deformities it will be seen that the same forces applied to diseased and softened bones explain the peculiarities of form that they assume.

Pelvis in Different Races.—The researches that have been made on the differences of the pelvis in different races prove that these are not so great as might have been expected. Joulin pointed out that in all human pelves the transverse (T) diameter was larger than the antero-posterior (C. V), while the reverse was the case in all the lower animals, even in the highest simiæ. This observation has been more recently confirmed by Von Franque,[1] who has made careful measurements of the pelvis in various races. In the pelvis of the gorilla the oval form of the brim, resulting from the increased length of the conjugate (C. V) diameter, is very marked. In certain races there is so far a tendency to animality of type that the difference between the transverse (T) and conjugate (C. V) diameters is much less than in European women, but it is not sufficiently marked to enable us to refer any given pelvis to a particular race. Von Franque makes the general observation that the size of the pelvis increases from south to north, but that the conjugate (C. V) diameter increases in proportion to the transverse (T) in southern races.

Soft Parts in Connection with Pelvis.—In closing the description of the pelvis, the attention of the student must be directed to the muscular and other structures which cover it. It has already been pointed out that the measurements of the pelvic diameters are considerably lessened by the soft parts, which also influence parturition in other ways. Thus, attached to the crests of the ilia are strong muscles which not only support the enlarged uterus during pregnancy, but are powerful accessory muscles in labor: in the pelvic cavity are the obturator and pyriformis muscles lining it on either side; the pelvic cellular tissue and fasciæ; the rectum and bladder; the vessels and nerves, pressure on which often gives rise to cramps and pains during pregnancy and labor; while below, the outlet of the pelvis is closed, and its axis directed forward by the numerous muscles forming the floor of the pelvis and perineum. The structures closing the pelvis have been accurately described by Dr. Berry Hart,[2] who points out that they form a complete diaphragm stretching from the pubis to the sacrum, in which are three "faults" or "slits" formed by the orifices of the urethra, vagina, and rectum. The first of these is a mere capillary slit, the last is closed by a strong muscular sphincter, while the vagina, in a healthy condition, is also a mere slit, with its walls in accurate apposition. Hence it follows that none of these apertures impairs the structural efficiency of the pelvic floor, or the support it gives to the structures above it.

[1] Scanzoni's Beiträge, 1867.
[2] The Structural Anatomy of the Female Pelvic Floor.

CHAPTER II.

THE FEMALE GENERATIVE ORGANS.

THE reproductive organs in the female are conveniently divided, according to their function, into: 1. The external or copulative organs, which are chiefly concerned in the act of insemination, and are only of secondary importance in parturition: they include all the organs situate externally which form the vulva; and the vagina, which is placed internally and forms the canal of communication between the uterus and the vulva. 2. The internal or formative organs: they include the ovaries, which are the most important of all, as being those in which the ovule is formed; the Fallopian tubes, through which the ovule is carried to the uterus; and the uterus, in which the impregnated ovule is lodged and developed.

1. The external organs consist of:

The mons Veneris (Fig. 14, F), a cushion of adipose and fibrous tissue which forms a rounded projection at the upper part of the vulva. It is in relation above with the lower part of the hypogastric region, from which it is often separated by a furrow, and below it is continuous with the labia majora on either side. It lies over the symphysis and horizontal rami of the pubes. After puberty it is covered with hair. On its integument are found the openings of numerous sweat and sebaceous glands.

The labia majora (Fig. 14, *a*) form two symmetrical sides to the longitudinal aperture of the vulva. They have two surfaces, one external, of ordinary integument, covered with hair, and another internal, of smooth mucous membrane, in apposition with the corresponding portion of the opposite labium, and separated from the external surface by a free convex border. They are thicker in front, where they run into the mons Veneris, and thinner behind, where they are united, in front of the perineum, by a thin fold of integument called the fourchette, which is almost invariably ruptured in the first labor. In the virgin the labia are closely in apposition, and conceal the rest of the generative organs. After childbearing they become more or less separated from each other, and in the aged they waste, and the internal nymphæ protrude through them. Both their cutaneous and mucous surfaces contain a large number of sebaceous glands, opening either directly on the surface or into the hair follicles. In structure the labia are composed of connective tissue, containing a varying amount of fat, and parallel with their external surface are placed tolerably close plexuses of elastic tissue, interspersed with regularly arranged smooth muscular fibres. These fibres are described by Broca as forming a membranous sac, resembling the dartos of the scrotum, to which the labia majora are analogous. Toward its upper

and narrower end this sac is continuous with the external inguinal ring, and in it terminate some of the fibres of the round ligament. The analogy with the scrotum is further borne out by the occasional hernial protrusion of the ovary into the labium, corresponding to the normal descent of the testis in the male.

FIG. 14.

External genitals of virgin with diaphragmatic hymen. *a*. Labium majus. *b*. Labium minus. *c*. Præputium clitoridis. *d*. Glans clitoridis. *e*. Vestibule just above urethral orifice. F. Mons Veneris. (After SAPPEY.)

The labia minora, or nymphæ (Fig. 14, *b*), are two folds of mucous membrane, commencing below, on either side, about the centre of the internal surface of the labium externum; they converge as they proceed upward, bifurcating as they approach each other. The lower branch of this bifurcation is attached to the clitoris (Fig. 14, *d*), while the upper and larger unites with its fellow of the opposite side, and forms a fold round the clitoris, known as its prepuce, *c*. The nymphæ are usually entirely concealed by the labia majora, but after child-bearing and in old age they project somewhat beyond them; then they lose their delicate pink color and soft texture, and become brown, dry, and like skin in appearance. This is especially the case in some of the negro races, in whom they form long projecting folds called the apron.

The surfaces of the nymphæ are covered with tessellated epithelium, and over them are distributed a large number of vascular papillæ, somewhat enlarged at their extremities, and sebaceous glands, which are more numerous on their internal surfaces. The latter secrete an odorous, cheesy matter, which lubricates the surface of the vulva, and prevents its folds adhering to each other. The nymphæ are composed of trabeculæ of connective tissue, containing muscular fibres.

The clitoris (Fig. 14, *d*) is a small erectile tubercle situated about half an inch below the anterior commissure of the labia majora. It is the analogue of the penis in the male, and is similar to it in structure, consisting of two corpora cavernosa, separated from each other by a fibrous septum. The crura are covered by the ischio-cavernous muscles, which serve the same purpose as in the male. It has also a suspensory ligament. The corpora cavernosa are composed of a vascular plexus with numerous traversing muscular fibres. The arteries are derived from the internal pudic artery, which gives a branch, the cavernous, to each half of the organ; there is also a dorsal artery distributed to the prepuce. According to Gussenbauer, these cavernous arteries pour their blood directly into large veins, and a finer venous plexus near the surface receives arterial blood from small arterial branches. By these arrangements the erection of the organ which takes place during sexual excitement is favored. The nervous supply of the clitoris is large, being derived from the internal pudic nerve, which supplies branches to the corpora cavernosa, and terminates in the glans and prepuce, where Pacinian corpuscles and terminal bulbs are to be found. On this account the clitoris has been supposed by some to be the chief seat of voluptuous sensation in the female.

