Soda.—Caustic soda destroys the fresh virus of symptomatic anthrax in the proportion of 1 to 5, but has no effect upon dried virus (Arloing, Cornevin, and Thomas). A ten-per-cent. solution destroys the tubercle bacillus in dried sputum after twenty-four hours' contact (Schill and Fischer).

The experiments of Jäger show that sodium hydroxide has about the same germicidal value as caustic potash. Boer obtained the following results, the time of exposure being two hours: anthrax bacillus 1 to 450; diphtheria bacillus 1 to 300, glanders bacillus 1 to 150, typhoid bacillus 1 to 190, cholera spirillum 1 to 150.

Sodium Biborate.—In the writer's experiments a saturated solution was found to have no germicidal power. A twenty-per-cent. solution does not destroy the virus of symptomatic anthrax, as proved by inoculation experiments (Arloing, Cornevin, and Thomas); 1 to 12 failed to kill the bacteria in broken-down beef infusion (De la Croix). A five-per-cent. solution failed in fifteen days to destroy the vitality of anthrax spores (Koch).

Sodium Chloride.—In the writer's experiments a five-per-cent. solution failed to destroy the virulence of septicæmic blood. A saturated solution failed in forty-eight hours to destroy the virus of symptomatic anthrax (Arloing, Cornevin, and Thomas). A saturated solution failed, in forty days, to destroy the vitality of anthrax spores (Koch). A saturated solution failed, in twenty hours, to destroy the tubercle bacillus in fresh sputum (Schill and Fischer).

Sodium Hyposulphite.—The writer's experiments show this salt to be without germicidal power. In saturated solution it failed, in two hours' time, to destroy any of the test organisms. Exposure for forty-eight hours to a fifty-per-cent. solution does not destroy the virus of symptomatic anthrax (Arloing, Cornevin, and Thomas).

Sodium Sulphite.—The results obtained by the writer correspond with those reported in the case of sodium hyposulphite, being entirely negative.

Stannous Chloride.—Abbott reports that this agent is active in the proportion of one per cent. and failed in 0.8 per cent., the test being the organisms in broken-down beef infusion, and time of exposure two hours.

Sulphuric Acid.—In the writer's experiments this acid was found to be fatal to micrococci in the proportion of 1 to 200; but a four-per-cent. solution failed to destroy the bacteria in broken-down beef infusion, doubtless on account of the presence of reproductive spores. An eight-per-cent. solution was, however, found to be effective (strength of acid, 1.480 gm. H_2SO_4 in each cubic centimetre). Salmon has found that a solution of 1 to 200 is fatal to the micrococcus of fowl cholera. A solution of one per cent. failed to destroy anthrax spores in forty days (Koch).

The experiments of Boer show a considerable difference in the resisting power of various pathogenic bacteria. The time of exposure being two hours, the anthrax bacillus was destroyed by 1 to 1,300, the diphtheria bacillus 1 to 500, the glanders bacillus 1 to 200, the typhoid bacillus 1 to 500, the cholera spirillum 1 to 1,300.

