Three branches proceed from the anterior border of the ganglion: the ophthalmic, the superior maxillary, and the inferior maxillary. They leave the skull through the sphenoidal fissure, the foramen rotundum, and the foramen ovale respectively. All three branches are nerves of sensation; the inferior maxillary is in addition a nerve of motion since it receives the motor root of the fifth nerve as stated above. It supplies with motor fibres the masseter, deep temporal, buccal, and internal and external pterygoid muscles.

The distribution of the sensory branches of the ganglion is as follows: The ophthalmic branch supplies the eyeball, the lachrymal gland, the conjunctival mucous membrane and that of the nasal fossa, and the integument and muscles of the eyebrow, forehead, and nose. The superior maxillary supplies the integument of the temple and part of the cheek, and the gums and teeth of the upper jaw. The inferior maxillary supplies the integument of the temple, external ear, lower part of the face, and lower lip, the teeth and gums of the lower jaw, and a part of the tongue. It also has a motor function as above mentioned.

The Gasserian ganglion has been of anatomical importance ever since its nature was recognized by Hirsch in 1765. The very great surgical interest which is now felt in this structure, and which is less than ten years old, is due to three facts. The fifth or trigeminal nerve is affected in neuralgia more often than any other nerve. The attacks of pain recur after operations upon the three divisions of the nerve, whether the operation be a simple nerve-stretching, or a division of the nerve, or a resection of a portion of the nerve, or a tearing out of as much of the affected nerve as possible, as advised by Thiersch. The removal of the Gasserian ganglion, first performed by Rose in 1890, affords the patient permanent relief from his neuralgia. It seems like a wanton act to open the skull, burrow in at the base of the brain, and tear out this great ganglion, but desperate conditions demand desperate remedies. Rose removed the superior maxilla and trephined the skull, putting the pin of the trephine in the foramen ovale. His patient recovered with the subsequent loss of an eye, and counted herself happy to be free from the neuralgia even at that price.

Other surgeons soon improved the technique of the operation. Hartley in America, and Krause in Germany, working independently, showed that the skull can be opened, and the ganglion removed by turning downward a flap of skin and bone from the temporal region. In a recent article upon this subject, Krause thus details the steps of the operation as performed by himself:

The patient is in a half-reclining position, with the head held exactly forward or turned a little toward the affected side, so that the blood may flow from the wound. Chloroform is used, if the patient's condition permits. Only dry sponges are employed. A flap of skin, fascia, muscle, periosteum, and bone is cut from the temporal region, and reflected downward. The base of this flap is about 1.5 inches wide and overlies the zygomatic process. Its height is 2.5 inches, and its greatest breadth is 2 inches. The dura mater is not opened. When all bleeding has been stopped by compression and ligature, and the flap, wrapped with gauze, has been reflected downward on the cheek, well out of the way, the dura is separated from the skull down to the bottom of the middle fossa, and the middle meningeal artery is exposed and ligated in two places and then divided. There is usually considerable venous hemorrhage due to the separation of the dura from the base of the skull. This can be controlled by pressure. The next step in the operation is the lifting up of the brain by means of a long retractor, and the dissection of the second and third branches of the fifth nerve from their origin in the Gasserian ganglion to their exit from the skull through the foramen rotundum and the foramen ovale. Then the ganglion itself is freed, at least above and below and backward, until the fifth nerve comes into view. The first division of the fifth nerve, the ophthalmic nerve, is then cut off close to the ganglion, no attempt being made to dissect it free, on account of the danger of injury to the third and fourth cranial nerves, which are intimately associated with it. As these nerves supply the muscles of the eye their injury would be a serious calamity. The fifth nerve is next seized with a pair of clamps close behind the Gasserian ganglion. The second and third divisions are cut off close to their foramina of exit. The ganglion and as much of the root of the fifth nerve as can be twisted out with it, is torn from the brain. The stumps of the second and third divisions are pushed outward through the foramina so as to prevent any union of divided nerve fibres. Inspection of the cavity occupied by the ganglion should prove to the operator that the removal has been a complete one. All bleeding is then to be controlled, and the flap of bone and soft parts replaced. The operation lasts usually from one and one-half to three hours. In a favorable case the patient can get up in one or two weeks and be discharged from the hospital in three weeks.

The two chief dangers of the operation are hemorrhage and prolonged pressure of the brain. The mortality of the operation is variously reckoned at from ten to twenty per cent. The patient awakes from his narcosis absolutely free from neuralgia. This is in striking contrast to the recovery after operations upon the peripheral nerves, since after these operations the attacks of pain recur for a few days in gradually diminishing intensity.

So far as is known removal of the Gasserian ganglion invariably gives permanent relief from the neuralgic attacks, although as the operation has been performed only in the last few years, one must not speak too positively. The numbness and partial paralysis of the muscles of mastication of the side operated upon are a small price to pay for relief from the fearful attacks of pain which these patients have been compelled to endure.

Edward Milton Foote.

GASTEIN.—A picturesque valley in the Duchy of Salzburg, Austria, famous for its mineral springs. It is an arm of the Salzbach Valley, and is about twenty-five miles long by a little more than a mile wide. Its sides are formed by two ranges of mountains which extend to the right and left from the two peaks, Nassfeld-Tauern, 7,820 feet high, and the Ankogel, of 10,700 feet. The situation is romantic, near the region of the glaciers, and at an elevation of about 3,000 feet. In the midst of the valley flows the dashing little river Ache, which forms two beautiful waterfalls near the village of Wildbad-Gastein, now the principal resort. The climate is mild and uniform, the variations in temperature being slight. It is claimed that the thermometer has never risen above 86° F. in summer and seldom above 70°. The barometric changes are also slight, averaging 29.50 inches pressure for the year. Rainy days are, however, rather numerous in the summer.

The thermal springs are eighteen or twenty in number, and are said to have been known as early as the seventh century. Many of them are designated by such names as the Fürstenquelle, the Hauptquelle, the Doctor's-Quelle, and the Spitalquelle. Seven of the springs issue from the solid granite rock or from artificial clefts; the others flow from stratified beds of feldspar, gneiss, and mica. Their deep origin is probably in the heart of the great Ankogel. The temperature of the springs ranges from 87° to 160° F., with but slight variation at any season. The waters are rich in the variety of their mineral salts, but they are very dilute. Of sodium sulphate, the most abundant ingredient, there is but 1.51 grains in a pint, while of calcium carbonate and sodium chloride, the next most abundant ingredients, there is only 0.36 grain each. Oxygen is found in 30.89 per cent. and nitrogen in 69.11 per cent.

The waters are employed almost entirely for bathing, for which purpose many public and private institutions have been erected. Their fame is said to have originated from the cure of Duke Frederick, of Austria, in 1436. Much of the efficacy attributed to them belongs no doubt to the bracing mountain atmosphere.