The vestibule (Fig. 14, *e*) is a triangular space, bounded at its apex by the clitoris, and on either side by the folds of the nymphæ. It is smooth, and, unlike the rest of the vulva, is destitute of sebaceous glands, although there are several groups of muciparous glands opening on its surface. At the centre of the base of the triangle, which is formed by the upper edge of the opening of the vagina, is a prominence, distant about an inch from the clitoris, on which is the orifice of the urethra. This prominence can be readily made out by the finger, and the depression upon it—leading to the urethra—is of importance as our guide in passing the female catheter. This little operation ought to be performed without exposing the patient, and it is done in several ways. The easiest is to place the tip of the index finger of the left hand (the patient lying on her back) on the apex of the vestibule, and slip it gently down until we feel the bulb of the urethra, and the dimple of its orifice, which is generally readily found. If there is any difficulty in finding the orifice, it is well to remember that it is placed immediately below the sharp edge of the lower border of the symphysis pubis, which will guide us to it. The catheter (and a male elastic catheter is always the best, especially during labor, when the urethra is apt to be stretched) is then passed under the thigh of the patient, and directed to the orifice of the urethra by the finger of the left hand, which is placed upon it. We must be careful that the instrument is really passed into the urethra, and not into the vagina.

It is advisable to have a few feet of elastic tubing attached to the end of the catheter, so that the urine can be passed into a vessel under the bed without uncovering the patient. If the patient be on her side, in the usual obstetric position, the operation can be more readily performed by placing the tip of the finger in the vagina, and feeling its upper edge. The orifice of the urethra lies immediately above this, and if the catheter be slipped along the palmar surface of the finger, it can generally be inserted without much trouble. If, however, as is often the case during labor, the parts are much swollen, it may be difficult to find the aperture, and it is then always better to look for the opening than to hurt the patient by long-continued efforts to feel it.

The urethra is a canal one and a half inches in length, and it is intimately connected with the anterior wall of the vagina, through which it may be felt. It is composed of muscular and erectile tissue, and is remarkable for its extreme dilatability, a property which is turned to practical account in some of the operations for stone in the female bladder.

About an eighth of an inch above its orifice are the openings of two glandular structures situated in its muscular walls. They are about three-quarters of an inch in length, and were first described by Professor Skene, of Brooklyn.[1]

The orifice of the vagina is situated immediately below the bulb of the urethra. In virgins it is a circular opening, but in women who have borne children or practised sexual intercourse it is, in the undistended state, a fissure, running transversely, and at right angles to that between the labia.[2] In virgins it is generally more or less blocked up by a fold of mucous membrane, containing some cellular tissue and muscular fibres, with vessels and nerves, which is known as the *hymen*. This is continuous with the anterior extremity of the vagina, the mucous membrane of which lines its internal surface; that covering its external surface being derived from the mucous membrane of the vulva.[3] The hymen is developed late in the female embryo, and at first is seen in the form of two projections on either side of the urogenital fissure, which ultimately unite in the central line. At birth it is very prominent, and has occasionally been taken for the internal labia.[4] It is most often crescentic in shape, with the concavity of the crescent looking upward; sometimes, however, it is circular with a central opening, or cribriform; or it may even be entirely imperforate, and this gives rise to the retention of the menstrual secretion. These varieties of form depend on the peculiar mode of development of the fold of vaginal mucous membrane which blocks up the orifice of the vagina in the fœtus, and from which the hymen is formed. The density of the membrane also varies in different individuals. Most usually it is very slight, so as to be ruptured in the first sexual approaches, or even by some accidental circumstance, such as stretching the limbs, so that its absence cannot be taken as evidence of want of chastity. A knowledge of this fact is of considerable importance from a medico-

[1] Amer. Journ. of Obstetrics, 1880, vol. xiii. p. 265.
[2] Hart: op. cit.
[3] Budin: Recherches sur l'Hymen et l'Orifice vaginal, 1879.
[4] Doran: Gynecological Operations, p. 7.

legal point of view. Sometimes it is so tough as to prevent intercourse altogether, and may require division by the knife or scissors before this can be effected; and at others it rather unfolds than ruptures, so that it may exist even after impregnation has been effected, and it has been met with intact in women who have habitually led unchaste lives. In a few rare cases it has even formed an obstacle to delivery, and has required incision during labor.

The carunculæ myrtiformes are small fleshy tubercles varying from two to five in number, situated round the orifice of the vagina, and which are generally supposed to be the remains of the ruptured hymen. Schroeder, however, maintains that they are only formed after childbearing, in consequence of parts of the hymen having been destroyed by the injuries received during the passage of the child.

Vulvo-vaginal Glands.—Near the posterior part of the vaginal orifice, and below the superficial perineal fascia, are situated two conglomerate glands which are the analogues of Cowper's glands in the male. Each of these is about the size and shape of an almond, and is contained in a cellular fibrous envelope. Internally they are of a yellowish-white color, and are composed of a number of lobules separated from each other by prolongations of the external envelope. These give origin to separate ducts which unite into a common canal, about half an inch in length, which opens in front of the attached edge of the hymen in virgins, and in married women at the base of one of the carunculæ myrtiformes. According to Huguier, the size of the glands varies much in different women, and they appear to have some connection with the ovary, as he has always found the largest gland to be on the same side as the largest ovary. They secrete a glairy, tenacious fluid, which is ejected in jets during the sexual orgasm, probably through the spasmodic action of the perineal muscles. At other times their secretion serves the purpose of lubricating the vulva, and thus preserves the sensibility of its mucous membrane.

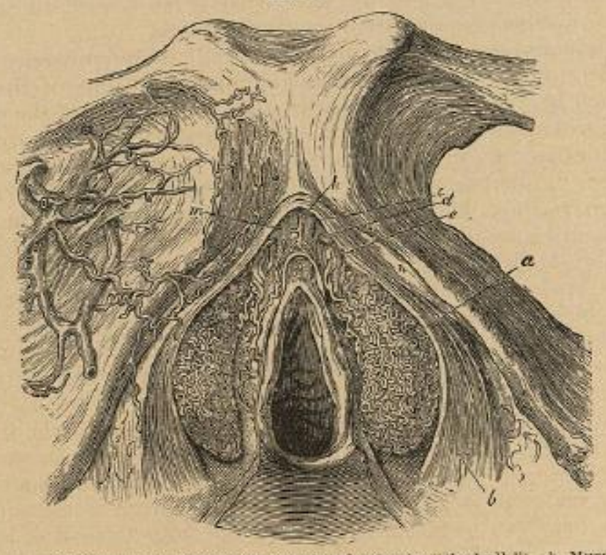
Fossa Navicularis.—Immediately behind the hymen in the unmarried, and between it and the perineum, is a small depression, called the *fossa navicularis*, which disappears after childbearing.