Sulphur Dioxide.—Wernich, in 1877, found that the bacteria of putrefaction are not destroyed by the presence of 3.3 volumes of sulphur dioxide in one hundred of air, when exposed upon strips of cotton or woollen goods saturated with putrid liquids. But four to seven per cent. was effective in six hours' time. Schotte and Gärtner, in 1880, found that strips of thick woollen goods soaked in culture liquids containing the bacteria of putrefaction were not disinfected by exposure in a chamber in which sulphur was burned in the proportion of 92 gm. per cubic metre (about six volumes per cent. of SO_2). Koch exposed various species of bacilli containing spores in a disinfection chamber for ninety-six hours, the amount of SO_2 at the outset of the experiment being 6.13 volumes per cent., and at the end of ninety-six hours 3.3 per cent. The results were entirely negative. The writer has also made numerous experiments which show that this agent is without power for the destruction of spores. Even when liquid SO_2 is poured upon the spores of anthrax or of *B. subtilis*, they germinate freely when transferred to a suitable culture medium. But this agent, especially in the presence of moisture, destroys micrococci and bacilli which do not contain spores. Thus, Koch found that the anthrax bacillus obtained from the spleen of a mouse recently dead, and exposed, while still moist, upon a silk thread, in an atmosphere containing one volume per cent. of SO_2, was destroyed in thirty minutes. In one of Koch's experiments the amount of SO_2 in the disinfection chamber was at the outset 0.84 per cent., and at the end of twenty-four hours 0.55 per cent. An exposure of one hour, in this experiment, destroyed anthrax bacilli (still moist) upon silk thread. Four hours' exposure failed to destroy the vitality of *Micrococcus prodigiosus* growing upon potato, but twenty-four hours' exposure was successful. The same result was obtained with the bacteria of blue pus. In experiments with an aqueous solution of SO_2, Koch found that five days' immersion in a solution containing 5.718 per cent. by weight was required to destroy the vitality of anthrax spores. A solution containing 11.436 per cent. by weight failed to kill anthrax spores in twenty-four hours, but was successful in forty-eight hours. According to Arloing, Cornevin, and Thomas, sulphur dioxide does not destroy the bacteria of symptomatic anthrax which contain spores. The writer's experiments show that micrococci are destroyed, even in the absence of moisture, when they are exposed for eighteen hours in a bell jar containing twenty volumes per cent. of SO_2. When the proportion was reduced to four volumes per cent. the result was not uniform, the test organisms—micrococci—were destroyed in some cases, and in others were not. In experiments with an aqueous solution of SO_2 the following results were obtained: The presence of 1 to 2,000, by weight, destroyed a micrococcus obtained from the blood of a patient with vaccinal erysipelas, and 1 to 4,000 failed; the same result was obtained with micrococci obtained from a vaccine vesicle, and with another species obtained from the blood of a patient having puerperal septicæmia.

Thoinot (1890) as a result of numerous experiments arrives at the conclusion that the bacillus of tuberculosis, of glanders, of diphtheria, of typhoid fever, and the spirillum of cholera are all destroyed by exposure for twenty-four hours in an atmosphere containing SO_2 developed by the combustion of sixty grains of sulphur per cubic metre of air space.

Sulphureted Hydrogen.—Bacteria develop readily in the presence of sulphureted hydrogen (Hamlet).

Sulpho-carbolates.—In experiments upon anthrax spores, Koch found that a five-per-cent. solution of sulpho-carbolate of zinc was effective in five days, while sulpho-carbolate of soda failed in five-per-cent. solution to destroy these spores after ten days' contact.

Tannic Acid.—The writer found, in his experiments, that a solution of one per cent. in half an hour is fatal to *M. Pasteuri* in the blood of a rabbit. A twenty-per-cent. solution has no effect upon the virus of symptomatic anthrax (Arloing, Cornevin, and Thomas). A five-per-cent. solution failed in ten days to destroy anthrax spores (Koch). A twenty-per-cent. solution failed in two hours to destroy the spores of *B. anthracis* or of *B. subtilis*, but was effective upon the organisms in broken-down beef-tea. Micrococci are destroyed by 1 to 400, while 1 to 800 failed (Abbott).

Tartaric Acid.—A twenty-per-cent. solution was found by Abbott to be effective, in two hours, for the destruction of organisms in broken-down beef infusion, but the same proportion failed with anthrax spores and with those of *B. subtilis*. Micrococci did not multiply in culture solutions, after exposure to 0.25 per cent., but one-half this amount (1 to 800) failed.

Thymol.—An alcoholic solution of 1 to 400 was found by the writer to destroy *M. Pasteuri* in fresh blood. One part in twenty is fatal to the bacteria in broken-down beef infusion (De la Croix). A five-per-cent. solution in alcohol does not destroy anthrax spores in fifteen days,

but the development of these spores is retarded by a solution of 1 to 80,000 (Koch).

The tubercle bacillus is destroyed by contact with thymol for three hours (Yersin). Thymol has about four times less germicidal power than carbolic acid (Behring).

Valerianic Acid.—A five-per-cent. a solution in ether failed in five days to destroy anthrax spores (Koch).