The baths are recommended chiefly for nervous disorders, especially in cases not amenable to more vigorous treatment. Their beneficial effects in senile marasmus have given them the name of "baths of the aged." Hysteria, hypochondriasis, spinal irritation, impotence, tabes dorsalis, paralysis, neuralgia, rheumatism, disorders of nutrition or of the blood-making functions, as well as pelvic exudations and wasting diseases, are in the category of especial indications. Gastein is also recommended as an after-treatment to a course at Carlsbad, Marienbad, and other springs. *James M. French.*

GASTRECTOMY, ETC. See *Stomach, Surgery of the.*

GASTRIC JUICE.—Nothing was known about the gastric juice until the middle of the last century. By some physiologists gastric digestion was supposed to be merely a mechanical process, the food being triturated by the contraction of the muscular walls of the stomach, as had been observed in the gizzards of fowls. By others the food was supposed to be reduced to a fluid state by maceration under the influence of the warmth of the stomach. By still others the vague and indefinite term fermentation was used to describe the unknown process going on within the stomach. Réaumur (1752) demonstrated satisfactorily by his experiments on a tame buzzard that meat was dissolved in the stomach under the influence of an acid fluid possessing antiseptic qualities. Stevens (1777) came to essentially the same conclusions by experimenting on a human being who possessed the power of regurgitation; and he was the first to carry on digestion outside the body by means of the gastric juice of a dog. Spallanzani (1777–83) deserves credit for having established beyond reasonable doubt that digestion is performed by a fluid in the stomach, and to this fluid, whose acidity and antiseptic properties he likewise recognized, he gave the name gastric juice. At the beginning of the present century this view was accepted and taught by nearly all physiologists.

The next great addition to our knowledge was made by Beaumont (1833), and his contribution may justly be called the most important one ever made to the science of gastric digestion. His observations were made upon a Canadian, Alexis St. Martin, in whom a permanent gastric fistula remained after a gunshot wound. As a result of these observations he described the gastric juice "as a clear, transparent fluid, inodorous, a little saltish, and very perceptibly acid. Its taste when applied to the tongue is similar to thin mucilaginous water slightly acidulated with muriatic acid." He further described it as powerfully antiseptic, and an effectual solvent of food.

In the winter of 1832–33 he submitted a sample of gastric juice contaminated with a little mucus to Professor Dunglison for examination. Dr. Dunglison reported that, in collaboration with Professor Emmet of the Virginia University, he had found the gastric juice to contain "free muriatic and acetic acid, phosphates and muriates, with bases of potassa, soda, magnesia, and lime, and an animal matter soluble in cold water, but insoluble in hot." He expressed astonishment at the large amount of free muriatic acid present.

Prout in 1824 had already declared that the acidity of the gastric juice was due to free hydrochloric acid.

In 1836 Schwann concluded that the digestive power of the gastric juice was due to some unknown active principle which he called pepsin, though he could not isolate it as a distinct chemical substance. This was done by Wassmann (1839) who prepared an impure pepsin as a yellowish powder soluble in water.

Lab ferment was discovered and isolated (also in an impure state) by Hammarsten in 1872.

During the past two decades experiments on animals and direct observations of the gastric juice of man, by means of gastric fistulæ and the stomach tube, have enabled us to gain more accurate information concerning the physical and chemical properties of gastric juice. It is probable that the chemical composition of the gastric juice varies somewhat under different conditions, and that the secretion adapts itself in a measure to the physiological task to be performed. The gastric juice secreted reflexly as a result of the *sight* or *smell* of savory food seems to differ slightly from that secreted after the *ingestion* of food; and it is probable that different foods call forth variations in the chemical composition of the secreted fluid. Beaumont had noticed that the gastric juice was by no means always the same. He noted that exercise leading to perspiration increased the secretion from the gastric cavity; that the fluid poured out under these conditions was only slightly acid, and that it had inferior solvent properties. The ingestion of alcohol in strong solution is known to cause a transudation from the gastric mucosa, the resulting fluid having but little resemblance to gastric juice. Our knowledge, however, of these physiological and pathological variations from the normal is as yet very fragmentary. The quantity of gastric juice secreted in twenty-four hours has never been even approximately determined and estimates range from 180 gm. to 6.5 kgm. The gastric contents as usually removed are made up of food, swallowed saliva, mucus, and gastric juice. As this mixture is being propelled constantly in small quantities into the duodenum throughout the whole process of digestion, any estimate of the total quantity of gastric juice must be subject to very great inaccuracies and no reliable data are at hand.

Human gastric juice contains about five per cent. of solids. Its specific gravity varies from 1.001 to 1.010; the average in the human being is between 1.002 and 1.003.

The mineral salts are chiefly the chlorides of sodium, potassium, and calcium, and the phosphates of magnesium, calcium, and iron. Together they constitute only two per cent. of the gastric juice.

The gastric juice is not rendered turbid by boiling, and is lævo-rotatory. It contains a trace of proteid (probably a peptone) and some mucin. Lactic acid, which until recently was considered a component part of normal gastric juice, is not present in the pure secretion, but occurs as a result of the fermentation of ingested carbohydrates. The active elements of the gastric juice are hydrochloric acid, pepsin, and lab ferment.

Neither the pepsin nor the lab ferment has ever been isolated in a chemically pure state.

Hammarsten separated lab ferment (rennin) from pepsin by fractional precipitation with lead acetate. Gamgee has summarized the qualities of an approximately pure solution of rennin as follows: It is not coagulated by heat; it is not precipitated by alcohol, nitric acid, tannin, iodine, nor by sugar of lead, but by basic lead acetate.

Lab ferment is not diffusible. It is destroyed by 0.5 to 1 per cent. Na_2CO_3.

Its chief characteristic is its power to clot solutions of casein. This it accomplishes by splitting up the casein into two forms of proteid, one of which remains in solution, while the other coagulates in the presence of lime salts.

Pepsin is probably not a proteid. It is soluble in water and glycerin. It is non-diffusible. In the presence of free mineral acid (especially hydrochloric) it has the property of changing albumin into peptone. It is rendered inert by alkalies.

The hydrochloric acid in the gastric juice exists partly in the free state and partly combined with some of the organic and inorganic constituents of the juice. In man the free acid constitutes from 1 to 2 pro mille of the pure gastric juice. In dogs the acidity is higher; in herbivorous animals it is less. When food is ingested the gastric mucous membrane secretes hydrochloric acid until the chemical affinity of the food for hydrochloric is satisfied, and then it continues to secrete acid until the amount of free acid present has reached a certain norm for that individual, usually 0.12 to 0.18 per cent. After the norm has been reached the secretion of acid comes to a standstill, and by this reflex mechanism the overproduction of hydrochloric acid is prevented in the healthy stomach. *Henry Wald Bettmann.*

GASTRULA.—(Dim. of L. *gaster* from the Greek γαστήρ, belly, stomach.) The *gastrula* is a stage in the embryonic development of at least one representative of nearly every great group of animals above the Protozoa. Moreover,

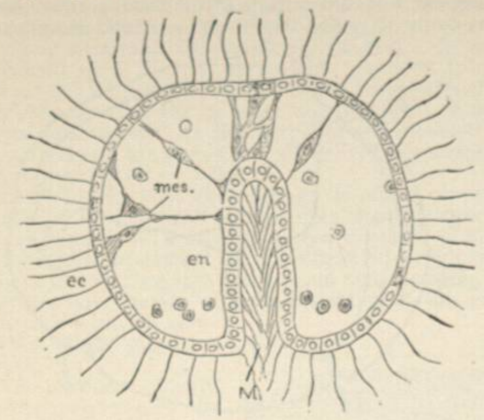

FIG. 2268.—Section of a Gastrula of a Sea-Urchin, *Toxopneustes lividus.* (After Selenka.) Highly magnified. *ec*, Ectoderm; *en*, endoderm; *mes*, mesoderm; *M*, blastopore.

those forms which do not possess a typical gastrula stage are found on careful examination to exhibit, with few exceptions, structures or modes of development which may be interpreted as vestiges of this stage.

In holoblastic eggs with equal cleavage (see article *Segmentation of the Ovum*) the cleavage results in the formation of a typical *blastula*. This is a rounded body composed of cells, the *blastomeres*, forming a continuous membrane, the *blastoderm*, which encloses a cavity, the *blastocœl*.

