ophryogenes of Taenzer and Unna and the xeroderma of Besnier.

ETIOLOGY.—This disease is shared in greater or less degree by a majority of people. It is usually attributed to lack of bathing, but may occur in persons who scrupulously observe hygienic rules. It may appear before puberty, although, as a rule, it does not. It is wanting where the hairs are atrophied, and it becomes attenuated and finally disappears with advancing age, the pilar system having become more atrophied. The disease is seen most frequently in persons having a thick, coarse, dark-colored skin.

PATHOLOGY.—Keratosis pilaris is essentially characterized by a hypergenesis of the epidermic cells in the hair follicle. The cells of the Malpighian layer in the hair follicle are found to undergo rapid cornification and to be arranged loosely around the hair shaft, so as to form a plug which projects above the surface. The hair shafts may be included. These are often twisted and deformed and the papillæ of the root are reduced in size, or entirely wanting. Patches of necrosis are found here and there at the point of insertion of the arrectores pilorum. On the other hand, actual infiltration may occur, usually affecting the superficial rather than the deeper portions of the follicles. Giovanni found in many cases that the sebaceous glands were entirely wanting, while, in the rest, they were reduced in size. As a rule, the sweat glands were unaffected.

DIAGNOSIS.—Keratosis pilaris differs from goose-flesh (cutis anserina) in its permanency and in the fact that it is uninfluenced by temperature. Pityriasis pilaris rubra is the only dermatosis which is able to simulate the affection. There is this difference, however: the latter is characterized by peripolar and squamous prominences, exhibiting a peculiarly dark and smirched appearance, on the back of the fingers; by the affection of the nails; and, finally, by palmar and plantar desquamation. Keratosis pilaris is distinguished from the papular syphilides by its persistently unchanging character and the absence of specific concomitants.

PROGNOSIS.—The general health is in no wise affected by the disease, even when most pronounced. The disease is curable, but, without proper treatment, may last indefinitely.

TREATMENT.—Frequent baths with the use of a proper toilet soap, or, better still, sapo viridis, will usually be found curative. Alkaline, Turkish, and vapor baths will also be useful, although, in very obstinate cases, Brocq considers that the surest treatment is the destruction of the hair follicles by electrolysis. *Grover W. Wende.*

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KERION. See *Trichophytosis.*

KEYSTONE MINERAL SPRING.—Androscoggin County, Maine.

POST-OFFICE.—East Portland.

LOCATION.—This spring is located in the town of Poland, about one mile from the Empire Road Station, on the Grand Trunk Railway, and about two miles from the Portland and Rumford Falls Railway. It is thirty miles from Portland and six miles from each of the two cities of Lewiston and Auburn. The spring is situated on an elevated ridge of land, and the water itself issues from a bed of rock barely distinguishable from granite, which can be seen in and about the spring. The water flows through a glass pipe direct from the spring into bottles, jugs, etc., which are being filled, and is not taken from storage tanks. According to Prof. Richard C. Stanley, of Bates College, the water contains about three grains of solid matter to the United States gallon, composed as follows:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Iron carbonate	0.45
Iron oxide	.25
Magnesium carbonate	.65
Potassium and sodium carbonate	.30
Potassium and sodium sulphate	.25
Sodium chloride	.25
Silica and alumina	.85
Organic matter	Traces.
Total	3.00

The water is remarkably pure, soft, and wholesome, and well adapted for the table. It is also recommended for dyspepsia and as a mild stimulating beverage in inflammatory, renal, bladder, and genito-urinary complaints. *James K. Crook.*

KEY WEST, FLA. See *Florida.*

KICKAPOO MAGNETIC SPRINGS.—Warren County, Indiana.

POST-OFFICE.—Kickapoo. Private inn.

LOCATION.—These springs are located on the line of the Chicago and Eastern Illinois Railroad, four miles northeast of Attica. The scenery about the springs is delightful, and abounds in historic interest. They are situated in a valley, on either side of which mounds rise to the height of fifty or sixty feet. Between the mounds run picturesque ravines, whose precipitous walls, composed in some places of soapstone, in others of gray or brown sandstone, show by their transverse marking the course of the ancient river as it flowed in torrents down the hillsides from the stranded and rapidly melting icebergs during the glacial period of our world's history. Among the objects of interest in the neighborhood may be mentioned Pine Creek, a romantic stream flowing through a deep valley, which is walled by towering cliffs of sand-rock, crowned by evergreen pines, cedars, and junipers, combining scenery at once grand, wild, and beautiful. This creek was used as a strong line of defence by the confederated Indian tribes prior to the battle of Tippecanoe in 1811. A number of picturesque cascades, from thirty to one hundred feet in height, are to be seen in the immediate neighborhood.