Zinc Chloride.—In the writer's experiments, *M. Pasteuri* failed to develop after exposure for two hours to 1 to 200, while a micrococcus obtained from gonorrhœal pus required for its destruction a solution of two per cent. The spores of *B. anthracis* are not destroyed by two hours' exposure in a ten-per-cent. solution. A five-per-cent. solution was, however, found to be effective in the same time in the case of *B. subtilis* spores, and upon the organisms in putrid beef-peptone solution. Koch's experiments are in accord with the above, in showing the superior resisting power of anthrax spores. He found that after being immersed in a five-per-cent. solution for thirty days, these spores still germinated freely. The development of *M. prodigiosus* was found by the same author to be only slightly retarded by exposure for more than sixteen hours to the action of a one-per-cent. solution.

Zinc Sulphate.—In the writer's first experiments with this agent, a solution of twenty per cent. failed in two hours to destroy micrococci obtained from the pus of an acute abscess. In later experiments a micrococcus from the same source resisted exposure for the same time to a ten-per-cent. solution, while *M. tetragenus* was destroyed by a 1 to 10 solution. Broken-down beef infusion, mixed with an equal quantity of a forty-per-cent. solution, was not sterilized after two hours' contact. In Koch's experiments anthrax spores were found to germinate after having been immersed for ten days in a five-per-cent. solution.

George M. Sternberg.

GERM LAYERS.—It has long been known that the bodies of embryos consist of distinct layers, which in many cases are separable from one another, so as to be recognized in gross as discrete membranes. It is now known that all such layers may be reduced to three primitive ones, named the ectoderm, mesoderm, and entoderm (by certain writers, epiblast, mesoblast, and hypoblast). The ectoderm is a layer of epithelium; so also is the entoderm; the mesoderm is more complex. In the lower animals, the mesoderm is less developed than in the higher forms; in the hydroids the body is constituted mainly by the two epithelial layers, the ectoderm covering the outside of the body, and the entoderm lining the digestive cavity; there is very little space between them, the space being occupied by the slightly developed mesoderm. As we ascend the scale the mesoderm increases gradually, constantly acquiring a greater predominance, until in mammals nearly the whole bulk consists of mesoderm. But, in spite of this change, the three layers are preserved throughout, and their essential relations are not altered, so that we are able to assert the unity of organization throughout the whole series of multicellular animals, without which it would be impossible to accept the doctrine of evolution. The demonstration, therefore, of the homologies of the germ layers, is the most important morphological generalization since the establishment of the cell doctrine. As these homologies have already been discussed under *Gastrula*, and also the metamorphoses of the layers under *Fœtus*, it only remains for us to review, with precision and brevity, the rôle of the layers in the construction of the human body.

The ectoderm covers the external surface of the body, and persists in adult life as the stratified epithelium (epidermis) of the skin; it forms, of course, all the so-called epidermal structures—hairs, nails, sebaceous and sweat glands, lens, cornea, etc. It also lines part of the buccal cavity; and the buccal portion gives rise to the hypophysis cerebri, to the enamel organs of teeth, and probably to all the salivary glands. It forms a small invagination to meet the rectum, so that it also lines the anus. It gives rise to the entire nervous system by producing the medullary canal, which makes the central nervous system, and from which grow out all the nerves, and probably all the peripheral ganglia, and from which also grows out the evagination which makes the optic nerve, the retina, the choroid, and the epithelial portions of the iris. It forms the epithelium of the olfactory and nasal cavities, and the epithelium of the auditory labyrinth.

The entoderm [also spelled "endoderm"] forms the epithelium which lines the digestive tract, including the surface of the tongue; also the epithelium of the trachea and lungs, and of all the glands appended to the respiratory passages, and to the digestive tract, including the thyroid, pancreas, and liver. The liver cells, it should be remembered, constitute a true though much modified epithelium. The notochord is developed from the entoderm.