The next stage is the *gastrula*, which is formed from the blastula usually by the invagination of its wall on one side. By this process the blastoderm becomes differentiated into the two primary germ layers. The part which remains on the outside is the *ectoderm*, and the part which is invaginated is the *endoderm*. (See *Germ Layers.*) In most animals the cells of the blastula are not all alike, those on one side, the animal pole, being smaller and containing less deutoplasm (yolk granules) than those on the other side, the vegetative pole, which are in many cases very large and heavily laden with deutoplasm. When such differentiation obtains it is always the cells of the vegetative pole that are invaginated to form the endoderm.

The nearly typical gastrula of a sea-urchin is represented in longitudinal section in Fig. 2268. This embryo contains two cavities,—one a closed cavity, the blastocœl, lying between the ectoderm (*ec*) and the endoderm (*en*), and the other, the primitive stomach, or *archenteron*, a cavity entirely surrounded by endoderm, except at one side, where it opens to the exterior by the primitive mouth, or *blastopore* (*M*). At the lips of the blastopore the ectoderm and endoderm are continuous. This embryo is not quite a typical gastrula on account of the presence in the blastocœl of mesenchyme cells (*mes*), which in most animals appear at a somewhat later stage.

Gastrulas of this same general type are to be met with in the sponges, cœlenterates, echinoderms, nemertians, annelids (Eupomatus), sipunculids, chætognaths, crustacea (Lucifer), mollusks, and chordata (tunicates and Amphioxus).

Of these various forms, the one of most interest to us is the gastrula of Amphioxus. If one were to draw a diagram to show the essential structures of a vertebrate reduced to their simplest forms, the drawing with slight alterations could be made to represent an amphioxus. This is a little fish-like animal an inch or two in length, that lives in the sand in shallow arms of the sea in various parts of the world. It is found in the Chesapeake Bay, in the lagoons of the Bahamas, and the writer has gathered hundreds of specimens on the sand flats by the railroad wharf at Port Tampa, Florida. The Amphioxus, having little more than a notochord by way of skeleton, has left no fossil remains, but its habitat is exactly similar to that in which countless generations of Lingula have dwelt with practically no change of structure, so far as we can see, since lower Silurian times. So it is not impossible that we may be right if we infer from its structure that Amphioxus is also of a very ancient type, and is a living representative of our ancestors, that lived before the appearance of the earliest fishes. For this reason the embryology of this form is of special interest. This proves to be just as diagrammatically primitive as the structure and confirms our inference from comparative anatomy.

The gastrula of Amphioxus (Fig. 2269) is a typical one of the *embolic* type. That is, the archenteron is formed, as in the sea-urchin, by the invagination of the endoderm. This is contrasted with the *epibolic* type of gastrula in which, owing to the large size of the slowly dividing endodermal cells, heavily laden with yolk, an invagination is impossible, and the smaller and more active ectodermal cells form the gastrula by growing over and around the large and less active endodermal cells. These types of gastrula grade into one another, so that in some cases it is difficult to tell to which type the gastrula belongs.

Fig. 2269 represents a vertical longitudinal section of a gastrula of Amphioxus. The archenteron is large and the endoderm is so closely pressed against the ectoderm that the blastocœl is obliterated except in a small space near each lip of the blastopore, which at this stage is widely open. The development of the gastrula of this species is represented in Fig. 2270.

The eggs of Amphioxus are laid, according to Wilson, as a rule, between five and six in the afternoon. Cleavage results in the formation of a globular blastula; and about midnight, according to Morgan, gastrulation begins by the flattening of one side of the blastula. This side may be distinguished from the other by the presence of larger cells more completely filled with yolk granules.

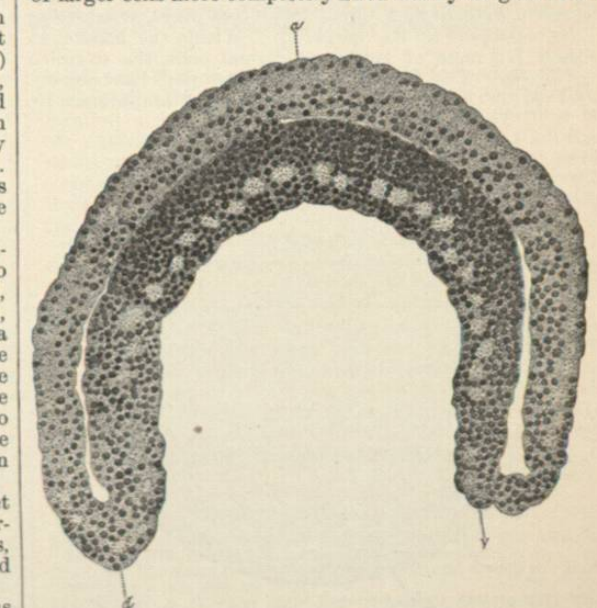

FIG. 2269.—Sagittal Section of a Gastrula of Amphioxus at 4 A.M. *a*, Anterior pole; *d*, dorsal lip of the blastopore; *v*, ventral lip. Reduced from camera drawing made with Zeiss 4, oil immersion 2 mm. (After Morgan and Hazen.)

About two hours later the flattened side has pushed inward until the endoderm nearly touches the ectoderm and the embryo has become saucer-shaped (Fig. 2270, *a*).

From this time on there is a gradual closing of the blastopore accompanied by the growth of its lips, until, when the blastopore is nearly closed, the embryo has the shape of a football (Fig. 2270, *d*), the small opening being a slight distance from the posterior end of the long axis of the embryo and on the dorsal side of it. The end of the gastrula stage is marked by the closure of the blastopore from direct communication with the exterior. But for a long time the inner part of it forms a passageway from the archenteron into the developing neural tube, it is then called the *neurenteric* canal.

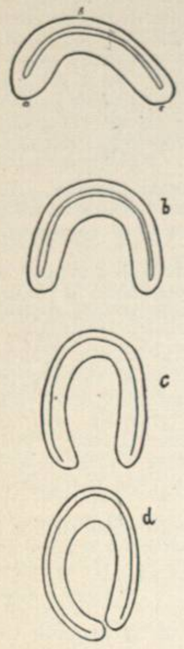

FIG. 2270.—Four Stages in the Development of the Gastrula and Closure of Blastopore of Amphioxus. Sagittal sections. *a*, Ventral lip of blastopore: *b*, anterior pole: *c*, dorsal lip. (After Morgan and Hazen.)

The simplest form of gastrula to be found in the true vertebrates is of the type observed in the cyclostomes, ganoids (Fig. 2271), and amphibians (Figs. 2272 and 2273). In the eggs of these forms the cleavage is always unequal and may be holoblastic as in the frog or meroblastic as in the gar-pike. In either case it results in the formation of a blastula in which the blastocœl is excentric, lying near the upper pole. In either case the roof of the blastocœl is composed of one or more layers of small cells, while its floor is composed of large cells or imperfectly divided yolk. The formation of the gastrula begins by the development of a slight groove on one side near the edge of the area of small cells. The upper edge of this groove is the dorsal lip of the blastopore. The ends of the groove extend in a circle until they meet, completing the blastopore at its ventral lip. Within the blastopore there is a mass of large endodermal cells, the so-called *yolk-plug*. The formation of the blastopore has been observed in living eggs of a number of amphibians by several investigators. The observations of H. V. Wilson upon a tree frog (*Chorophilus feriarum*) are of special interest because by the skilful use of an inverted microscope he was able to watch the changes in uninjured eggs in their normal position. He finds that all parts of the edge of the blastopore, as soon as they are formed, begin to grow over the yolk cells. During this process, not only the yolk cells disappear under the advancing edge of the blastopore, but cells outside of the blastopore are seen to move to the edge and then to roll over and disappear beneath it, so that there is here a combination of overgrowth (*epiboly*) and invagination (*emboly*). The dorsal lip being the first to form, Wilson finds that it grows over an angular distance of 25° before the ventral lip starts, at which time the width of the blastopore is 95°. After that the rate of closure is equal on all sides.