It is said that the principal spring was discovered by the Kickapoo Indians as early as June, 1750. The water was analyzed in 1885 by H. A. Huston, of Purdue University, assistant State chemist, with the following result:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Calcium carbonate	12.35
Magnesium carbonate	5.38
Ferrous carbonate	.05
Silica	.68
Sodium sulphate	.99
Sodium carbonate	.36
Organic and volatile matter	4.61
Total solids	24.42

The flow of water from this spring is about fifteen hundred gallons per hour, having a temperature of 50° F. The water is a very good antacid and diuretic. In large quantities it is said also to have a mild cathartic action. It is useful in flatulent dyspepsia with acid eructations, in irritability of the bladder and prostatitis, and in rheumatism. A peculiar black mud deposited near the springs is also used for bathing purposes. *James K. Crook.*

KIDNEYS, ANATOMY AND PHYSIOLOGY OF.—I. ANATOMY.—The kidneys are bean-shaped organs situated on either side of the spinal column. They are usually said to lie in the lumbar region but are really intersected by the horizontal and vertical planes which separate the hypochondriac, lumbar, epigastric, and umbilical regions from each other and may therefore be said to lie in all these segments of the abdominal space. They lie on the fascia of the M. quadratus lumborum and on the vertebral portion of the diaphragm and extend from the first or the third lumbar vertebra to the eleventh rib or even higher. The left kidney is usually somewhat higher than the right.

The kidney presents two surfaces, two borders, and two extremities. The surfaces are ventral and dorsal, the ventral surface being more convex than the dorsal. The external border is convex, while the internal border is fissured by the hilum. The upper extremity is usually larger than the lower and is usually somewhat nearer to the median line.

The kidneys are usually of a flattened oval shape with the long diameter nearly parallel to the vertebral column. The form is, however, very variable. The kidneys may be slender, the length being three times the breadth and the convex and concave borders almost concentrically curved, or they may be short and broad, the vertical diameter being only a little greater than the transverse. More rarely the kidney may appear as an almost elliptical disc. In this case the place of entrance of the vessels is crowded toward the posterior surface. The sagittal diameter (thickness) is generally in inverse ratio to the transverse. The left kidney is usually higher, narrower, and thicker than the right. The vertical diameter of the kidney averages 12 cm., the transverse 6 cm., and the sagittal 3.5 cm. The volume is from 100 to 175 c.c., averaging 135 c.c. (Krause). The weight of a normal kidney varies between 90 and 180 gm., the left being 5 to 7 gm. heavier than the right. The kidneys of males are ordinarily heavier than those of females. The weight of the two kidneys is to the weight of the body as 1 to 240.

The hilus renalis is a longitudinal cleft with anterior and posterior lips, the posterior usually projecting nearer to the median line than the anterior. Between the two lips pass the renal vessels and nerves, the duct, and a quantity of fat-bearing connective tissue. The sinus renalis is flattened in the sagittal diameter, bounded by an anterior and a posterior wall, having circular or elliptical sharp borders. It extends mesially to the hilus and repeats the external contour of the kidney. The sinus contains a mass of adipose tissue in which are embedded the branches of the blood-vessels and excretory duct. It gives attachment to the primary branches (calices) of the duct.

The kidneys are covered on the anterior surface by the peritoneum. The entire organ is enveloped and supported by a capsule of connective tissue containing a larger or smaller amount of adipose tissue. This is known as the capsula adiposa. The fat in this capsule may be so poorly developed that the sheath may be mistaken in operations for peritoneum or fascia, or it may be excessively developed. The organ with its fatty capsule may normally be easily stripped off from the posterior wall, the adipose tissue being but loosely attached. In some cases the attachment becomes impaired, as a result of injury or strain, the kidney is loosened from the abdominal wall, being held in position only by the renal vessels. This gives rise to the phenomenon known as movable kidney, palpable kidney, or floating kidney. This condition is most common in women and can be determined by bimanual palpation. The left hand is placed in the lumbar region behind the eleventh and twelfth ribs, the right hand in the hypochondriac region just under the edge of the liver. In rare cases, the kidney may be surrounded by peritoneum and be held in position by a mesonephron.

The lower edge of the left kidney is usually nearly 5 cm. from the iliac crest, a little below the level of the second lumbar spine; that of the right is generally from 1.25 to 2 cm. lower. The right kidney is covered in front by the descending duodenum and flexura coli dextra, while the liver with its *impressio renalis* often covers a considerable portion of the upper part. In front of the left kidney is a part of the posterior portion of the stomach, and the *flexura coli sinistra.* The external margin of the left kidney is partially covered by the spleen. The adrenals cover the upper extremities of both kidneys, projecting a little over the anterior surface and mesial border.