The perineum separates the orifice of the vagina from that of the rectum. It is about one and a half inches in breadth, and is of great obstetric interest, not only as supporting the internal organs from below, but because of its action in labor. It is largely stretched and distended by the presenting part of the child, and, if unusually tough and unyielding, may retard delivery, or it may be torn to a greater or less extent, thus giving rise to various subsequent troubles.

Vascular Supply of the Vulva.—The structures described above together form the *vulva*, and they are remarkable for their abundant vascular and nervous supply. The former constitutes an erectile tissue, similar to that which has already been described in the clitoris, and which is specially marked about the bulb of the vestibule. From this point, and extending on either side of the vagina, there is a well-marked plexus of convoluted veins (Fig. 15, *a*), which, in their distended state, are likened by Dr. Arthur Farre to a filled leech. The distention of the erectile tissue, as well as that of the clitoris, is brought

about under excitement, as in the male, by the compression of the efferent veins, by the contraction of the ischio-cavernous muscles, and by that of a thin layer of muscular tissues surrounding the orifice of the vagina, and described as the constrictor vaginæ.

Fig. 15.



Vascular supply of vulva. *a*. Plexus of convoluted veins (or "the bulb"). *b*. Muscular tissue of vagina. *c, d, e, f*. The clitoris (*f*) and muscles. *g, h, i, k, l, m, n*. Veins of the nymphæ and clitoris communicating with the epigastric and obturator veins. (After Kobelt.)

The vagina is the canal which forms the communication between the external and internal generative organs, through which the semen passes to reach the uterus, the menses flow, and the fœtus is expelled. Roughly speaking, it lies in the axis of the pelvis, but its opening is placed anterior to the axis of the pelvic outlet, so that its lower portion is curved forward, so as to lie parallel to the pelvic brim. It is narrow below, but dilated above, where the cervix uteri is inserted into it, so that it is more or less conoidal in shape. Under ordinary circumstances, especially in the virgin, the anterior and posterior walls lie in close contact with each other (see Plate I.), and there is, strictly speaking, no vaginal canal, although they are capable of wide distention, as in copulation, and during the passage of the fœtus. The anterior wall of the vagina is shorter than the posterior, the former measuring on an average two and a half inches, the latter three inches; but the length of the canal varies greatly in different subjects and under certain circumstances. In front the vagina is closely connected with the base of the bladder, so that when the vagina is prolapsed, as often occurs, it drags the bladder with it (Fig. 17); behind, it is in relation with the rectum, but less intimately; laterally, with the broad ligaments and pelvic fascia; and superiorly, with the lower portion of the uterus and

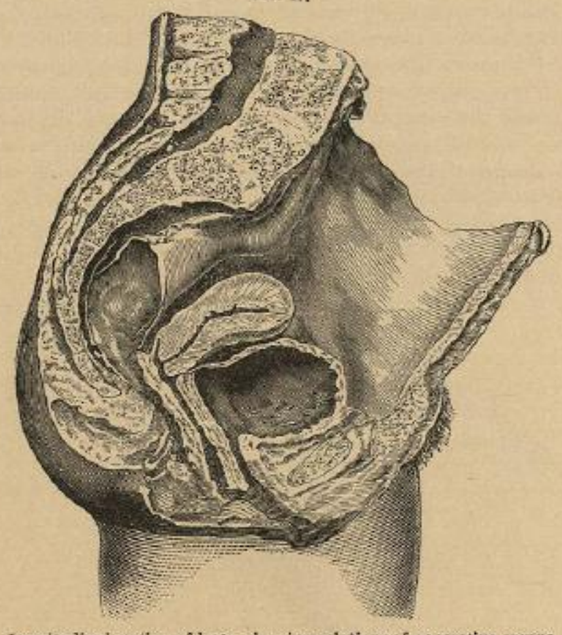
folds of peritoneum both before and behind. The vagina is composed of mucous, muscular, and cellular coats. The mucous lining is thrown into numerous folds. These start from longitudinal ridges which exist on both the anterior and posterior walls, but most distinctly on the anterior. They are very numerous in the young and unmarried, and greatly increase the sensitive surface of the vagina (Fig. 16). After childbearing, and in the aged, they become atrophied, but they never completely disappear, and toward the orifice of the vagina, where they exist in greatest abundance, they are always to be met with. The whole of the mucous membrane is lined with tessellated epithelium, and it is covered with a large number of papillæ, either conical or divided, which are highly vascular and project into the epithelial layer. Unlike the vulvar mucous membrane, that of the vagina seems to be

Fig. 16.

Right half of virgin vagina, with walls held apart, showing the abundant transverse rugæ, the greater depth of the vagina above than below, and the hymeneal segment. (After Hart.)

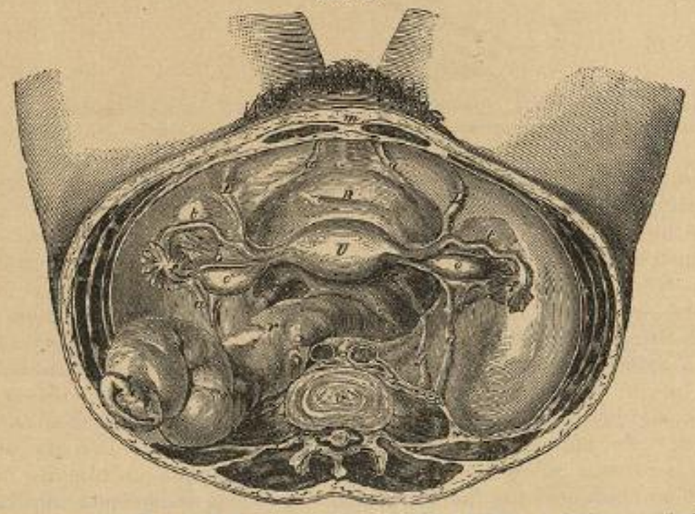
destitute of glands. Beneath the epithelial layer is a submucous tissue containing a large number of elastic and some muscular fibres, derived from the muscular walls of the vagina. These are strong and well developed, especially toward the ostium vaginæ, where they are arranged in a circular mass, having a sphincter action. They consist of two layers—an internal longitudinal, and an external circular—with oblique decussating fibres connecting the two. Below they are attached to the ischio-pubic rami, and above they are continuous with the muscular coat of the uterus. The muscular tissue of the vagina increases in thickness during pregnancy, but to a much less degree than that of the uterus. Its vascular arrangements, like those of the vulva, are such as to constitute an erectile tissue. The arteries form an intricate network around the tube, and eventually end in a submucous capillary plexus from which twigs pass to supply the papillæ; these, again, give origin to venous radicles which unite into meshes freely interlacing with each other, and forming a well-marked venous plexus.