The mesoderm may be conveniently divided into three portions—the mesenchyma, the mesamœboids, and the mesothelium (*cf. Coelom*). 1. The *mesenchyma* produces all the connective tissues of the body, and includes therefore the cutis, the non-epithelial walls of the alimentary tract, etc.; tendons, cartilage, and bone, the marrow of bones, lymph glands, and spleen; it produces also the blood-vessels and blood, the entire lymphatic system proper, and the heart. Pigment cells, fat cells, and smooth muscles are derived from the mesenchyma also. 2. The *mesamœboids* include the leucocytes and wandering cells, and perhaps the embryonic red blood cells, and the marrow cells. 3. The *mesothelium* is the epithelium of the cœlom; it produces the peritoneal and pleural epithelia, the striated muscles (myotomes), except those of the heart, and all the non-mesenchymal tissues of the entire urogenital apparatus, except, of course, the external genitalia. (Spee traces the Wolffian duct to the ectoderm.)

Now, in classifying organs, it is best to rank them as belonging to that layer from which their functionally essential and characteristic part is derived. Thus, although the pancreas, ovary, and spinal cord all contain connective tissue, we do not call them mesodermal, but respectively entodermal, mesothelial, and ectodermal. The gland cells of the pancreas come from the entoderm; the ova and the Graafian follicles come from the mesothelium; the ganglion cells and nerve fibres (axis cylinders) from the ectoderm. Adopting this principle, we may classify the organs of the human body as follows:

Ectodermal.	Mesodermal.	Entodermal.
Skin (epidermis).	1. Mesenchyma:	Epithelium (of digestive tract):
Epidermal structures:	Connective tissue:	Thyroid,
Hair,	Cutis, etc.,	Trachea and lungs,
Nails,	Tendons,	Œsophagus,
Glands:	Cartilage,	Stomach,
Sebaceous,	Bone,	Liver,
Sudorific,	Marrow.	Pancreas,
(Salivary ?),	Lymph glands.	Intestine,
(Thymus ?).	Spleen.	Yolk sac,
Corneal epithelium,	Blood-vessels:	Cœcum,
Lens of eye.	blood (in part).	Vermix,
Central nervous system:	Lymphatic system,	Colon,
Nerves,	Fat cells,	Rectum,
Ganglia.	Smooth muscle.	Allantois:
Eye, optic vesicle:	2. Mesamœboids:	(Bladder).
Optic nerve,	Leucocytes,	Notochord.
Retina, etc.	Embryonic red blood cells,	
Olfactory organ.	(Marrow cells ?).	
Auditory organ.	3. Mesothelium:	
Lining of mouth:	Peritoneum,	
Teeth,	Pleuræ,	
Hypophysis.	Urogenitals:	
Anus.	Wolffian body,	
Chorion:	Kidney,	
Placenta.	Testis,	
Amnion:	Ovary,	
(Wolffian duct ?).	Oviduct:	
	Uterus,	
	Vagina.	
	Striated muscles.	

The human body may be defined as two tubes of epithelium, one inside the other; the outer tube, epidermal or ectodermal, is very irregular in its form; the inner tube, entodermal, is much smaller in diameter, but much longer than the outer, and has a number of branches (lung, pancreas, etc.), and is placed within the ectodermal tube. Between these two tubes is the very bulky mesoderm, which is divided by large cavities (abdominal and thoracic) into two main layers, one of which is closely associated with the epidermis and forms the body wall, the somatopleure of embryologists; the other joins with the entoderm to complete the walls of the splanchnic viscera, and constitute the splanchnopleure of embryologists. The mesoderm is permeated by two sets of cavities: (1) the heart and blood-vessels; (2) the lymphatic system. It is also differentiated into numerous tissues, muscle, tendon, bone, etc., and organs, urogenital system. The nervous system, although developed from the ectoderm, is found separated from its site of origin, and completely encased in mesoderm.

As we ascend the animal scale, we discover in all parts an increasing complexity; especially in the nervous system is this marked, but it is even more strikingly shown by the evolution of the mesoderm in relative size and differentiation. This important correspondence between the organization of the mesoderm and the degree of evolution of animals has not, to my knowledge, hitherto attracted express attention.

Charles Sedgwick Minot.