The kidney is surrounded by three sheaths, an outer fatty sheath, a middle fibrous sheath and an inner muscular layer. The outer sheath, or *capsula adiposa* consists of loose connective tissue, containing an amount of fat which varies with the nutritive conditions of the body. It is loosely connected to the middle sheath, which consists of a thin but firm layer of fibrous tissue, which can be easily peeled off from the healthy kidney, leaving a smooth surface and causing but little hemorrhage when undertaken during a renal operation. This capsule consists of two layers which are easily separated, the outer 0.1 to 0.2 mm. in thickness which fuses in the sinus renalis with the connective-tissue sheaths of the blood-vessels. The inner and thinner layer continues to the point of attachment of the calices. Under this inner layer is a thin layer of smooth muscle fibres, which form a network, whose meshes are about equal in size to the diameter of the larger superficial veins. From this plexus fine processes enter the substance of the kidney.

After the removal of the capsules, the outer surface of the kidney usually appears smooth, reddish-brown in color, and of firm consistency. The color and consistency, however, vary with the blood content. Exceptionally the outer surface is traversed by shallow furrows, the remains of the lobulation of the fœtal kidney, which is distinctly marked in the kidneys of the new-born infant. The inner surface bordering on the sinus renalis is also smooth in the neighborhood of the entrance of the sinus, but presents some transverse furrows on the anterior lip, the impressions of the arteria renalis. The hilum is merely an orifice opening into the cavity of the sinus renalis. This sinus is from 10 to 12 mm. in diameter and from 30 to 35 mm. deep. In the deeper portion of the sinus the surface is uneven, presenting low, pyramidal projections with flat or rounded summits. These are the papillæ renales, of which there are from four to thirteen, generally seven or eight quite uniformly distributed over the anterior and posterior walls. The papillæ may be simple, or several may be fused into a single papilla having a larger base and furrowed sides. The simple papillæ are about 8 mm. in height, the bases having a diameter of 6 to 10 mm. Near the base of each papilla is fused the circular edge of an end branch of the ureter, a so-called renal calyx, so that the papilla forms the base of the calyx, its apex projecting into it. Numerous blood-vessels penetrate the inner surface of the kidney above the neck of the papillæ and thus outside of the calices; these are often arranged concentrically about the base of the papilla.

On section of the kidney through the hilum, the parenchyma is seen to be composed of two essentially different structures, the medulla and the cortex. The medulla consists of a variable number (eight to eighteen) of conical segments called pyramids of Malpighi, the apices of which project into the sinus and are surrounded by the calices, while the bases of the pyramids are turned toward the surface of the kidney and are surrounded by the cortex. The pyramids are smooth and glistening and present, even to the unaided eye, a longitudinal striation, indicating the course of the collecting tubules. The apex or papilla when viewed with a low-power lens presents numerous apertures, the foramina papillaria, through which the secretion escapes into the duct. The cortex may be divided into two portions: a peripheral layer, the cortex proper, which extends in a layer 5–7 mm. in thickness over the entire surface of the kidney between the bases of the Malpighian pyramids and the fibrous capsule, and an interpapillary portion, the columnæ Bertini, dipping down between the Malpighian pyramids to the bottom of the sinus, where they are covered by the fibrous capsule and more or less adipose tissue. The cortical substance is granular, grayish in color, varying however with the blood content, and characterized especially by the occurrence at quite regular intervals of red points visible with the unaided eye; these are the so-called glomeruli, consisting of coils of fine capillaries. At quite regular intervals processes extend from the bases of the Malpighian pyramids toward the outer surface of the kidney. These have the color and the striated appearance of the medullary substance and are known as pyra-

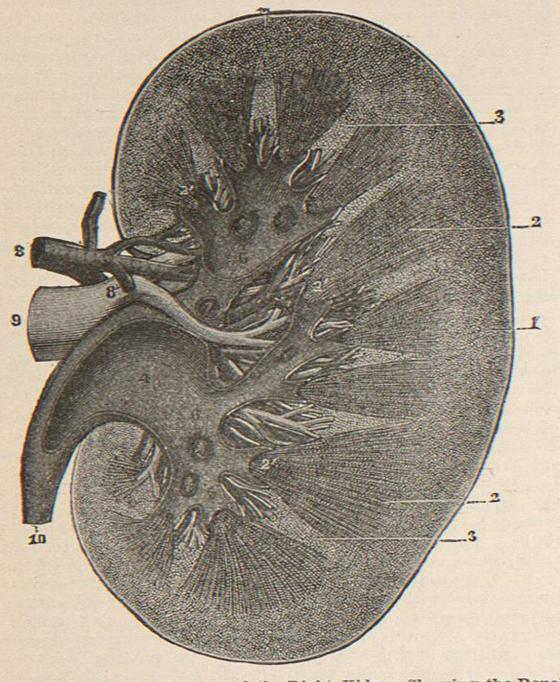

FIG. 3053.—Median Section of the Right Kidney Showing the Renal Pelvis, Papillæ, Calices, with Blood-vessels and Ureter; also the general Structure of Kidney. 1, Cortical substance; 2, pyramids of Malpighi, with two papillæ; 3, columns of Bertini; 4, pelvis; 5, calyx; 6, papillæ situated in a plane anterior to that of the section; 7, section of a calyx receiving the papilla of a pyramid in the segment posterior to the section; 8, renal artery with 8′ its posterior branch; 9, renal vein; 10, ureter. (Testut.)

midal processes or medullary rays or pyramids of Ferrein. Pyramidal processes also extend from one pyramid to another through the cortical substance which separates the pyramids.