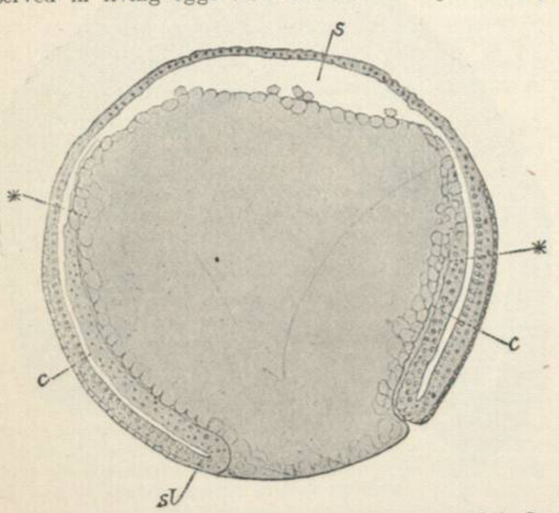

FIG. 2271.—Sagittal Section of a Gastrula of Forty Hours of the Gar-pike, Lepidosteus. *c*, Endoderm; *sl*, dorsal lip of blastopore; *s*, blastocœl; **, innermost limit of archenteron. (After Dean.) × 30.

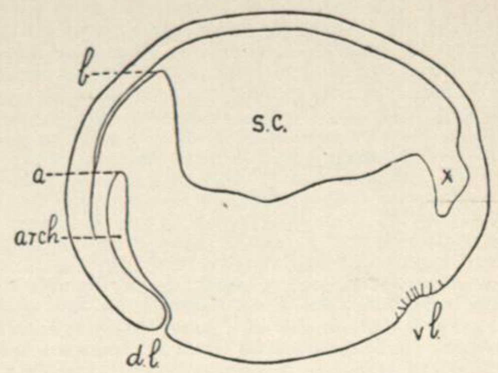

FIG. 2272.—Sagittal Section of the Gastrula of a Tree-toad, Chorophilus. *arch*, Archenteron; *a–b*, "tongue" of uncleft yolk in front of archenteron; *d.l.*, dorsal lip; *v.l*, ventral lip, *s.c.*, blastocœl; *x*, space produced artificially. (After H. V. Wilson.) Camera drawing, Zeiss A, 2.

When the blastopore has been reduced to a very small opening, the overgrowth stops at the dorsal and ventral sides, but continues laterally, so that the blastopore finally becomes a mere slit and at length the lips fuse in the middle, leaving a minute opening at each end. The dorsal one is the neuropore, or neurenteric canal, and the ventral one may or may not persist as the permanent anus.

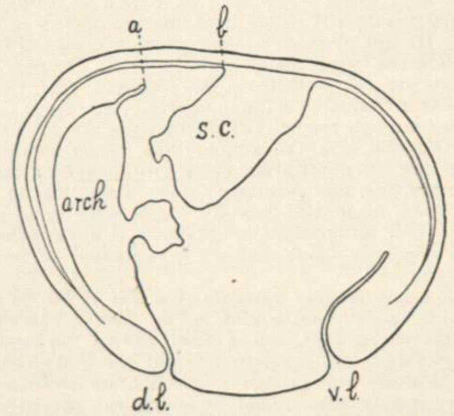

FIG. 2273.—Sagittal Section of the Gastrula of a Tree-toad, Chorophilus. Later stage than that shown in Fig. 2272. Reference letters the same. (After H. V. Wilson). Zeiss A, 2.

Figs. 2271, 2272, and 2273 represent sagittal sections of gastrulas of the gar-pike and the tree frog. Comparing these with Fig. 2269 we see that they are similar to the gastrula of Amphioxus, except that in these forms the endoderm forming the ventral and anterior wall of the archenteron is greatly thickened so as nearly to fill the cavity of the archenteron and to protrude through the blastopore.

In the Sauropsida, reptiles and birds, we find an enormous increase in the proportion of yolk in the egg.

Nevertheless, there is a stage in the development of these forms that may be regarded as a gastrula. The hen's egg may be taken as the type of this class. Cleavage begins and the egg passes through the blastula stage while in the oviduct. The germinal area in the blastula stage consists of two layers of cells. The outer layer forms a membrane of completely divided cells and is separated by a shallow cavity, the blastocœl, from the lower layer of cells, in which the cell boundaries are incomplete, so that the cells are not separated from the white yolk below. At the margin of the germinal area the two layers are united and all the cell boundaries are incomplete below.

At about the time that the egg is laid the posterior border of the germinal disc becomes sharply defined by the appearance of a crescentic groove, which gradually extends around toward the anterior side. Inside of the groove the disc becomes thicker and more opaque. The gastrula stage begins with the formation of this groove and ends with the completion of the primitive streak.

The blastocœl quickly disappears and the groove opens into a new cavity lying between the germinal disc and the yolk, the subgerminal cavity or archenteron. Fig. 2274 represents a sagittal section through a late gastrula stage of the hen's egg and may be compared with the dorsal half of the gastrula of the frog, Fig. 2273. At the anterior end of the section the ectoderm is seen to be growing over the yolk while the endoderm below is continuous with the yolk (*kw*), while at the posterior end the endoderm and ectoderm are continuous with one another and separated from the yolk by a slit (*bl*), which connects with the archenteron and may be regarded as homologous with the blastopore of the frog. As in the frog the blastopore begins as a crescentic groove and the dorsal lip proceeds to grow backward over the yolk. But, unlike the frog's egg, the egg of the hen contains so much yolk that the ends of the crescent are unable to meet around the yolk-plug. So the closure of the blastopore is effected in another way,—by the progressive separation of the ectoderm from the endoderm, beginning at the ends of the crescent, and the growth of the ectoderm as a distinct layer over the yolk, as described in the article on the *Area embryonalis* (see Vol. i., pp. 441, 442).

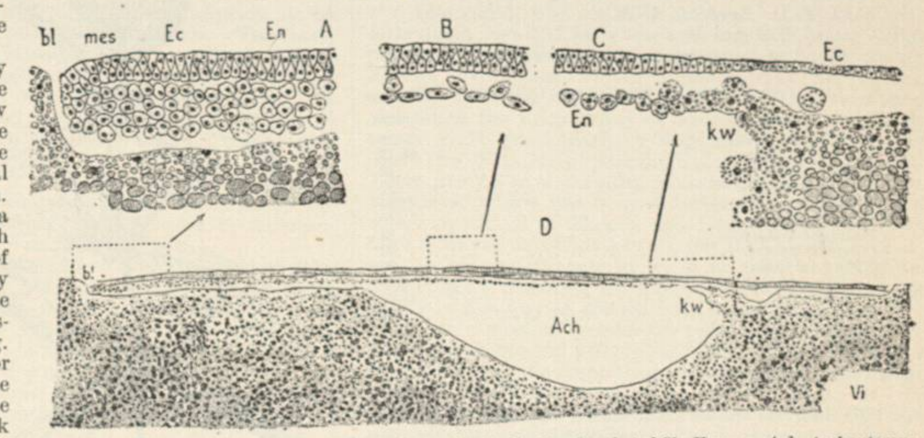

FIG. 2274.—Sagittal Section through the Blastoderm of a Hen's Egg Incubated Six Hours. *Ach*, Archenteron; *bl*, dorsal lip of blastopore; *Ec*, ectoderm; *En*, endoderm; *kw*, germinal wall; *mes*, marginal rim; *Vi*, Yolk. (After Duval, from Minot.) *D*, × about 40; *A*, *B*, *C*, details of *D* more highly magnified.

