be made to the full paper, to be published later.

THE DEVELOPMENT OF THE SWIMMING MOVEMENT IN AMPHIBIAN EMBRYOS. By G. E. COGHILL, *Denison University.*

The first reaction of embryos of *Triton torosus* to a touch on the side of the head or on the tail bud is a flexure of the head. As the embryo advances in age the flexure progresses caudad till the whole trunk is involved. After the stage of complete trunk flexure is reached the head may be reversed before the initial flexure is completed in the caudal region. This produces an "S reaction." Any particular flexure develops, also, by cephalo-caudal progression. This mode of movement in a series of "S reactions" produces normal, upright, direct swimming. It appears, then, that the earliest centralization of the nervous system, ontogenetically, is in the region of the funicular nuclei, which region functions as a tactile locomotor center, in correlation with the cephalo-caudal progression of movements in locomotion. This law in the development of movement is correlated with the order of development of the nervous system cephalo-caudad, and it may have been an important phylogenetic factor in establishing this mode of development of the nervous system of vertebrates. It is in harmony, also, with the theory of migration caudad of the afferent roots of the cranial nerves, since such a shift would bring these roots into a most direct course to the primitive locomotor center.

THE COURSE OF THE BLOOD THROUGH THE FETAL MAMMALIAN HEART. By A. G. POHLMAN. *From the Department of Anatomy, Indiana University.*

A series of experiments were carried out on the living fetal pig to determine the course of the blood through the heart with a view of determining whether mixed blood passed through the foramen ovale

(Harvey, 1628); whether most of the blood entering the heart through the inferior cava passed through the foramen (Sabatier, 1791); or whether Wolff's conception (1778) that the vena cava opened on the foramen in such a manner that the blood was split into halves, one passing into the left and one into the right auricle.

Corn starch suspended in normal salt solution was injected into the selected vein (cava superior or umbilical vein) and recovered simultaneously and under identical conditions from the beating ventricles. The result shows that granules injected into the umbilical vein are recovered in equal amount from either ventricle (disproving Sabatier's theory), and granules injected into the superior cava are also recovered in equal amounts from both ventricles (disproving Wolff's theory). Double injection of superior and inferior cavæ showed a mixing of blood in the right auricle and proving the Harvey theory.

Investigations on the turtle seem to show that the blood of the two auricles does not remain distinct in the common ventricle, and that the present scheme of the course of the blood through the turtle heart, like that through the mammalian heart, is incorrect.

SOME RESULTS OF RECENT INVESTIGATIONS ON THE MAMMALIAN HEART. By ROBERT RETZER. *From the Anatomical Laboratory, Johns Hopkins University.*

In my paper before this society last year, attention was called to the fact that the Purkinje fibres are the final branches of the atrio-ventricular bundle, as had been described by Tawara. I have since continued the investigations on the structure and development of the Purkinje fibres, and results which are not alone interesting in themselves, but which open a field of research on the histological structure of the heart, were obtained.

Owing to the abundance of accessible material, the study was confined to pig's heart. Comparisons were also made with hearts of human embryos in Professor Keibel's and Dr. Mall's collections, and these confirmed the results obtained by the more minute study of the embryo pig's heart. The hearts were fixed in one of the usual fixing fluids, imbedded in paraffin and cut from front to back. For convenience, the heart is considered with the base upwards and the septum in a sagittal plane. Reconstructions were made of the hearts of 34, 23 and 14.5 mm. embryos.

Before describing the development of the Purkinje fibres, a few words must be said about the development of the heart, because that portion

which interests us mostly, the sinus and the formation of the atrial septum, is incorrectly described by His and Born. As the latter's description has been accepted by most embryologists, a short resumé of the points at issue will not be out of place. In the rabbit embryo, Born finds that the first or posterior septum of the atria is perforated before it reaches the septum intermedium and a second one arises from the anterior and upper wall, which becomes the ultimate septum. The venous valves, which arise as invaginations of the sinus walls, grow as thin lamellæ towards the lumen of the right atrium. The left partly atrophies and partly fuses with the septum I, the right forms the valvula venæ cavæ (Eustachii) and the valvula sinus coronarii (Thebesii).

In the pig the septum secundum, in Born's sense, does not exist. Search for it was made in vain in the embryonic hearts of man, monkey and rabbit. This supposed septum which His correctly described as a "muskulöse Leiste" is nothing but a fold in the atrial wall at that place. The conus arteriosus is the physically fixed point and the growing atria in their efforts to expand and form auricles grow around the fixed point and cause a bulging inwards of its wall. It is therefore a "passive" formation and never attains such a size that one is justified in calling it a septum. The septum I of Born remains the ultimate septum. I am at present not able to say whether the perforation that one sees is due to a rupture of the thin lamella, which at first consists of but two rows of cells, or is actually an opening formed during the growth of the heart. The valvula venosa sinistra remains throughout life as a portion of the atrial septum. It fuses with the septum and assists in the closing of the foramen ovale.