The calices open into the expanded pelvis of the kidney, which is continuous with the ureter, the excretory duct of the kidney.

Various anomalies of form and structure of the kidneys have been described. The form of the kidneys, as previously stated, may be markedly different from the typical form described. They may be unequal in size, one being small, while the other is compensatingly large. One kidney may be lacking, the other occupying the normal position on one or the other side. As a very rare anomaly, the occurrence of three kidneys has been reported. In this case, the supernumerary kidney is either lateral or median. Numerous cases have been reported in which the ureter on one or the other side was double. In some cases the two ureters were separate throughout their entire length, opening separately into the bladder, while in other cases the two fused after an independent course varying in length. The position of one or both of the kidneys may be changed; they may encroach upon the iliac fossa, or even enter the pelvis in front of or behind the rectum; or the organ may lie upon the vertebral column or even cross to the opposite loin. The two kidneys may be fused; if only the lower extremities are fused, this phenomenon results in the formation of the horseshoe-shaped kidney, which is usually median in position. In other cases the mass consisting of the fused kidneys is on one or the other side and varies in shape. In the case described by McMurrich, the fused mass occupied the left side, the left kidney being fairly normal in shape, while the right was discoidal in shape and had crossed over and fused with the anterior surface of the left. A ureter arose from each portion of the mass passing downward and opening into the bladder in the normal position. While the anterior surface showed the line of demarcation between the two kidneys, the posterior surface was smooth and showed no indication of a separation. Only twenty-eight similar cases have been recorded. The variations in motility, with the phenomena of palpable and movable kidney, have already been mentioned.

On microscopic examination the kidney is seen to be composed of numerous twisted and convoluted tubules known as the uriniferous tubules. Each tubule begins in the cortex of the kidney between the medullary rays in an enlarged, expanded, cup-shaped portion called the capsule of Bowman, which surrounds the glomerulus, the two together bearing the name of the Malpighian corpuscle. The capsule of Bowman opens through a narrow neck into a larger convoluted portion, called the proximal convoluted tubule. After describing many tortuous windings, the tubule passes in the form of a straight, slender tubule toward the sinus. After going a variable distance into the medullary substance it turns sharply, describing a loop and returns into the cortex in a larger straight tubule running parallel to the descending limb of the loop. The small descending limb, the loop, and the larger ascending limb have collectively received the name of the loop of Henle. The tubule then becomes somewhat larger and somewhat twisted (the distal convoluted tubule or the intercalated portion) and then passes into the arched collecting tubule. This changes into the straight collecting tubule, many of which unite as they pass downward into the medullary pyramid to form the large collecting tubules or tubes of Bellini. The capsules, the neck, the proximal and distal convoluted portions of the uriniferous tubules and the arched collecting tubules are found in the cortex between the medullary rays. The medullary rays are formed by the cortical portions of the collecting tubules and a portion of the ascending limbs of the loops of Henle. The medulla is made up mainly of straight collecting tubules of various sizes and of the descending limbs and loops of Henle's loops, the latter being often found in the boundary zone between cortex and medulla. The different portions of the tubules vary markedly in size, the Malpighian corpuscle measuring 120 to 220 μ in diameter, the proximal convoluted tubule from 40 to 70 μ in diameter, while the loops of Henle present tubules having a diameter of 9 to 15 μ in the descending limb and 23 to 28 μ in the ascending limb. The distal convoluted portion is from 39 to 45 μ in diameter, while the collecting tubules vary from 45 to 75 μ in diameter. The tubes of Bellini unite in the Malpighian pyramids to form about twenty papillary ducts from 200 to 300 μ in diameter which empty into the pelvis of the kidney through the foramina papillaria.