In the mammalia, although the egg is minute and undergoes a holoblastic cleavage, the development of the embryo is a very complex process, to be explained probably by the supposition that the ancestors of the mammals had eggs with a large amount of yolk. In this group the gastrula stage has almost entirely disappeared, the stage figured by Haeckel as such not being a gastrula at all. Hubrecht, however, described structures in the primitive streak of the shrew (Sorex) that resemble what is found at the lip of the blastopore of the frog, and he finds there a minute canal that he regards as a vestige of the neurenteric canal.

The gastrula has been a stage of more than ordinary interest to embryologists because of the importance attributed to it in the *Gastræa Theory* of Haeckel. This theory is based primarily upon the discovery made by Huxley in 1849: "That a Medusa consists essentially of two membranes enclosing a variously-shaped cavity, inasmuch as its various organs are so composed"; and that "a complete identity of structure connects the foundation membranes of the Medusa with corresponding organs in the rest of the series; and it is curious to remark, that throughout the outer and inner membranes appear to bear the same physiological relation to one another as do the serous and mucous layers of the germ; the outer becoming developed into the muscular system and giving rise to the organs of offence and defence; the inner, on the other hand, appearing to be more closely subservient to the purposes of nutrition and generation." To these two layers Allman in 1853 gave the names ectoderm and endoderm, respectively. Later, Alexander Kowalevsky, beginning in 1866, made a brilliant series of observations upon the embryonic development of a large number of invertebrates, corals, hydromedusæ, scyphomedusæ, ctenophores, worms, Phoronis, brachiopods, echinoderms, mollusks, and insects, and also upon various lower chordata, including tunicates, Amphioxus, and fishes. He concluded that in all the invertebrates that he had studied, two germ layers are formed at the beginning of development, and that in most cases there is formed at first a vesicle of cells, one side of which becomes invaginated, forming a double cup with a central cavity opening to the exterior. He found a similar condition in tunicates and Amphioxus and by comparison of their subsequent stages of development demonstrated the affinity of the tunicates with Amphioxus and, through that form, with the true vertebrates.

In 1872 Haeckel published a description of the two-layered, cup-shaped larva of the calcareous sponges, and asserted that this stage, to which he gave the name *Gastrula*, is a fundamental one for all metazoa.

In 1874 and 1875 he elaborated more fully the theory that the gastrula represents the type of the most primitive metazoan, the common ancestor of the whole great group of animals above the protozoa. To this hypothetical ancestor he gave the name *Gastræa*. As already indicated, this generalization of Haeckel has been, in the main, confirmed by subsequent investigations.

Robert Payne Bigelow.

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GAYLORD AND GULICK MINERAL SPRINGS.—(Formerly Blossburg Mineral Springs.) Tioga County, Pennsylvania.

Post-Office.—Blossburg. Hotels in the village.

Access.—Viâ Tioga branch of Erie Railroad to Blossburg; also viâ Northern Central Railroad to Roaring Branch, and thence by stage line over the mountains.

These springs are located in a picturesque mountain region 1,500 feet above the sea-level. They are surrounded by a charming tract of woodland containing 213 acres, from which a fine view of the valley of the Tioga may be obtained. The place offers many attractions as a summer resort, but is not fully developed as yet. The springs are two in number, and flow about 1,800 gallons of water per hour. The following analysis was made by Prof. F. A. Genth in 1879:

Sulphated Acid Chalybeate.

One United States Gallon Contains:

Solids.	Grains.
Magnesium sulphate	13.10
Calcium sulphate	23.13
Lithium sulphate	.12
Sodium sulphate	.27
Potassium sulphate	.24
Sodium chloride	.10
Manganese sulphate	1.83
Cobalt sulphate	.03
Nickel sulphate	.36
Aluminum sulphate	6.58
Iron sulphate	31.31
Iron phosphate	.32
Sulphuric acid	5.64
Silicic acid	2.15
Total	85.18

This analysis shows a sulphated acid chalybeate water of great potency. It is remarkably rich in ferruginous ingredients, and contains a considerable proportion of the sulphate of magnesia or Epsom salt. The analysis also shows appreciable quantities of the rare ingredients manganese, nickel, and cobalt. The water possesses excellent properties as a tonic and reconstructive, and has been found very useful in conditions characterized by anæmia and general debility. It is also used in dyspepsia and intestinal disorders. Locally it has decided astringent and stimulant effects, and as such is recommended as a douche, spray, gargle, or lotion. The water is used commercially. A mineral water of this strength should always be taken under the direction of a physician.

James K. Crook.

GEISSOSPERMUM.—*Pao Pereira Bark.* The bark of one or more species of *Geissospermum* (fam. *Apocynaceæ*), *G. læve* Miers being the important one, used in Brazil as a febrifuge. Three alkaloids have been reported, *geissospermine*, *pereirine* (this is not the only alkaloid of this name), and *vellosine* (from *G. Vellosii* Allem.). The drug and its alkaloids have been used experimentally, especially in Europe, but have found no accepted position in medicine.

Henry H. Rusby.

GELATIN.—Gelatinum. *Gelatin* has been defined by the British Pharmacopœia as "the air-dried product of the action of boiling water upon such animal tissues as skin, tendons, ligaments, and bones." It appears in a variety of forms. That which has not been purified, made usually from animal matter which has partly decomposed, is *glue*. When purified by special processes it becomes *sparkling*. It usually occurs in sheets which have been dried upon coarse matting, but frequently in narrow strips cut from such sheets (*shredded gelatin*). Gelatin should be almost or quite colorless and transparent, without odor, and nearly tasteless. Dissolved in 50 parts of hot water, it should yield a firm jelly on cooling. The aqueous solution is precipitated by tannin, but not by alum, subacetate of lead, or ferric chloride T. S. Gelatin is soluble in acetic acid, but not in strong alcohol or ether. It has no medicinal activity, but is a nutrient of the albuminoid class, used in the diet of invalids and in the kitchen generally. Its chief use in medicine is, strictly speaking, pharmaceutical, for the manufacture of the well-known soft and hard gelatin capsules and for the coating of pills.

Gelatose is gelatin which, as a result of certain changes, especially those of bacterial causation, can no longer be gelatinized.

Henry H. Rusby.

GELSEMIUM.—Yellow Jasmine, Yellow Jessamine. "The dried rhizome and roots of *Gelsemium sempervirens* (L.) Ait. f. (fam. *Loganiaceæ*)," U. S. P. The yellow jessamine of the Southern States is a pretty climbing shrub, with a large woody rhizome, and numerous fine roots, and slender, smooth, twining, purplish stems. It has dark green, glossy, lanceolate, entire, evergreen leaves, growing opposite to each other, and bearing in their axils solitary or clustered flowers. The latter are large, sweet-scented, bright yellow, and slightly irregular. Calyx small, of five-pointed sepals; corolla funnel-shaped, with a slightly oblique, five-lobed border; stamens five, perigynous. Fruit an oblong, flattened, drooping pod; seeds margined. This is one of the most attractive flowers in the Southern States. It grows abundantly from Virginia southward, in woods, and mounts to the tops of tall trees. The flowers, which appear in the spring, load the air with their sweet odor.