It was stated above that the valvulæ venosæ dextra and sinistra are formed by invaginations of the sinus. The questions naturally arise, What becomes of the sinus in the adult mammalian heart? Are the Eustachian and the Thebesian valves and a portion of the atrial septum the only vestiges of the sinus? Even reconstructions of successive stages would not help us if we were to consider only the morphological changes that take place, but as soon as we direct our attention to the histological structure of the musculature in various parts of the embryonic heart, we are confronted with a fact that gives us the key to the answer. As soon as the heart becomes differentiated into sinus, atria, ventricles and conus the musculature of each of these divisions has a distinctly differentiated structure, which becomes more marked as the

heart grows older and which persists in the adult. The reason why this has been overlooked so far is probably due to the fact that this differentiation undergoes marked changes that go hand in hand with the physiological changes. While the heart is a simple tube, the various portions perform the same function—the heart contracts similarly to the intestine with a peristaltic movement. The musculature is then not differentiated, but consists of a mesenchymal syncytium. As soon as the tube becomes bent into an S shape and constrictions arise in the region of the canalis auricularis and later between the ventricles and the conus arteriosus and between the sinus and the atria, the muscu-

Fig. 1.

FIG. 1. The folding in of the sinus, forming the right and left venous valves.

lature becomes differentiated in order to adapt itself to the change in function. The conus is the most highly differentiated; then, in order, come the ventricles, the auricles and the sinus. It lies without the scope of this paper to give in detail the minute description of the cystogenesis of the various musculatures. It was, however, the cognizance of these variations in structure that made it possible to trace the origin of the Purkinje fibres to the sinus.

As long as the heart has not been definitely divided into four chambers there is a continuity of the musculature of the atria and ventricles in the sulcus coronarius and ostia venosa. This is the same condition that we find in the fishes and amphibia. As soon as the septa have

formed, this musculature is replaced by connective tissue, the ostia venosa, then being called annuli fibrosi. At the same time, however, that the musculature of the sulcus coronarius is being replaced by connective tissue, the septum intermedium, which was originally composed of connective tissue, becomes invaded by musculature from the sinus, and through it the muscular continuity between the atria and ventricles, which would otherwise be destroyed, remains established. In hearts of pig embryos of 15 mm. we begin to see the sinus musculature breaking

Fig. 2.

FIG. 2. The division of the right venous valve into the Eustachian and Thebesian valves. The septum superius has reached the septum intermedium.

through the septum intermedium. In a 20 mm. pig this musculature has formed a small strand which passes forward just above the ventricular septum, and in a little later stage we see the bifurcation of the strand, one branch passing beneath the endocardium to the right side of the ventricular septum and the other to the left. In the ventricular portion we recognize the forerunners of the ultimate Purkinje fibres, but not so in the atrial portion. This difference remains throughout life (Tawara).

The differences in structure of the musculature of various parts of the foetal heart have also made it possible to trace the fate of the conus

musculature. In a foetus of 160 mm. the musculature of the conus is different from that of any other part of the heart, and therefore it is safe to say that it persists in the adult, and is not replaced by the ventricular musculature.

FIG. 3.

FIG. 3. The invasion of the septum intermedium by the sinus musculature and the division of it into the right and left branch of the conductive system. Fibres from the right venous valve join those of the left posteriorly to the plane of the diagram.

Both in the embryonic and the adult heart has it been impossible to verify Tawara's "Knoten." Professor Aschoff, under whose direction Tawara's work was done, kindly looked through my series with great

care and agreed with me that "Knoten," as he had seen it in the sheep, cat, rabbit, calf, etc., is not present. He tells me that the condition in the pig is most like that in the human heart. The "Knoten" is not confined to the atrial portion, but spreads out to both ventricular branches. It must be considered as nothing but a condition due to a difference in the age of the fibres. The atrial part of the Knoten is the result of rapid direct division of the nuclei and the ventricular portion the result of the division of the fibrillæ. The nuclear division is, however, not confined to the atrial portion of the "conductive system."

A description of this system must necessarily be too long to fall within the limits of this paper, and will be deferred to a later communication containing a more complete analysis of the structures of the heart. The conclusion derived from the study of the development and cytological structure of the conductive system is that it is a neuro-muscular apparatus akin to the neuro-muscular spindle of voluntary muscle. Whether it is sensory in its function is a problem for the physiologists to decide. It is interesting to note at this place that the first sympathetic ganglion cells that appear in the embryonic heart lie in the atrial septum immediately above the beginning of the "conductive system." Thus far the connection between these ganglion cells and the system has not been established, but researches on this subject are under way. The Purkinje fibres are surrounded by a plexus of non-medullated nerves. The similarity between these and elastic fibres is presumably the foundation for the statement that the endocardium contains a large number of elastic fibres arranged similarly to the tunica elastica interna (Henle) of the arteries.