The character of the epithelium lining the uriniferous tubules in the different portions varies markedly and has been subjected to most careful histological investigation. The epithelium of the capsule of Bowman, which forms a double-walled membrane around the glomerulus, leaving a cleft-like space which forms the beginning of the uriniferous tubule and communicates with the lumen of the proximal convoluted tubule, is simple squamous in type. The glomerular epithelium is very flat, with nuclei projecting slightly into the lumen, while that lining the outer wall of the capsule is somewhat higher, but still distinctly squamous in type. The flattened epithelium of the capsule changes gradually into cubical epithelium of the neck and that into short and rather irregular columnar epithelium of the proximal convoluted tubules. These cells show a basal striation and often a cuticular border, and, as the investigations of Nussbaum

and Heidenhain seemed to show that they were especially concerned in the process of secretion in the kidney, these cells have been subjected to most searching study, with the view of determining the structure of the cells and the changes of structure during the process of secretion. Henle showed that the epithelium of this portion of the uriniferous tubule is characterized by a dark, granular appearance of the protoplasm, while Krause mentions the basal striation of these cells. A zone of short stiff cilia was demonstrated in certain renal cells of amphibia and fishes by Nussbaum, the observation being extended to mammalia, including man, by Cornil, Tornier, Klein, and others. This zone is characterized by Tornier as the *Bürstensaum*. Since this zone was not always found and when present was always connected with a certain thickness of epithelium found in different kidneys and different areas of the same kidney, the conclusion was drawn that the cells undergo uniform histological changes during the processes of secretion. Van der Stricht says that the resting cell presents a homogeneous cuticular zone, below which is a close-meshed protoplasmic network, which shows a parallel arrangement of its fibrils in the peripheral portion of the cell, producing the "rod structure" of Heidenhain. When the secretion begins, clear droplets of secretion form, especially in the neighborhood of the nucleus, which press toward the free surface, fill the formerly homogeneous cuticular zone and break it up into the "Bürstensaum." In a later work, Van der Stricht describes four types of cells in the convoluted tubules: (1) Cells like those above described, which he regards as resting cells; (2) cells with the Bürstensaum, in the protoplasmic network of which the secretion is in the form of fine droplets, especially toward the lumen; (3) cells without a cuticular border also filled with the secretion; (4) granular cells with distinct rod structure in the peripheral portion of the cell, while the central portion is changed into a clear mass filled with granules. Such cells are also found in the ascending limb of Henle's loop together with cells which have a distinct cuticular border. Van der Stricht also describes in the glomerular epithelium during the process of secretion the collection of clear droplets with processes in the protoplasm of the cells. Disse, working on fresh, well-fixed human tissue, distinguished four forms of tubules: (1) Tubules with wide lumen and low, quite uniformly granular epithelial cells in which cell contour and rod structure cannot be distinguished. The free surface shows the Bürstensaum distinctly developed, formed of stiff hairs provided with nodular thickenings at their bases. (2) Tubules with narrow cylindrical lumen and spherical epithelium. The protoplasm is still generally uniform, but in some cells clearer parts begin to be seen giving the cell a spotted appearance. The Bürstensaum is wanting. (3) Tubules with narrow, irregularly star-shaped lumen and tall cells. In these, two portions are distinguished, a central clear part containing the nucleus, and a darker basal portion in which rows of fine granules begin to produce the picture of the "rod structure." No Bürstensaum is seen in these cells. (4) Tubules entirely filled by the tall epithelial cells, which show a distinct differentiation of the central and basal portions. The nucleus in the central portion of the cell is very bright and clear and resembles a vesicle filled with clear fluid. Rod structure is very distinct in the basal portion of these cells, but no Bürstensaum is to be seen. Sauer, however, states that the secretory portions of the uriniferous tubules have the same type of epithelium, while the lumina naturally are subject to great variation. The striation of Heidenhain and the peculiar terminations of Tornier were found by him in all phases of secretion, being finer or coarser according to the height of the cells. Hence he concludes that these peculiarities of structure have nothing to do with the processes of secretion, but are permanent structural appearances. The nucleus seems not to suffer any changes of structure during secretion, although changes of position have been observed. It ascends toward the free surface of the cell with the secretion, returning toward the basal portion of the resting cell. Disse concludes that, as signs of proliferation are never seen in these cells in the adult, the cells do not degenerate after secretion. Rothstein describes an irregular branching and interlocking of the processes of the cells of the convoluted tubules in the dog and rabbit, giving to these cells a peculiar frayed-out appearance similar to that described for these cells in the guinea-pig as mentioned in the text-book of Böhm, Davidoff, and Huber. Landauer investigated these cells in many species of vertebrates and also in man and concluded that the convoluted tubules and the ascending limb of Henle's loop are lined by cells which are sharply outlined and provided with longitudinal folds, which interlock, and it is these folds that give these cells the striated appearance (rod structure of the authors). Zimmermann describes in detail the epithelium lining the different portions of the uriniferous tubules, especially emphasizing the presence and relations of the "Centralkörper or Centralgeissel" in these cells. He also distinguishes the darker cells showing striation and brush-like border and cells which are large and clear, the structure of which is quite indistinct. He describes fine densely placed fibres