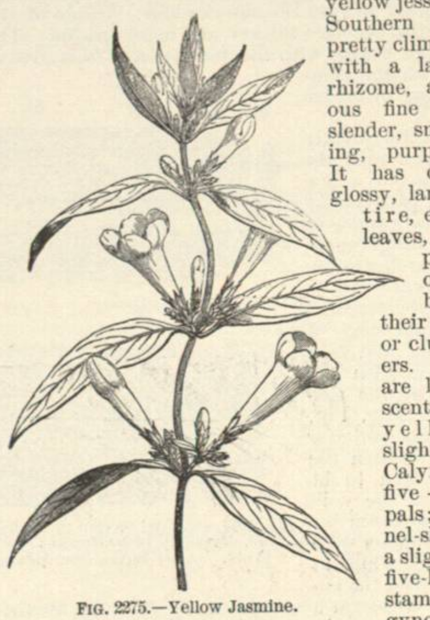

Fig. 2275.—Yellow Jasmine.

Of course, so conspicuous a plant was early noticed; in fact, it was carried to England as an ornament in the first half of the seventeenth century. Its poisonous properties were also early known, but its medicinal employment is of rather recent date.

Description.—Rhizome cylindrical, short-flexuous, elongated or cut in sections of variable length, mostly from 0.5 to 1.5 cm. ($\frac{1}{5}$ to $\frac{3}{5}$ in.) and occasionally 3 cm. (a little more than an inch) in diameter, the roots much thinner, a few elongated, unbranched, coarsely hair-like tough rootlets usually attached; externally of a light yellowish-brown, commonly with some purple or purplish-brown longitudinal lines or patches, or occasionally deep purple-brown with yellowish-brown, fine ridges; heavy, hard, and tough; internally yellowish-white; fracture of the rhizome splintery, the roots breaking with half the fracture transverse, the other oblique or short-splintery; bark thin, closely adhering, that of the rhizome with fine, silky bast fibres, the wood porous, with numerous fine medullary rays; odor peculiar; taste slightly aromatic, bitter.

Composition.—It contains two alkaloids, *Gelsemine* ($C_{49}H_{63}N_5O_{17}$), crystalline, but inert upon the human subject, and *Gelseminine* ($C_{12}H_{14}NO_2$), which, like its salts, is amorphous, occurring as a white powder, soluble in alcohol, not in water, and which is the active constituent. Gelseminic acid is a saponin-like substance. A little resin and volatile oil, with starch, are also present.

Action and Use.—Gelsemium is an active paralyzing poison, capable of killing both animals and man in small doses, expending its action upon the nervous system. It does not affect consciousness until near the end of fatal cases; sometimes, but not always, it produces convulsions, due apparently to respiratory interference. Reflex excitability is increased at first, afterward diminished, while its paralyzing effect upon the motor columns steadily increases to the end. Death takes place by asphyxia, proceeding from central paralysis. It depresses or paralyzes the nerve endings to a less extent, and less promptly than the centres. Locally, and to a less extent systematically, it dilates the pupil and paralyzes the power of accommodation precisely like atropine. The following symptoms are observed in man after moderate doses: languor, debility, dizziness, disturbances of vision, dilatation of the pupils, paresis, especially of the flexors of the arm, and drowsiness. The poison appears to be quickly absorbed and promptly eliminated. This root, whose medicinal value is said to have been discovered by accident, has been considerably used in the South and West in the treatment of malarial and other fevers. It is occasionally employed in pneumonia and pleurisy as a depressant; in asthma, whooping-cough, etc., it is also indicated, but is not, in the East at least, very frequently given. In neuralgias it holds, perhaps, its place most firmly. It has also been useful when dilatation of the pupil is desirable, differing from atropine in the transientness of its effects.

Administration.—From 25 to 30 cgm. (0.25 to 0.30 gm. = gr. iv. ad gr. v.) of the powder, or the same measures of the fluid extract (*Extractum Gelsemii Fluidum*, U. S. P.) are suitable doses. The official 15-per-cent. tincture is given in doses of 1-4 c.c. (fl. ʒ $\frac{1}{4}$-i.).

It has been observed quickly to counteract mild disturbances due to overdoses of strychnine, and might be found efficacious as an antidote to that poison.

W. P. Bolles.

GELSEMIUM, POISONING BY.—In Gelsemium sempervirens are found an acid and two alkaloids. The alkaloids are gelsemine and gelseminine. Gelsemine has a tetanizing action, and causes in the frog violent spinal excitement with increased reflexes followed by paralysis due to the action upon the nerve endings. Gelseminine is the more active of the two, producing a paralysis by direct action upon the spinal centres, and having a curare-like paralytic influence upon the nerve trunks. The acid, gelseminic acid, was by Robbins regarded as identical with æsculin, the glucoside of the horse chestnut; Dragendorf and Schwartz arrived at similar results, but Professor Wormley in re-investigating the subject proved that gelseminic acid is not identical with aesculin. According to Kunkel, the acid is of no toxicological importance. Nottage says that commercially the alkaloids are found as a crystalline alkaloid and an amorphous alkaloid of which the former has about ten times the potency of the latter. From the amorphous alkaloid the dosimetric granules are commonly made. The paralyzing alkaloid is the more potent and causes the characteristic symptoms in poisoning from preparations of the whole plant, such as the tincture or fluid extract. The symptoms come on usually within a half-hour, but in some cases the action is immediate. A full dose gives rise to languor, muscular relaxation, and weakness, drooping of the eyelids, double vision, and dilated pupils. When a poisonous dose is taken the muscular relaxation is more pronounced, the jaw usually drops, the skin becomes cold and cyanotic, the respiration shallow and weak, the heart is weakened, and at times the patient has such paroxysms of dyspnœa as to clutch at the throat for air. Sensation is not so early impaired as motion, and intellection is preserved in most instances until the impaired respiration poisons the brain.

The fatal dose is difficult to determine. Twelve minims of the fluid extract have proved fatal to a boy of three years; thirty-five drops of the tincture of the bark have resulted fatally in an hour and a half. In one instance known to the writer a drachm of the tincture taken by mistake proved fatal to a young lady in one-half hour. Dr. Hartwell has known twelve grains of the resenoid to result fatally. Recoveries have occurred after the ingestion of considerable-sized doses. Dr. Main recovered in somewhat over an hour after taking by mistake a drachm of the fluid extract. Blake's patient recovered after taking two drachms of the tincture, although the depression was most profound, and there was intense cyanosis with fearful paroxysms of dyspnœa. In my own case of fatal poisoning the patient, who had taken small doses of the tincture at intervals after a debauch without any marked effect, took probably a half ounce of the fluid extract, and when found a half-hour later was intensely cyanosed, pupils dilated, jaw dropped, lids drooped, muscles completely relaxed, with weak heart and shallow and weak respiration. The patient was somnolent, but could be aroused. Despite all efforts death resulted in seven and one-half hours. The poison seems to be a spinal depressant, as is shown by its late involvement of the higher intellectual centres, and the fact that the poison acts upon the pithed frog and when the main artery of an extremity is tied. It seems to be particularly a respiratory poison. After death no distinctive pathological changes are found. There are no true chemical or physiological antidotes. Morphine, which has been extolled as an antidote and which appeared in Blake's and Courtwright's cases to have rendered excellent service, has been shown by Rehfuss in his experiments to be in no sense an antidote, only slightly retarding the effects of gelsemium and not acting in this way as efficiently as atropine.