FIG. 17.



Longitudinal section of body, showing relations of generative organs.

FIG. 18.



Transverse section of the body, showing relations of the fundus uteri. *m*. Pubes. *a a* (in front). Remainder of hypogastric arteries. *a a* (behind). Spermatic vessels and nerves. *B*. Bladder. *L L*. Round ligaments. *U*. Fundus uteri. *t t*. Fallopian tubes. *o o*. Ovaries. *r*. Rectum. *g*. Right ureter, resting on the psoas muscle. *c*. Utero-sacral ligaments. *v*. Last lumbar vertebra.

2. The internal organs of generation consist of the uterus, the Fallopian tubes, and the ovaries; and in connection with them we have to study the various ligaments and folds of peritoneum which serve to maintain the organs in position, along with certain accessory structures. Physiologically, the most important of all the generative organs are the ovaries, in which the ovules are formed, and which dominate the entire reproductive life of the female. The Fallopian tubes, which convey the ovule to the uterus, and the uterus itself—whose main function is to receive, nourish, and eventually expel the impregnated product of the ovary—may be said to be, in fact, accessory to these viscera. Practically, however, as obstetricians, we are chiefly concerned with the uterus, and may conveniently commence with its description.

The uterus is correctly described as a pyriform organ, flattened from before backward, consisting of the body, with its rounded fundus, and the cervix, which projects into the upper part of the vaginal canal. In the adult female it is deeply situated in the pelvis, being placed between the bladder in front and the rectum behind, its fundus being below the plane of the pelvic brim (Fig. 18). It only assumes this position, however, toward the period of puberty; and in the fœtus it is placed much higher, and lies, indeed, entirely within the cavity of the abdomen. It is maintained in this position partly by being slung by its ligaments, which we shall subsequently study, and partly by being supported from below by the pelvic cellular tissue and the fleshy column of the vagina. The result is that the uterus, in the healthy female, is a perfectly movable body, altering its position to suit the condition of the surrounding viscera, especially the bladder and rectum, which are subjected to variations of size according to their fulness or emptiness. When from any cause the mobility of the organ is interfered with—as, for example, by some peri-uterine inflammation producing adhesions to the surrounding textures—much distress ensues, and if pregnancy supervenes more or less serious consequences may result. Generally speaking, the uterus may be said to lie in a line roughly corresponding with the axis of the pelvic brim, its fundus being pointed forward and its cervix lying in such a direction that a line drawn from it would impinge on the junction between the sacrum and coccyx. According to some authorities, the uterus in early life is more curved in the anterior direction, and is, in fact, normally in a state of anteflexion. Sappey holds that this is not necessarily the case, but that the amount of anterior curvature depends on the emptiness or fulness of the bladder, on which the uterus, as it were, moulds itself in the unimpregnated state. It is believed also that the body of the uterus is very generally twisted somewhat obliquely, so that its anterior surface looks a little toward the right side, this probably depending on the presence and frequent distention of the rectum in the left side of the pelvis. The anterior surface of the uterus is convex, and is covered in three-fourths of its extent by the peritoneum which is intimately adherent to it. Below the reflection of the membrane it is loosely connected by cellular tissue to the bladder, so that any downward displacement of the uterus drags the bladder along with it. The

posterior surface is also convex, but more distinctly so than the anterior, as may be observed in looking at a transverse section of the organ (Fig. 19). It is also covered by peritoneum, the reflection of which on the rectum forms the cavity known as Douglas's pouch. The fundus is the upper extremity of the uterus, lying above the points of entry of the Fallopian tubes. It is only slightly rounded in the

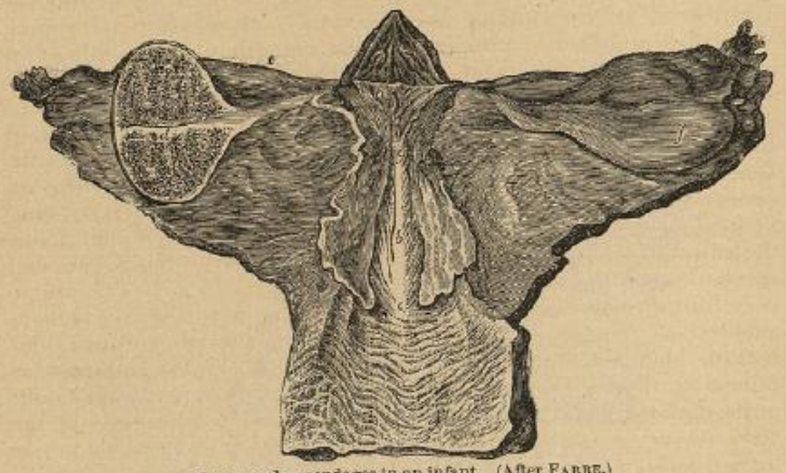
FIG. 19.

Transverse section of uterus.

virgin, but becomes more decidedly and permanently rounded in the woman who has borne children.

Until the period of puberty the uterus remains small and undeveloped (Fig. 20); after that time it reaches the adult size, at which it remains until menstruation ceases, when it again atrophies. If the woman has borne children, it always remains larger than in the

FIG. 20.



Uterus and appendages in an infant. (After FARRE.)

nullipara. In the virgin adult the uterus measures 2½ inches from the orifice to the fundus, rather more than half being taken up by the cervix. Its greatest breadth is opposite the insertion of the Fallopian tubes; its greatest thickness, about 11 or 12 lines, opposite the centre of its body. Its average weight is about 9 or 10 drachms. Independently of pregnancy, the uterus is subject to great alterations of size toward the menstrual period, when, on account of the congestion then present, it enlarges—sometimes, it is said, considerably. This fact should be borne in mind, as this periodical swelling might be taken for an early pregnancy.