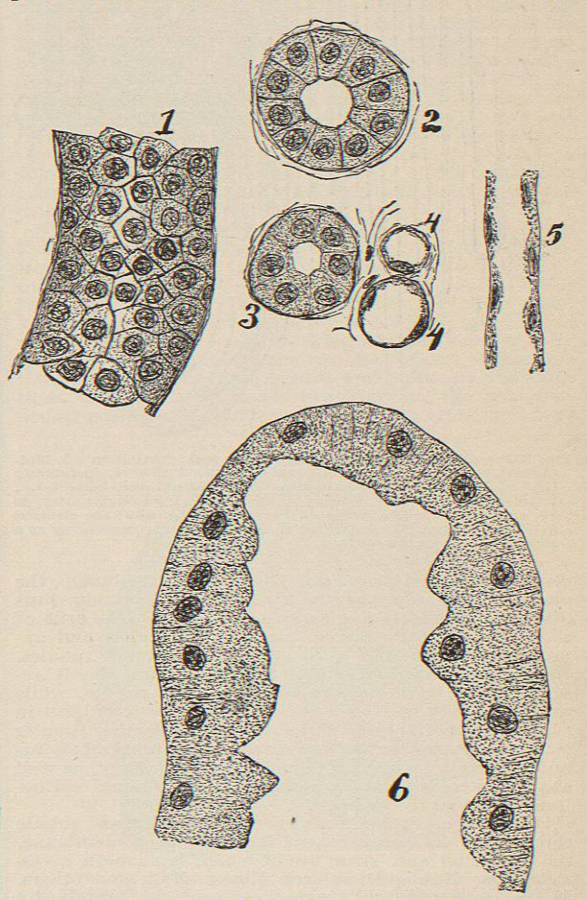

FIG. 3054.—Epithelium of Kidney. 1, Collecting tube viewed in longitudinal section; 2, transverse section of collecting tube; 3, ascending limb of Henle's loop; 4, descending or narrow limb of Henle's loop; 5, longitudinal section of descending limb; 6, convoluted tube.

staining black in the iron-lake hæmatoxylin, which run circularly around the tubuli contorti between the bases of the cells and the basement membrane. He was unable to decide, however, whether these were special kinds of fibres, or cell processes or basal lines of cement substance. The descending limb of Henle's loop is lined by flattened

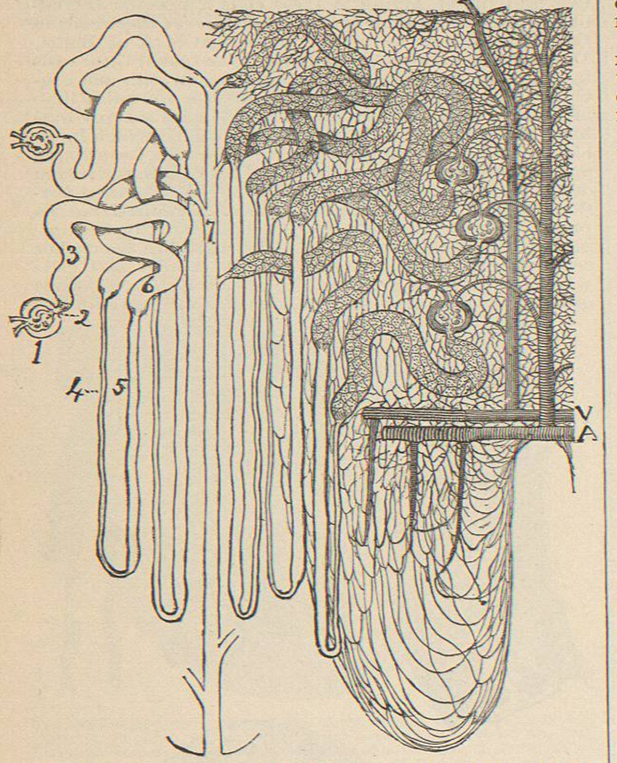

FIG. 3055.—Diagram of the Renal Tubes and Circulation. 1, Malpighian body; 2, neck; 3, proximal convoluted tube; 4, descending limb of Henle's loop; 5, ascending limb; 6, distal convoluted tube; 7, collecting tube; A, artery; V, vein. An intralobular artery is shown ascending and giving off branches to the tufts; the straight arteries descend; the intralobular vein is shown commencing as a stellate plexus on the surface.

cells, with nuclei projecting slightly into the lumen, the nuclear projections of the two sides alternating, thus giving to the section a wavy appearance. The cells of the loop and of the ascending limb are higher and approach the columnar type of the convoluted tubules. In the intercalated portion, the epithelium closely resembles that in the proximal convoluted tubule, while the lining of the arched collecting tubule is cubical in type. The epithelium of the straight collecting tubules is low columnar at first, increasing in height as the tubules increase in size. The pelvis of the kidney, as well as the ureter, is lined by a stratified transitional epithelium, like that in the bladder.