GESTATION.—The word is derived from the Latin verb *gestare* to carry, and therefore describes the function performed by the pregnant woman from the time of the fecundation of the ovum to that of delivery. Gestation and pregnancy are synonymous, but most authors do not apply either term to those pathologic conditions characterized by prolonged retention of a dead fœtus or secundines.

The German synonym *Schwangerschaft* expresses this same idea of carrying something; the French *grossesse* refers to the increase in the size of the abdomen during pregnancy; the Italian *gravidanza*, like the English terms *gravid* and *gravidity*, imply an increase in the weight of the uterus (*gravo*, to weigh down).

When more than one fœtus is present the gestation is designated as *multiple*, in distinction from a *single* or *simple* pregnancy. Normally the ovum should develop within the uterine cavity, and all other forms of gestation are known as *ectopic*, viz., out of place. In this article the subject of ectopic gestation will not be considered.

MODIFICATIONS CAUSED BY GESTATION.—The presence of the fecundated ovum at once stimulates the maternal organism, and a series of changes take place in order to

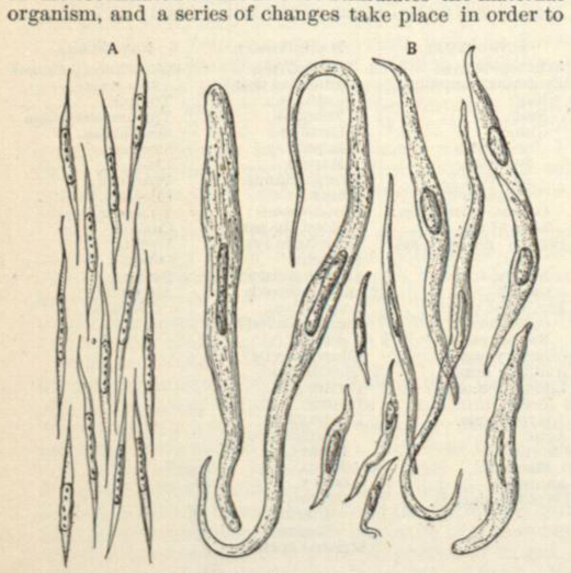

FIG. 2289.—*A*, Muscle-elements from Non-pregnant Uterus; *B*, cells from uterus shortly after delivery. (Sappey.)

meet the following requirements: 1. A place must be provided in which the fœtus can develop and be protected. 2. There must be a physiologic hypertrophy of all organs concerned in the processes of nutrition and excretion. 3. There must be preparations for labor and subsequent nourishment of the child. Under these heads will fall all the local and general changes induced by gestation, but as the genital system is the centre of physiologic disturbance it is there we expect to find the most striking modifications.

Uterus—Modifications of its Body.—Increase in the size of the womb in order to keep pace with the growing demands of the fœtus constitutes one of the most prominent features of gestation. The volume of the uterus augments gradually, but not regularly, the growth during the later months being more rapid than at first. Of course the size of the uterus at term varies somewhat, depending upon the size of the fœtus, the number of children in utero, and the amount of liquor amnii; but the following figures give a general idea of the extent of uterine enlargement:

Before impregnation the uterus weighs about an ounce, its capacity is about one cubic inch, and the length of the cavity is two and one-half inches. At term the uterus weighs two pounds, has a capacity of four hundred cubic inches, and its cavity measures fifteen by ten by nine inches.

The increase in size is due chiefly to hypertrophy of all the constituents of the organ, and occurs, although in a less degree, even when the ovum develops outside of the uterine cavity. During the latter part of pregnancy distention undoubtedly plays a rôle in producing the uterine tumor.

Changes in the Form, Position, and Direction of the Uterine Body.—At first the uterus preserves its pyriform shape, but the gradual increase in its antero-posterior diameter gives it a spherical outline during the third and fourth months. From the fifth month onward the expansion of the fundus and lower uterine segment alters the sphere into an ovoid with the larger end up. Herrgott ("Essais sur les differentes variétés de forme de matrice pendant la gestation et l'accouchement," Strasbourg, 1839) found that the fundus of the uterus rarely took on a symmetrical development, but that the right half usually contained the breech and was more elevated than the left. The anterior portion of the lower segment is more developed than the posterior so that the axis of the uterine body passes in front of the cervix.