For the purpose of description the uterus is conveniently divided into the *fundus*, with its rounded upper extremity, situated between the insertions of the Fallopian tubes; the *body*, which is bounded above by the insertions of the Fallopian tubes, and below by the upper extremity of the cervix, and which is the part chiefly concerned in the reception and growth of the ovum; and the *cervix*, which projects into the vagina, and dilates during labor to give passage to the child. The cervix is conical in shape, measuring 11 to 12 lines transversely at the base, and 6 or 7 in the antero-posterior direction; while at the apex it measures 7 to 8 transversely, and 5 antero-posteriorly. It projects about 4 lines into the canal of the vagina, the remainder of the cervix being placed above the reflection of the vaginal mucous membrane. It varies much in form in the virgin and nulliparous married woman, and in the woman who has borne children; and the differences are of importance in the diagnosis of pregnancy and uterine disease. In the virgin it is regularly pyramidal in shape. At its lower extremity is the opening of the external os uteri, forming a small circular opening, sometimes difficult to feel, and generally described as giving a sensation to the examining finger like the extremity of the cartilage at the tip of the nose. It is bounded by two lips, the anterior of which is apparently larger on account of the position of the uterus. The surface of the cervix and the borders of the os are very smooth and regular.

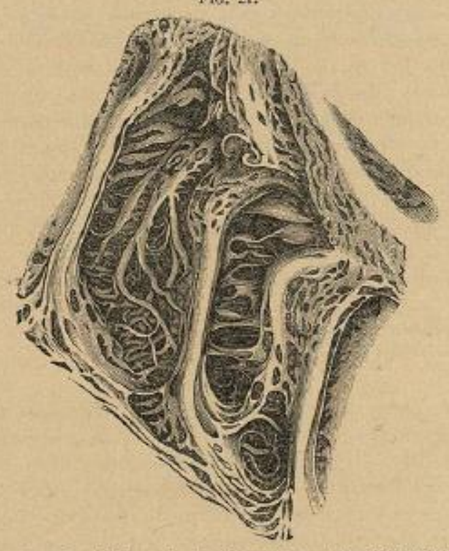
In women who have borne children these parts become considerably altered. The cervix is no longer conical, but is irregular in form and shortened. The lips of the os uteri become fissured and lobulated, on account of partial lacerations which have occurred during labor. The os is larger and more irregular in outline, and is sometimes sufficiently patulous to admit the tip of the finger. In old age the cervix atrophies, and after the change of life it not uncommonly entirely disappears, so that the orifice of the os uteri is on a level with the roof of the vagina.

The internal surface of the uterus comprises the cavities of the body and cervix—the former being rather less than the latter in length in virgins, but about equal in women who have borne children—separated from each other by a constriction forming the upper boundary of the cervical canal. The cavity of the body is triangular in shape, the base of the triangle being formed by a line joining the openings of the Fallopian tubes, its apex by the upper orifice of the cervix, or internal os, as it is sometimes called. In the virgin its boundaries are somewhat convex, projecting inward. After childbearing they become straight or slightly concave. The opposing surfaces of the cavity are always in contact in the healthy state, or are only separated from each other by a small quantity of mucus.

The cavity of the cervix is spindle-shaped or fusiform, narrower

above and below, at the internal and external os uteri, and somewhat dilated between these two points. It is flattened from before backward, and its opposing surfaces also lie in contact, but not so closely as those of the body. On the mucous lining of the anterior and posterior surfaces is a prominent perpendicular ridge, with a lesser one at each side, from which transverse ridges proceed at more or less acute angles. They have received the name of the *arbor vitæ*. According to Guyon, the perpendicular ridges are not exactly opposite, so that they fit into each other, and serve more completely to fill up the cavity of the cervix, especially toward the internal os (Fig. 21). The arbor vitæ is most distinct in the virgin, and atrophies considerably after childbearing.

FIG. 21.



Portion of interior of cervix. (Enlarged nine diameters.) (After TYLER SMITH and HASSALL.)

The superior extremity of the cervical canal forms a narrow isthmus separating it from the cavity of the body, and measuring about three-eighths of an inch in diameter. Like the external os, it contracts after the cessation of menstruation, and in old age sometimes becomes entirely obliterated.

The uterus is composed of three principal structures—the peritoneal, muscular, and mucous coats. The peritoneum forms an investment to the greater part of the organ, extending downward in front to the level of the os internum, and behind to the top of the vagina, from which points it is reflected upward on the bladder and rectum respectively. At the sides the peritoneal investment is not so extensive, for a little below the level of the Fallopian tubes the peritoneal folds separate from each other, forming the broad ligaments (to be afterward described); here it is that the vessels and nerves supplying the uterus

gain access to it. At the upper part of the organ the peritoneum is so closely adherent to the muscular tissue that it cannot be separated from it; below the connection is more loose. The mass of the uterine tissue, both in the body and cervix, consists of unstriped muscular fibres (Fig. 22), firmly united together by nucleated connective tissue and elastic fibres. The muscular fibre cells are large and fusiform, with very attenuated extremities, generally containing in their centre a distinct nucleus. These cells, as well as their nuclei, become greatly enlarged during pregnancy (Fig. 23); according to Stricker, this is only the case with the muscular fibres which play an important part in the expulsion of the fœtus, those of the outermost and innermost layers not sharing in the increase of size.[1] In addition to these developed fibres there are, especially near the mucous coat, a number of round elementary corpuscles, which are believed by Dr. Farre[2] to be the elementary form of the muscular fibres, and which he has traced in various intermediate states of development. Dr. John Williams[3] believes that a great part

FIG. 22.

Muscular fibres of unimpregnated uterus. *a*. Fibres united by connective tissue. *b*. Separate fibres and elementary corpuscles. (After FARRE.)

FIG. 23.

Developed muscular fibres from the gravid uterus. (After WAGNER.)

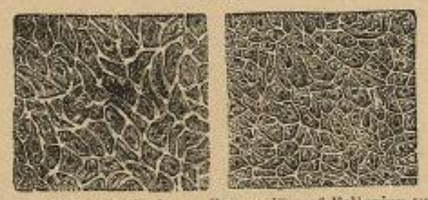
of the muscular tissue of the uterus, rather more indeed than three-fourths of its thickness, is an integral part of the mucous membrane, analogous to the muscularis mucosæ of the mucous membrane of the alimentary canal. This he describes as being separated from the rest of the muscular tissue by a layer of rather loose connective tissue, containing numerous vessels. In early fœtal life, and in the uteri of some of the lower animals, this appearance is very distinct; in the adult female uterus, however, it can be readily made out.

On examining the uterine tissue in an unimpregnated condition, no definite arrangement of its muscular fibres can be made out, and the whole seemed blended in inextricable confusion. By observation of

[1] Comparative Histology, vol. iii.; Syd. Soc. Trans., p. 477.
[2] The Uterus and its Appendages, p. 632.
[3] "On the Structure of the Mucous Membrane of the Uterus," Obstet. Journ., 1875-6, vol. iii. p. 496.

their relations when hypertrophied during pregnancy, Helié[1] has shown that they may, speaking roughly, be divided into three layers: an external; a middle, chiefly longitudinal; and an internal, chiefly circular. Into the details of their distribution, as described by him, it is needless to enter at length. Briefly, however, he describes the external layer as arising posteriorly at the junction of the body and cervix, and spreading upward and over the fundus. From this are derived the muscular fibres found in the broad and round ligaments, and more particularly described by Rouget. The middle layer is made up of strong fasciculi, which run upward, but decussate and unite with each other in a remarkable manner, so that those which are at first superficial become most deeply seated, and *vice versâ*. The muscular fasciculi which form this coat curve in a circular manner round the large veins, so as to form a species of muscular canal

FIG. 24.