The treatment of gelsemium poisoning must be conducted upon general principles. The stomach should be evacuated, and the respiration maintained by strychnine, atropine, artificial respiration, and faradism of the respiratory muscles. The heart suffers secondarily, and nitroglycerin and digitalis will be of service in maintaining its action. Rehfuss, as a result of his experimental studies, recommends emetics, ammonium carbonate, brandy, and the early and repeated use of small doses of atropine to sustain respiration; in addition sinapisms, faradic current, and artificial respiration. Jepson used hypodermics of strychnine successfully in one case. In my own fatal case there was very marked improvement following the administration of atropine and nitroglycerin combined with artificial respiration and faradism of the respiratory muscles. The pulse, which had been very feeble, increased in strength, the cyanosis disappeared; the respirations, which had been shallow, feeble, and irregular, became full and deep, so that the lips previously blue became rosy. The patient was lying upon a blanket before an open fire in a rapidly chilling room. The improvement was so marked that we felt the worst had been averted, and we then attempted to move him nearer the fire by lifting him by the corners of the blanket. By this his diaphragm was cramped, and he died instantly —a warning regarding the care which should be used in moving patients under these circumstances. Were the writer to be again confronted with a case of gelsemium poisoning he would rely upon repeated hypodermics of atropine and strychnine, and would, if the Fells apparatus, which has proved so successful in opium poisoning, were at hand, maintain artificial respiration by the aid of this instrument. Faradism of the respiratory muscles is a powerful adjuvant, but that its application to the hands should have had the result of banishing all symptoms "instantaneously and permanently" in Dr. Main's own case seems remarkable.

William Wotkyns Seymour.

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GENEVA LITHIA SPRINGS.—Ontario County, New York.

POST-OFFICE.—Geneva.

LOCATION.—Geneva.

The well-known Geneva lithia water is obtained from an artesian well over eight hundred feet deep, which was bored in 1886. Issuing from a stratum of pervious rock defined by a layer of mediæval sandstone sixty feet thick and a deep substratum of hard slate, the water is forced up by an internal pressure of one hundred and twenty pounds to the square inch, and, if unimpeded at the surface, would form a fountain eighty feet high. The water is bright, clear, and sparkling, being agreeable to the palate and excellently adapted for table use. The following analysis was made by Prof. A. Auchie Cunningham, F.C.S.:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Magnesium sulphate	83.13
Magnesium carbonate	16.00
Potassium chloride	13.40
Sodium chloride	24.54
Sodium sulphate	17.64
Aluminum sulphate	8.75
Lithium bicarbonate	10.03
Lithium sulphate	4.10
Iron carbonate	2.15
Calcium sulphate	18.75
Calcium carbonate	35.84
Phosphoric acid	Trace.
Total	234.33

There is an entire absence of organic matter. The analysis shows a valuable lithia water, which possesses many excellent qualities. It may be classed as belonging to the lithiated-saline chalybeate variety. Aside from its strong impregnation with the bicarbonate and sulphate of lithia, it possesses enough of the sulphates of magnesium and sodium to give it laxative properties, and enough iron to make it a valuable ferruginous tonic when taken continuously. The water is used commercially, and has an extensive sale. It has the indorsement of many prominent physicians of the great Eastern cities. The water resembles that of a spring at Rippoldsau, in the Duchy of Baden, but is more heavily charged with iron and free phosphoric acid. It is extensively employed in anæmic states and general debility, and in many of the conditions resulting from the uric-acid diathesis, viz., gout, dyspepsia, rheumatism, renal and vesical calculus, Bright's disease, etc.

James K. Crook.

GENITAL ORGANS, FEMALE. See *Sexual Organs, Female.*

GENITAL ORGANS, MALE.—EMBRYOLOGY OF THE GENITAL ORGANS.—In order to have a proper knowledge of the normal and at times abnormal anatomy of the human male genital organs, it is essential that a brief review of the main facts of their embryology should be presented.

That the higher types of vertebrates, during their development, pass through stages the essentials of which are permanent in some of the forms below them, is particularly well exemplified by a study of the embryology of the genital organs.

In the light of the theory of development many cases of anomaly of the genital organs will furnish striking evidence of either *atavism* or *arrested development.* In the growth of the embryo there is at first a period during which there is no indication of any provision either for a urinary or a generative function. A little later the rudiments of a urogenital apparatus are developed, but as yet there is no evidence of sexual differentiation.

In the course of embryological changes it will be observed that certain of the structures concerned appear and assume their permanent characters. Gradually and without modification of plan other structures, at first employed for purposes unrelated to the urogenital apparatus, become adapted, secondarily, for special purposes in this system; others, though belonging to this system from the first and attaining to a condition of functional activity in one direction, are later adapted to altogether different activities in another direction; lastly, other rudiments, according to the sex developed, either become elaborated into efficient and important parts of the reproductive organs, or dwindle into useless vestiges that never take any part in the normal work of the body.

In order that the reader may appreciate, to some extent, the significance of references to the lower animals, it may be well to state here that Tunicates are the lowest vertebrates known. Then, according to the grade of organization and from the simpler to the higher, come, in order, the Acrania (Amphioxus), Cyclostomes, Fishes, Amphibians, Reptiles and Birds, and, highest of all, the Mammals. The Mammals are further subdivided, according to grade of organization, into the Monotremes, Marsupials, and Placentals.

The common embryonic foundations of the sexual organs, male and female, are as follows, viz.: for the internal organs of generation they are the *germinal gland, the Wolffian duct,* the *mesonephros,* the *Müllerian duct,* a part of the *intra-embryonic allantois,* a part of the *cloaca,* and a part of the *proctodeum* (Figs. 2277 and 2278).

For the external organs of generation they are the *genital eminence, genital groove, genital folds,* and *genital ridges* (Figs. 2281 and 2282).

In intimate relation with the Wolffian duct arise, in orderly sequence, three important structures—viz., the *pronephros* or head kidney, *mesonephros* or Wolffian body (midkidney), and the *metanephros* or hind (permanent) kidney (Fig. 2277).

These nephric structures all lie in the dorsal wall of the embryo's abdominal cavity (cœlom) near the point where the somatic and splanchnic layers join (Fig. 2276); they extend, on either side of the notochord (primitive vertebral column), from the neighborhood of the heart to the tail end of the embryo, one behind the other in the order indicated by their names.

The intestinal, urinary, and reproductive organs are not only intimately related in the adult, but they are still more intimately related in the embryo (Fig. 2277), and therefore they must be referred to, in varying degrees, in describing the development of the male sexual apparatus.

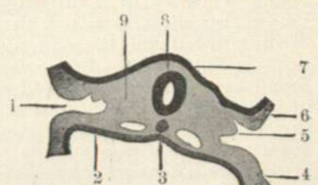

FIG. 2276.—Transverse Section of a Seventeen-Day Sheep Embryo. Diagrammatic. 1, Cœlom (pleuroperitoneal cavity); 2, entoderm; 3, notochord; 4, splanchnic mesoderm or mesoblast; 5, middle plate; 6, somatic mesoderm or mesoblast; 7, ectoderm; 8, neural canal; 9, paraxial mesoblast.