Under the epithelium of the uriniferous tubule throughout its entire extent is a basement membrane, the character and structure of which have been investigated by Rühle, Disse, von Ebner, Mall, and others. Mall's investigations were carried on largely by pancreatic digestion and subsequent staining in acid fuchsin and picric acid. As a result of this work, the framework of the kidney was shown to consist of white fibrous connective tissue and reticulum, Mall and Rühle describing "baskets" of reticular fibrils as surrounding the tubules and forming the basement membranes. Disse and von Ebner, however, refer the fibrillar appearance to the methods of preparation, and Mall, in his latest work on these membranes, demonstrates clearly within the "basket" of connective-tissue fibrils previously described, a homogeneous membrane which was destroyed by pancreatic digestion and which is chemically different from the reticular tissue and also from both white fibrous and yellow elastic connective tissue.

Between the tubules is found a small amount of connective tissue, which is more abundant around the blood-vessels and Malpighian corpuscles, near the junction of cortex and medulla and between the collecting tubules in the apices of the Malpighian pyramids.

Blood Supply of the Kidney.—The kidney receives a very rich blood supply, and the arrangement and distri-

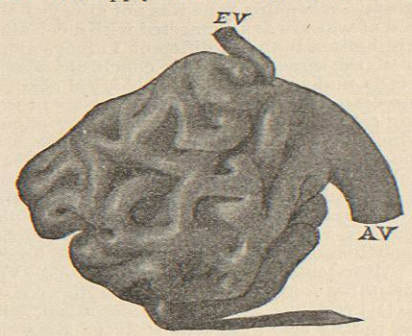

FIG. 3056.—Wax Model of Glomerulus of Human Kidney. Enlarged 444 diameters, seen in profile from the left side. *AV*, Afferent vessel; *E V*, efferent vessel.

bution of its blood-vessels are of the utmost importance both from a physiological and from a surgical point of view. The main arterial supply is from the renal artery, a branch of the abdominal aorta. Collateral branches, however, reach the surface of the kidney through the capsule, arising from the suprarenal, spermatic, lumbar, and other arteries.

The renal artery divides at the hilum into anterior and posterior branches, which redivide and pass through the columns of Bertini between the pyramids of Malpighi to the border of cortex and medulla. Here the branches unite to form an arch known as the arcus arteriosus. From the convex border of this arch, ascending or intralobular arteries arise to supply the glomeruli and also to pass through the cortex and supply the capsules of the kidney. From the concave border, branches known as the vasa recta pass down into the medulla, between

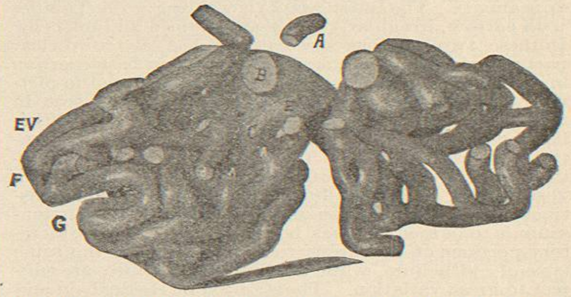

FIG. 3057.—Wax Model of Glomerulus. Same enlargement and view as Fig. 3056. The left lateral group of capillaries is separated from the median group and turned back, exposing the interior of the glomerulus, *A*. A short section of a capillary of the median group is removed to show the course of the deeper lying capillaries. (Johnston.)

the straight collecting tubes of the pyramids, breaking up into capillaries around these tubes. The intralobular arteries in the cortex send branches to the glomeruli, the arteriæ glomeruliferæ, the afferent vessels entering

the glomerulus and dividing into several branches, which redivide and break up into a network of anastomosing capillaries, as described by Johnston. This arrangement is shown diagrammatically in Fig. 3058 and more exactly