From the body. From orifice of Fallopian tube.

Lining membrane of uterus, showing network of capillaries and orifices of uterine glands. (After FARRE.)

through which they run. This arrangement is of peculiar importance, as it affords a satisfactory explanation of the mechanism by which hemorrhage after delivery is prevented. The internal layer is mainly composed of circular rings of muscular fibres, beginning around the openings of the Fallopian tubes, and forming wider and wider circles which eventually touch and interlace with each other. They surround the internal os, to which they form a kind of sphincter. In addition to these circular fibres on the internal uterine surface both anteriorly and posteriorly, there is a well-marked triangular layer of longitudinal fibres, the base being above and the apex below, which sends muscular fasciculi into the mucous membrane.

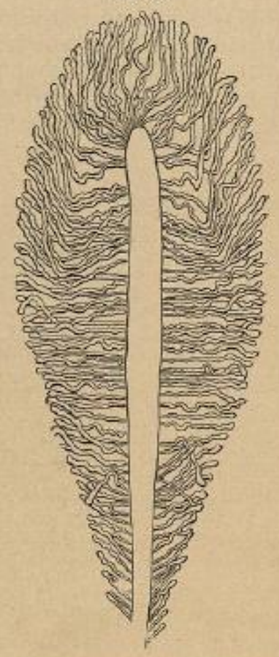
The anatomy of the lining membrane of the uterus has been the subject of considerable discussion. Its existence has been denied by many authorities, most recently by Snow Beck,[2] who maintains that it is in no sense a mucous membrane, but only a softened portion of true uterine tissue. It is, however, pretty generally admitted by the best authorities that it is essentially a mucous membrane, differing from others only in being more closely adherent to the subjacent structures, in consequence of not possessing any definite connective-tissue framework.

It is a pale pink membrane of considerable thickness, most marked

[1] Recherches sur la Disposition des Fibres musculaires de l'Utérus. Paris, 1869.
[2] Obstet. Trans., 1872, vol. xiii. p. 294.

at the centre of the body, where it forms from one-eighth to one-fourth of the thickness of the whole uterine walls. At the internal os uteri it terminates by a distinct border, which separates it from the mucous membrane lining the cervical cavity.

FIG. 25.



The course of the glands in the fully developed mucous membrane of the uterus, viz., just before the onset of a menstrual period. (After WILLIAMS.)

On the surface of the mucous membrane may be observed a multitude of little openings, about one-thirtieth of a line in width (Fig. 24). These are the orifices of the utricular glands, which are found in immense numbers all over the cavity of the uterus, and very closely agglomerated together. They are little cul-de-sacs, narrower at their mouths than in their length, the blind extremities of which are found in the subjacent tissues (Fig. 26). Williams describes them as running obliquely toward the surface at the lower third of the cavity, perpendicularly at its middle, while toward the fundus they are at first perpendicular, and then oblique in their course (Fig. 25). By others they are described as being often twisted and corkscrew-like. One or more may unite to form a common orifice, several of which may open together in little pits or depressions on the surface of the mucous membrane. These glands are composed of structureless membrane lined with epithelium, the precise character of which is doubtful. By some it is described as columnar, by others as tessellated, and by some again as ciliated. The most generally received opinion is that it is columnar, but not ciliated; therein differing from the epithelium covering the surface of the membrane, which is undoubtedly ciliated, the movements of the cilia being from within outward. Williams, however, has observed cilia in active movement on the columnar epithelium lining the glands, and also states that at the deep-seated extremities of the glands, which penetrate between the muscular fibres for some distance, the columnar epithelium is replaced by rounded cells. The capillaries of the mucous membrane run down between the tubes, forming a lacework on their surfaces, and around their orifices. No true papillæ exist in the membrane lining the uterine cavity. The mucous membrane of the uterus is peculiar in being always in a state of change and alteration, being thrown off at each menstrual period in the form of *débris*, in consequence of fatty degeneration of its structures, and re-formed afresh by proliferation of the cells of the muscular and connective tissues, probably from below upward, the new membrane commencing at the internal os. Hence its appearance and structure vary considerably according to the time at

which it is examined. The subject, however, will be more particularly studied in connection with menstruation.

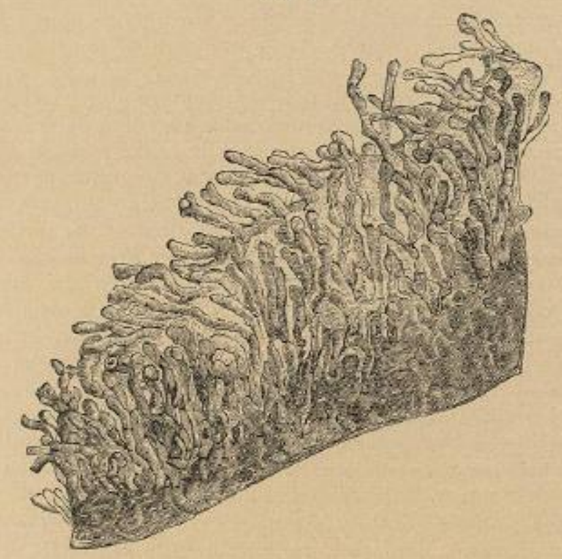
The mucous membrane of the cervix is much thicker and more transparent than that of the body of the uterus, from which it also differs in certain structural peculiarities. The general arrangements of its folds and surface have already been described. The lower half of the membrane lining the cavity of the cervix, and the whole of that covering its external or vaginal portion, are closely set with a large number of minute filiform, or clavate papillæ (Fig. 27). Their

FIG. 26.

Vertical section through the mucous membrane of the human uterus. *e*. Columnar epithelium; the cilia are not represented. *g g*. Utricular glands. *ct ct*. Interglandular connective tissue. *v v*. Bloodvessels. *m m*. Muscularis mucosæ. (After TURNER.)