At an early stage of the embryo an evagination occurs from the ventral surface of the hind gut near its caudal end to form the *allantois* (Fig. 2277, *A*). The part of the hind gut caudad of the allantois is the *cloaca* (*Cl*). The cloaca is present permanently in all vertebrates from Fishes to Monotremes.

Development of the Internal Genital Organs.—The pronephros and Wolffian duct are evolved as follows: the mesothelial cells of the *somatic mesoderm* (Fig. 2276, No. 6) near the *middle plate* (No. 5) evaginate on both sides, and form a cord of cells parallel with the notochord; at several points along the cephalic extremity of this longitudinal cord of cells it retains its connection with the lining cells of the cœlom (abdominal cavity) by short transverse cords of cells. Soon the cell cords are hollowed out, and thus are formed the segmental or Wolffian duct (Fig. 2277, *W*), which passes caudad and empties into the *cloaca* (*Cl*), and several short transverse *tubules* (Nos. 1, 1, 1), opening at one end into the cœlom and at the other extremity into the Wolffian duct. The transverse tubules in the immediate neighborhood of their cœlomic extremities are evaginated by a tuft of capillary blood-vessels from a branch of the adjacent axial blood-vessel (aorta), so that a series of *glomeruli* are formed. Through the physiological activity of the cells of the glomeruli the urinary constituents are eliminated in the Anamnia from the blood and passed along the transverse tubules into the Wolffian duct and cloaca and thence evacuated from the body. It is thus seen that the transverse tubules and their glomeruli constitute a segmental primitive kidney (pronephros). This pronephros (Fig. 2277, Nos. 1, 1, 1), though functional in Cyclostomes, Teleosts, and larval Amphibians, is vestigial in Selachians, Reptiles, Birds, and Mammals, and never functionates as a urinary organ; it soon gives place to the more important *mesonephros* (Fig. 2277, Nos. 2, 2, 2, 2).

Simultaneously with the segmentation of the paraxial mesoderm (Fig. 2276, No. 9) into the somites, the *middle plate* undergoes segmentation, and each segment is called a *nephrotome.* In the lower vertebrates each nephrotome is hollow and is formed by evagination of the cœlomic mesothelium; but in Reptiles, Birds, and Mammals the nephrotomes are at first solid cords of cells which subsequently become hollowed out and converted into a series of transverse, short canals situated behind, caudad of, the pronephros. They soon acquire connection with the previously formed Wolffian duct. Collectively they constitute the Wolffian body or *mesonephros.* At the cephalic end of the Wolffian duct, the now atrophied transverse tubules and glomeruli of the pronephros are still in connection with it. Embryologists usually compare the mesonephros with its Wolffian duct to a comb, the duct corresponding to the back of the comb, and the short transverse tubules representing the teeth.

In the further development of the mesonephros each transverse tubule becomes somewhat saccular midway between its two extremities, and then the sacculated portion is invaginated by a tuft of capillary blood-vessels derived from an arterial branch of the aorta. The invaginating tuft of capillaries is known as a Malpighian tuft, while the invaginated portion of the transverse tubule is called the Malpighian capsule; the two together constitute a primitive Malpighian body, analogous with the Malpighian bodies of the permanent kidney or metanephros. By the development of secondary tubules and Malpighian bodies the complexity of the mesonephros is greatly increased.

In those vertebrates in which the pronephros attains to a temporary functional activity, as in Cyclostomes, Teleosts, and Amphibians, the mesonephros appears relatively late; on the contrary, in those animals in which the pronephros remains rudimentary, as in Sharks, Reptiles, Birds, and Mammals, the mesonephros is developed early.

In the Anamnia (Fishes and Amphibians) the mesonephros not only acquires relations with the sexual apparatus, but also functionates as a urinary organ. Hence in these animals there is no metanephros. In the Amnia (Reptiles, Birds, and Mammals) the mesonephros functionates as a urinary organ only a short period during embryonic life; it undergoes profound retrograde and adaptive changes soon after its formation and enters into the exclusive service of the sexual apparatus, serving as channels to conduct the sexual cells from the germinal glands in the male, and becoming entirely vestigial in the female (parovarium and paroöphoron).

The transverse tubules of the mesonephros are divisible, in man, into an anterior or cephalic series and a posterior or caudal set. The former are the *sexual* set, and the latter become vestigial as the paradidymis and vas aberrans (homologous with the paroöphoron of woman) (Fig. 2279).

In the Amnia the permanent urinary organ is the metanephros. While the mesonephros and its Wolffian duct are temporarily functionating as a kidney, an evagination occurs from the caudal extremity of the duct.

This evagination soon lengthens into a tube (Fig. 2277, *Met*), which extends cephalad, toward the caudal part of the mesonephros. The cephalic end of the rudimentary metanephros branches freely to form a number of smaller tubes. The surrounding undifferentiated mesodermic cells form enveloping connective and vascular tissue. The blind end of each little tube becomes dilated and then invaginated by a tuft of capillary blood-vessels so that Malpighian bodies are formed analogous to those in the pro- and mesonephros. The tubules, owing to excessive growth in length, become tortuous and convoluted. The stalk of the diverticulum becomes the *ureter*, while the dilated part from which the branches are given off differentiates into the pelvis of the kidney with its infundibula and calyces.

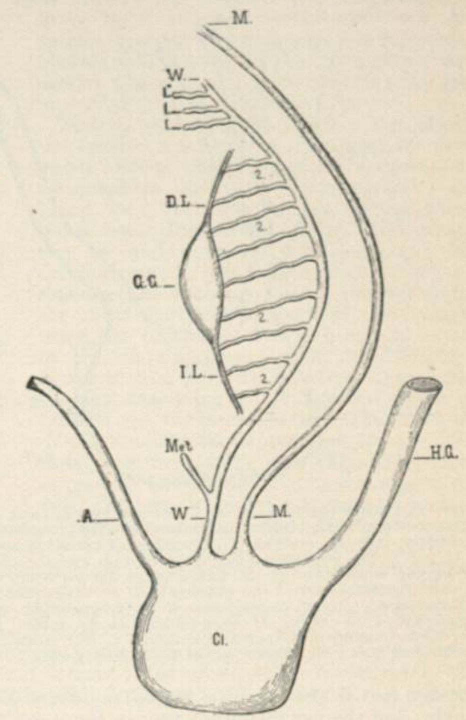

FIG. 2277.—Early Embryonic Condition of the Urogenital System. Diagrammatic. Sex undifferentiated. *A.*, Allantois; *Cl.*, cloaca; *H. G.*, hind gut; *W.*, Wolffian duct; *M.*, Müllerian duct; 1, 1, 1, pronephros; 2, 2, 2, 2, mesonephros (Wolffian body); *Met.*, metanephros (rudimentary permanent kidney); *G. G.*, germinal gland; *D. L.*, diaphragmatic ligament; *I. L.*, inguinal ligament.

Shortly after the formation of the mesonephros another tube (*Müllerian duct*) appears (Fig. 2277, *M.*). It lies close to the outer side of the Wolffian duct and parallel with it. It arises by evagination of the mesothelium of the cœlom in the form of a solid cord of cells and later acquires a lumen. The cephalic end of the duct, near the pronephros, maintains a communication with the cœlom by means of an expanded funnel-shaped mouth, while the caudal part empties into the cloaca. Its lower segment becomes closely associated with its fellow of the opposite side and with the two Wolffian ducts, thus forming the *genital cord.* The cloacal segments of the Müllerian ducts fuse early into a common tube, except in the Monotremes, where they remain permanently separate and empty into the urogenital sinus (Fig. 2278, *M.*). In all