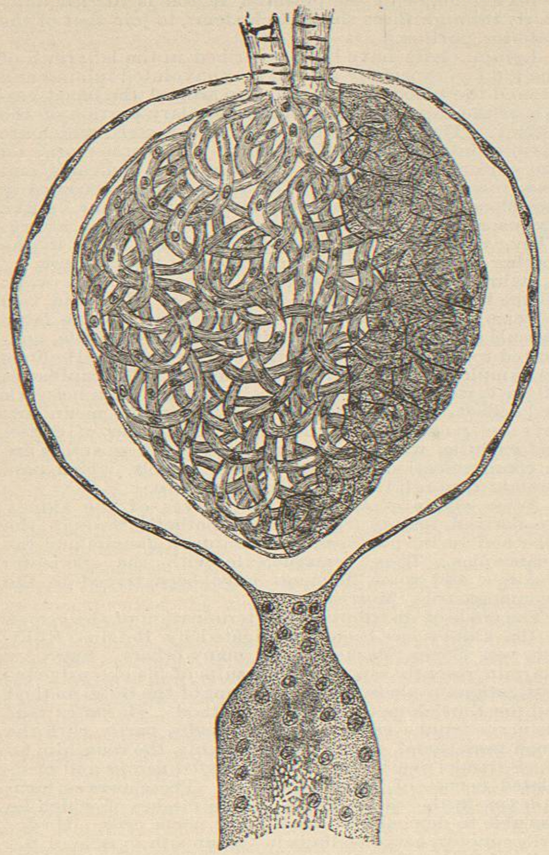

FIG. 3058.—Diagram of a Malpighian Body Showing the Afferent and Efferent Vessels above, with the Tuft. The reflection of the cells of Bowman's capsule over the vessels is shown on the left; on the right, the cells are shown in the flat; the neck and part of a convoluted tube are shown below. The space between the tuft and the capsule is drawn wider than normal.

in Figs. 3056, 3056, representing Johnston's models of the human glomerulus. He describes a network of reticular tissue arising from the membranes surrounding the glomerulus and forming the framework of the glomerulus in the meshes of which are found the capillaries and fine branches of the afferent artery. The blood collects into small branches which unite to form the efferent artery, which runs for a variable distance and finally breaks up into a second system of capillaries around the convoluted tubules. The intralobular vessels open into the glomeruli only after forming an arch, so that the blood passing through the glomeruli is already on its way to the medulla, and the secretion is directed, not toward the periphery, but toward the medulla and the apex of the pyramid (Zondek). Virchow thinks that this arrangement prevents the tearing of the glomeruli which might result if the blood entered them directly under the strong pressure from the aorta.

In addition to the *rete mirabile* in the glomerulus, other retia mirabilia are formed in the course of the intralobular arteries, differing from those in the glomeruli by the fact that the branches are much larger than capillaries. Some of the ascending arteries arise from the larger vessels in the columns of Bertini, before the formation of the arch; a few of the branches of the intralobular arteries do not pass to the glomeruli, but break up directly into capillary plexuses, rarely around the convoluted tubules, but more frequently in the fatty capsule. These are known as perforating arteries. In addition to the arteries arising from the renal artery in the hilum, branches from the suprarenal, lumbar, etc., penetrate the capsule and form glomeruli of their own in the peripheral portion of the cortex. These may not only assist in establishing the collateral circulation, but also may act as a partial functional substitute in case of injury to the renal arterial system. Golubew, Hoyer, and Geberg assert that between the arteries and veins of the kidney, in the cortical substance, in the columns of Bertini, and at the bases of the Malpighian pyramids, direct anastomoses exist by means of precapillary twigs.

From the capillaries, the venous blood is collected into the intralobular veins, which have an arrangement similar to that of the intralobular arteries. The venous blood of the capillaries in the labyrinth is also collected into the intralobular veins, so that at the surface of the kidney, the flowing together of these different systems of veins results in the formation of peculiar star-like figures, known as the venæ stellatæ or stars of Verheyen. The intralobular veins empty into the venous arches, which correspond in position to the arterial arches and from which the blood is carried by means of larger veins through the columns of Bertini and through the hilum side by side with the larger arteries. Venæ rectæ also collect the blood from the medulla and empty into the concave side of the venous arch.

The terminal branches of the intrinsic arteries of the kidney have recently been investigated by Zondek to determine whether the vascular supply of cortex and medulla was common or separate and by Broedel and Keiller to determine the relation of the branches in the pelvis and kidney, with especial reference to their significance in nephrectomy. Although working independently and by quite different methods, the two last-named writers arrived at nearly the same results and at nearly the same time. Broedel used, in his investigation, the Schiefferdecker corrosion method, combined with injection of the

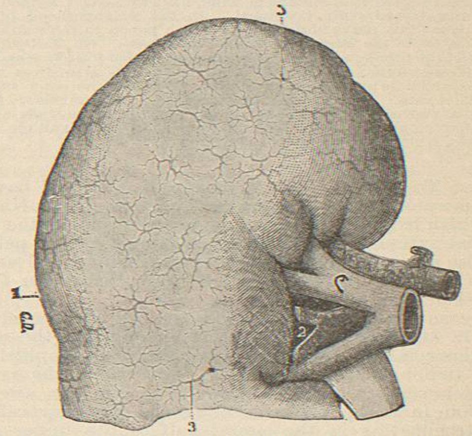

FIG. 3059.—The Venous Stars of Verheyen, seen on the Anterior Face of the Right Kidney. (Testut.) 1, External border of the kidney; 2, hilum with the renal vessels; 3, venæ stellatæ.

arteries, of the veins and pelvis, and finally triple injection of arteries, veins, and pelvis. He divides the renal pelves into true pelves, in which all the calices, major and minor, open into a common pelvis, and divided pelves, in which there is no free communication between all the calices of the kidney. He states: "The renal artery divides at the hilum, as a rule, into four or five branches,