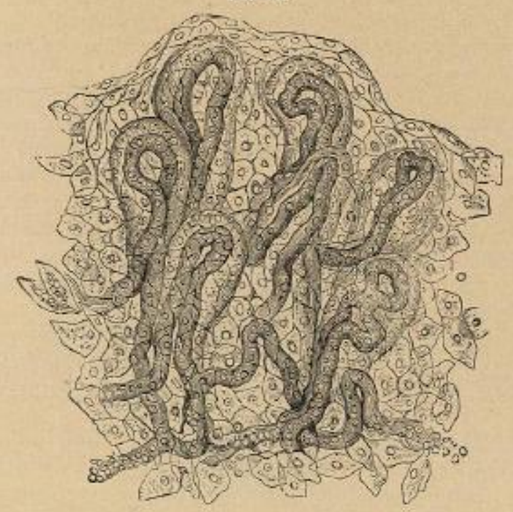
structure is similar to that of the mucous membrane itself, of which they seem to be merely elevations. They each contain a vascular loop (Fig. 28), and they are believed by Kilian and Farre to be mainly concerned in giving sensibility to this part of the generative tract. All over the interior of the cervix, both on the ridges of the mucous membrane and between their folds, are a very large number of mucous follicles consisting of a structureless membrane lined with cylindrical epithelium, and intimately united with connective tissue. They cease at the external orifice of the cervix, and they secrete the thick, tenacious, and alkaline mucus which is generally found filling the cervical cavity. The transparent follicles, known as the *ovula Nabothii*, which are sometimes found in considerable numbers in the cavity of the cervix, consist of mucous follicles the mouths of which have

FIG. 27.



Villi of os uteri stripped of epithelium. (After TYLER SMITH and HASSALL.)

FIG. 28.



Villi of uterus, covered with pavement epithelium and containing looped vessels. (After TYLER SMITH and HASSALL.)

become obstructed, and their canals distended by mucous secretion. The lower third of the cervical canal, as well as the exterior of the cervix, is covered with pavement epithelium; while on its upper portion is found a columnar and ciliated epithelium similar to that lining the uterine cavity.

Bandl[1] describes the cervical mucous membrane as extending much higher in the virgin than in women who have borne children, being traceable in the former nearly to the middle of the body of the uterus. During the first pregnancy he believes that the upper portion of the cervix is taken up into the body of the uterus, its mucous membrane never regaining the arrangement peculiar to that of the cervical canal.

The arteries of the uterus are derived from the internal iliac and from the ovarian. They enter the uterus between the folds of the broad ligaments, and, penetrating its muscular coat, anastomose freely with each other and with the corresponding vessels of the opposite side. They are described by Williams[2] as entering the uterus on its sides and then running a somewhat superficial course, being separated from the peritoneum by a thin layer of muscular fibres. They are here placed in a distinct layer of connective tissue, and give off branches which pass perpendicularly toward the uterine canal. Their walls are thick and well developed, and they are remarkable for their very tortuous course, forming spiral curves, especially in the upper part of the uterus. They end in minute capillaries which form the fine meshes surrounding the glands, and in the cervix give off the loops entering the papillæ. Beneath the uterine mucous membrane these capillaries form a plexus, terminating in veins without valves, which unite with each other to form the large veins traversing the substance of the uterus, known during pregnancy as the uterine sinuses, the walls of which are closely adherent to the uterine tissues. These veins run a similar course to the arteries, and end in a venous plexus lying in the layer of connective tissue already mentioned, which Williams believes to be the true submucous tissue of the uterus, the thick layer of muscular tissue between it and the uterine cavity being really "muscularis mucosæ." In consequence of this arrangement the circulation of the uterus can hardly be disturbed by mechanical causes. The veins, freely anastomosing with each other, pass from the uterus to the folds of the broad ligaments, where they unite to form, with the ovarian and vaginal veins, a large and well-developed venous network, known as the *pampiniform plexus*.

The lymphatics of the uterus are large and well developed, and they have recently, and with much probability, been supposed to play an important part in the production of certain puerperal diseases. A more minute knowledge than we at present possess of their course and distribution will probably throw much light on their influence in this respect. According to the researches of Leopold,[3] who has studied their minute anatomy carefully, they originate in lymph spaces between the fine bundles of connective tissue forming the basis of the mucous

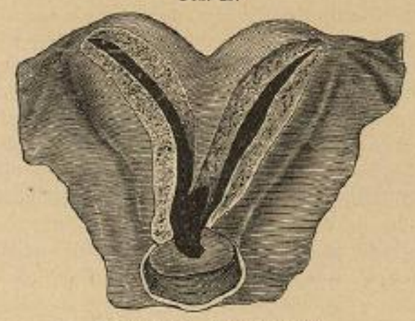
[1] Arch. f. Gynäk., 1879, Bd. xiv., S. 237.
[2] Trans. Obst. Society, 1885, vol. xxvii. p. 112.
[3] Arch. f. Gynäk., 1873, Bd. vi., Heft 1, S. 1.

lining of the uterus. Here they are in intimate contact with the utricular glands and the ultimate ramifications of the uterine blood-vessels. As they pass into the muscular tissue they become gradually narrowed into lymph-vessels and spaces, which have a very complicated arrangement, and which eventually unite together in the external muscular layer, especially on the sides of the uterus, to form large canals which probably have valves. Immediately under the peritoneum these lymph-vessels form a large and characteristic network covering the anterior and posterior surfaces of the uterus, and present, in various parts of their course, large ampullæ. They then spread over the Fallopian tubes. The lymphatics of the body of the uterus unite with the lumbar glands, those of the cervix with the pelvic glands.

The distribution and arrangement of the nerves of the uterus have been the subject of much controversy. They are derived mainly from the ovarian and hypogastric plexuses, inosculating freely with each other between the folds of the broad ligament, from which they enter the muscular tissue of the uterus, generally, but not invariably, following the course of the arteries. They are chiefly derived from the sympathetic; but, as the hypogastric plexus is connected with the sacral nerves, it is probable that some fibres from the cerebro-spinal system are distributed to the cervix. It is now generally admitted that nervous filaments are distributed to the cervix, even as far as the external os, although their existence in this situation has been denied by Jobert and other writers. The ultimate distribution of the nerves is not yet made out. Polle describes a nerve filament as entering the papillæ of the cervical mucous membrane along with the capillary loop, and Frankenhauser says the nerve fibres surround the muscles of the uterus in the form of plexuses, and terminate in the nuclei of the muscle cells.

Anomalies of the Uterus.—Various abnormal conditions of the uterus and vagina are occasionally met with, which it is necessary to

FIG. 29.



Bifid uterus. (After FARRE.)

mention, as they may have an important practical bearing on parturition. The most frequent of these is the existence of a double, or partially

double uterus (Fig. 29), similar to that found normally in many of the lower animals. This abnormality is explained by the development of the organ during fœtal life. The uterus is formed out of structures existing only in early fœtal life, known as the Wolffian bodies. These consist of a number of tubes, situated on either side of the vertebral column, and opening externally into an excretory duct. Along their external border a hollow canal is formed, termed the canal of Müller, which, like the excretory ducts, proceeds to the common cloaca of the digestive and urinary organs which then exists. The canal of Müller unites with its fellow of the opposite side to form the uterus and Fallopian tubes in the female, and subsequently the central partition at their point of junction disappears. If, however, the progress of development be in any way checked, the central partition may remain. Then we have produced either a complete double uterus or the uterus bicornis, which is bifid at its upper extremity only; or a double vagina, each leading to a separate uterus.