The following is a very satisfactory method for demonstrating the Purkinje fibres: With a scalpel make incisions into the myocardium of the ventricle of the sheep's or pig's heart, so as to outline a centimeter square. The endocardium consists of two layers. With fine forceps, strip off the first layer, consisting of the endothelial cells and white fibrous tissue. Then tear off the second layer, which consists mostly of fibrous tissue to which the myocardium and the Purkinje fibers adhere. This preparation is then placed, myocardium uppermost, on a slide and scraped with a scalpel until thin. The advantage of tearing off the first coat is that it enables you to get a clearer picture of the Purkinje fibres and their transitions to cardiac muscle, and also of the nerve fibres when stained with methylene blue.

It will be interesting to pathologists to know that rhabdomyoma of the heart is a pathological condition, probably hypertrophy, of the Purkinje fibres and not of the cardiac muscle. A specimen that was shown me last year showed without doubt the similarity between the new growth and a mass of Purkinje fibres.

THE TOPOGRAPHY OF SPINAL NERVE ROOTS. BY WESLEY M. BALDWIN.
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This investigation consists of an examination of thirty adult human cadavers to determine the relation of the tips of the spinous processes of the vertebræ to the superficial origin of the spinal nerves from the spinal cord and to their distribution in the skin of the back. During this investigation the subjects were placed face down on the dissecting table with the head so flexed that the nose and forehead were both in contact with the table. All measurements were made with a steel tape, following the curvature of the body.

It was learned (1) that in general the spinous processes are exceedingly variable in position, and hence should only be used to give relations merely approximating exactness; (2) there was not observable the astonishing prevalence of anomalous conditions of thoracic nerve root origin mentioned by Adamkiewicz in 1882; (3) corresponding anterior and posterior roots differ but slightly in the level at which they leave the cord; (4) in the cervical, lumbar and sacral regions corresponding roots of the two sides emerge at practically the same level, but in the thoracic region there was a distinct tendency for the nerves of one side to arise from a uniformly higher level than corresponding nerves of the opposite side; in some cases the right roots were higher, in others the left were higher; (5) lastly, in many cases, the thoracic nerves did not pursue a perfectly straight course from their origin to the intervertebral foramen, but, running to a level lower than their foramen, they turned abruptly and ran upwards for several millimeters before emerging from the spinal canal; (6) in the cervical region it was usual for adjacent dorsal root fascicles to fuse before reaching the cord.

The average length of the spinal columns, measured from the foramen magnum to the tip of the coccyx, was 73.6 cm.; the longest, 78.8 cm.; the shortest, 67.4 cm. The average length of the spinal cords, measured from the foramen magnum, was, in female subjects, 41.5 cm.; in male, 45.9; the longest, 52.8 cm. (male); the shortest, 40.7 cm. (female).

The cords terminated on an average at the level of the lower border of the body of the first lumbar vertebra.

The distance along the surface of the skin of the back of the neck from the spinous process of the axis to that of the seventh cervical vertebra was found to be on an average 6.5 cm., with limits of 6.0 cm. and 7.1 cm. Since the spine of the axis can be palpated as the first median bony prominence caudal to the external occipital prominence, this would seem to suggest a ready and accurate method for the enumeration of the spinous processes of the other vertebrae.

An Accessory Device for Aid in Cutting Serial Paraffin Sections.

BY

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All who have had to make serial paraffin sections for purposes of reconstruction will realize the advantages of a device by which all the sections of a given piece of tissue may be cut of equal thickness throughout the entire block.

The device described below is the result of an attempt to obviate two of the difficulties usually met in preparing serial sections:

(1) The necessity of having to stop the microtome at intervals of ribbons of short length, in order to remove these ribbons from the knife and place them aside, most always results in having to start the ribbon again and consequently, quite often, the loss of several sections. Also, very often during the pause, either because of imperfections in the construction of the microtome or because of peculiarities in the paraffin block, the first one or two succeeding sections are either thicker or thinner than the thickness desired and intended for the series. The first section is usually too thick and this is no doubt largely due to a slight swelling of the paraffin block during the period of cessation of friction and pressure against the knife, and the second section is usually too thin, due probably to the fact that the knife has bitten more deeply in cutting the preceding section.

(2) It also frequently happens when serial sections are made and removed in short ribbons in the usual way that confusion results in keeping them in their natural order. The short ribbons may be disturbed from the order in which they are placed, may be turned over and may be accidentally placed with their ends reversed. Further, since in