The enlargement of the uterus necessitates a change of position, especially as the organ soon becomes too large for the pelvic cavity. Many books describe a descent during the early weeks of gestation, but Tarnier and Pinard never have noted this downward movement except as a part of that pathologic condition known as prolapse. During the first months of gestation the gravid state of the uterus tends to exaggerate the normal anteflexion, and after the fourth month, when the fundus emerges from the pelvis, the degree of anteflexion is regulated by the position of the woman and the tonicity of the abdominal walls.

It usually is stated that by the fifth month the fundus has reached half-way to the umbilicus; by the sixth that it is on the level of the umbilicus, and that by the eighth, or eight and a half, the fundus lies under the ensiform cartilage. Pinard, however, says that the fundus usually is much higher than is described by most authors, and that he never found a uterus whose fundus was not above the umbilicus at the fifth month of gestation. On the other hand, Ribemont-Dessaignes mentions a case in which, at the sixth month, he found the fundus below the level of the umbilicus, the child weighing over seven pounds at birth. A possible explanation of these discrepancies may lie in the fact that the umbilicus is not a fixed point. At some time during the last two weeks of gestation the presenting part slips into the brim of the pelvis and the fundus sinks. In multiparæ this readjustment may be quite sudden and give rise to a sensation of "lightening," but it is much more gradual in primiparæ owing to greater rigidity of the abdominal walls.

The fundus of the uterus seldom lies in the median line of the abdomen. On examining 100 women at the ninth

month of pregnancy P. Dubois and Pajot found a right lateral deviation in 76, a left in 4; in the remaining 20 the fundus lay in the median line. Not only does the fundus tend to fall to the right, but the body of the uterus rotates so that the left side is turned to the front. Probably both the deviation and the torsion proceed from the same cause; the distended sigmoid and rectum prevent the uterus from balancing upon the prominent vertebral column and push the organ toward the right; as the uterus rolls into the concavity at the right of the spine the right face becomes posterior. Unless this physiologic torsion of the uterus is remembered at the time of performing the operation of Cesarian section, the surgeon is in danger of making his incision into the left border of the uterus and severing some of the large vascular trunks lying in that region.

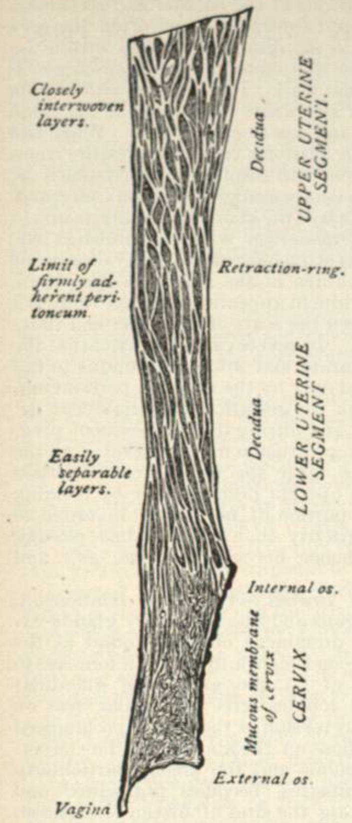

FIG. 2290.—Section of Wall of Pregnant Uterus. (Hofmeier.)

Changes in the Structure of the Uterus.—All the constituents of the uterus are involved in the process of development. There is marked hyperplasia of the serous coat, allowing the peritoneum to cover the uterus at the different stages of enlargement. The muscular fibres in the walls are greatly increased in size, but it is not proved that a true hyperplasia occurs. In the pregnant womb three layers of muscular fibres can be demonstrated. The superficial layer is made up of longitudinal and transverse fibres, which are continuous with those upon the surfaces of the tubes and round ligaments. The median layer forms the bulk of the uterine walls and contains interlacing fibres running in all directions. This layer is traversed by numerous vascular trunks around which the muscular fibres take an arciform direction. In the case of the veins, the external and middle coats of the vessels disappear so that the blood is conveyed in muscular channels lined by endothelial cells and known as sinuses. By the constricting action of these arciform fibres, which Pinard calls *ligatures vivantes*, hemorrhage is prevented after labor. The internal muscular layer is very thin and best marked by circular fibres at the orifices of the tubes, although a set of longitudinal and transverse fibres may be found just beneath the mucous membrane. In the lower uterine segment there is a predominance of longitudinal muscular fibres.

The advent of pregnancy stimulates the mucous membrane of the uterus so that it becomes congested, thickened, and thrown up into folds. The hypertrophy is the result of an increase in the interglandular tissue and a growth of the cellular layer in which may be found the large decidual cells of Friedländer. The superficial, or *compact layer*, of the decidua vera is in contact with the ovular decidua by the third month and then rapidly atrophies; it is through the deeper, or *spongy, layer* that the line of separation runs when the decidua is cast off.

All the blood-vessels of the uterus become much enlarged, and at the placental site the arteries empty directly into the lacunæ, the blood spaces penetrated by the villi. The veins form the uterine sinuses as described above and constitute an extensive plexus. The lymphatics are increased both in size and in number, communicating freely with those of the peritoneum and adnexa, an arrangement which readily explains the seriousness of puerperal infection and the ease with which it occurs. Nerve cells and trunks take part in the general hypertrophy. Keiffer (*Gaz. hebdom. de Méd. et de Chir.*, June 7th, 1900) claims that the uterus has a set of independent nerve cells which are found along the vessels and can be detected by Golgi's method of staining. These local ganglia have sensory, motor, secretory, and glandular functions, giving to the uterus an independence similar to that of the heart.

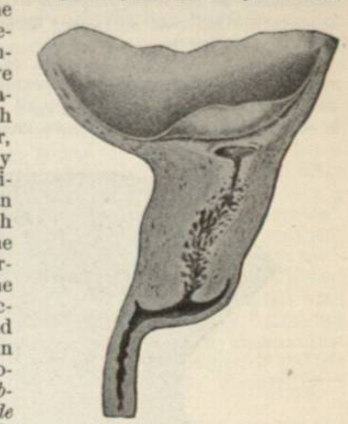

FIG. 2291.—Cervix in the Fifth Month of Pregnancy. (Leopold.)

During the first part of gestation the general hypertrophy of the tissues gives the uterine walls a thickness of five-eighths of an inch, but later distention reduces this measurement to one-quarter of an inch. Instead of being firm and unyielding, as are the walls of the virgin uterus, the tissues of the gravid womb are elastic and permit the fœtal movements, or a change in the woman's position, to alter the outline of the organ.

Modifications of the Cervix.—The hypertrophy of the cervix is much less marked than is that of the body of the uterus and is mostly completed by the fifth month of gestation. The mucous membrane of the cervix takes no part in the formation of the decidua, but the glands secrete a quantity of mucus which securely plugs the canal from the beginning of gestation. In primiparæ the form of the cervix is that of a cone with its apex down; in multiparæ the cone has its base down. In primiparæ, during the latter months of gestation when the presenting part lies low down and against the anterior wall of the

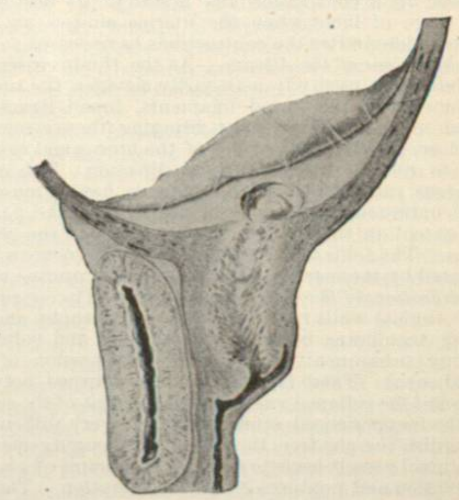

FIG. 2292.—Cervix in the Seventh Month. (Leopold.)