If pregnancy occur in any of these anomalous uteri, and many such cases are recorded, serious troubles may follow. It may happen that one horn of the double uterus is not sufficiently large to admit of pregnancy going on to term, and rupture may occur. It is supposed that some cases, presumed to be tubal gestation, are really thus explicable. Impregnation may also occur in the two cornua at different times, leading to superfœtation. It is, however, quite possible that impregnation may occur in one horn of a bifid uterus, and labor be completed without anything unusual being observed. A remarkable case of this sort has been recorded by Dr. Ross, of Brighton,[1] in which a patient miscarried of twins on July 16, 1870, and on October 31st, fifteen weeks later, she was delivered of a healthy child. Careful examination showed the existence of a complete double uterus, each side of which had been impregnated. Curiously enough, this patient had formerly given birth to six living children at term, nothing remarkable having been observed in her labors. It can only rarely happen that, under such circumstances, so favorable a result will follow, and more or less difficulty and danger may generally be expected. Occasionally the vagina only is double, the uterus being single. Dr. Matthews Duncan has recorded some cases of this kind,[2] in which the vaginal septum formed an obstacle to the birth of the child, and required division.

[Double uteri are of several distinct types, the extremes of which are the "partitioned uterus," where the organ is single without, and double within, and the "completely bifid uterus," where there is a double vagina and cervix with a Y-shaped or double-barrelled body. The former can only be diagnosticated from within and is rarely discovered until after the second stage of a labor has been completed. In a case reported by Dr. B. F. Baer, of Philadelphia, the patient bore twins, one fœtus from each compartment, the birth of which was followed by two single placentæ at intervals of a quarter of an hour. Where there is only one fœtus the uterus develops mainly on one side, and the unoccupied one lies much lower than the fundus of the other. Dr.

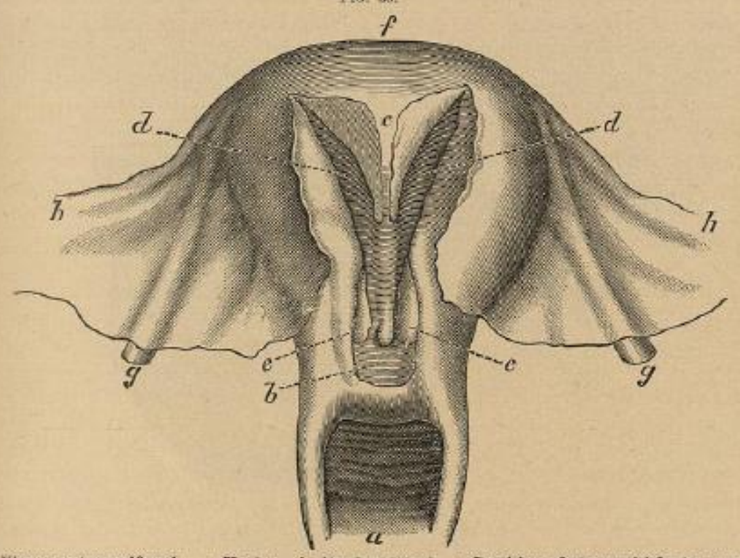
[1] Lancet, 1871, vol. ii. p. 188.

[2] Researches in Obstetrics, p. 443.

Drysdale, of this city, discovered one such case by the touch after labor, and no doubt a careful scrutiny would find that they are less rare than might be presumed.

Where one side of a bifid uterus is impregnated, the unoccupied one rotates into the hollow of the sacrum, and the other develops under the abdominal wall. The sound will readily enter the empty half of the organ in the median line, and may lead to an error in diagnosis, the pregnancy being regarded as extra-uterine. Very skilful obstetricians have been deceived in this way.

Fig. 30.



Uterus septus uniformis. *a*. Vagina. *b*. Single os uteri. *c*. Partition of uterus, thick above and thin below. *d d*. Right and left uterine cavities. *e e*. Two ridges in the posterior wall of the cervix. (From KUSSMAUL, after GRAVEL.)

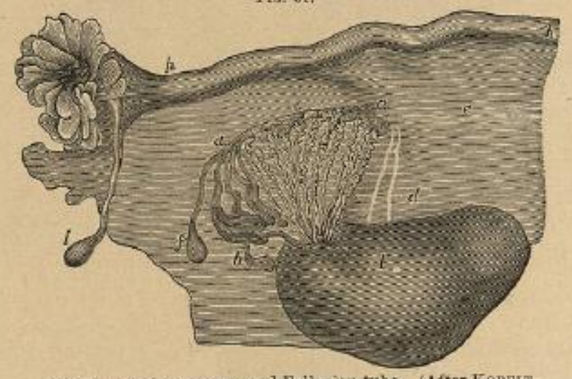
Pregnancy in a uterus unicornus is apt to terminate fatally by rupture, but exceptional cases may occur and the fœtus be delivered at term. In one case seen by the writer the development of the abnormal uterus gave rise to much pain and distress for several months, and an extra-uterine pregnancy was regarded as almost certain by the family physician. The child was a female of four pounds, and died in three days from an undeveloped duodenum and an imperforate rectum: the cornu was on the right side.—ED.]

Ligaments of the Uterus.—The various folds of peritoneum which invest the uterus serve to maintain it in position, and they are described as its ligaments. They are the broad, the vesico-uterine, and sacro-uterine ligaments; the round ligaments are not peritoneal folds like the others.

The broad ligaments extend from either side of the uterus, where their laminæ are separated from each other, transversely across to the

pelvic wall, and thus divide the cavity of the pelvis into two parts; the anterior containing the bladder, the posterior the rectum. Their upper borders are divided into three subsidiary folds, the anterior of which contains the round ligament, the middle the Fallopian tube, and the posterior the ovary. The arrangement has received the name of the *ala vespertilionis*, from its fancied resemblance to a bat's wing. Between the folds of the broad ligaments are found the uterine vessels and nerves, and a certain amount of loose cellular tissue continuous with the pelvic fasciæ. Here is situated that peculiar structure called the organ of Rosenmüller, or the *parovarium* (Fig. 31), which is the remains of the Wolffian body, and corresponds to the epididymis in the male. This may best be seen in young subjects, by holding up the broad ligaments and looking through them by transmitted light; but it exists at all ages. It consists of several tubes (eight or ten according

FIG. 31.



Adult parovarium, ovary, and Fallopian tube. (After KOELLIKER.

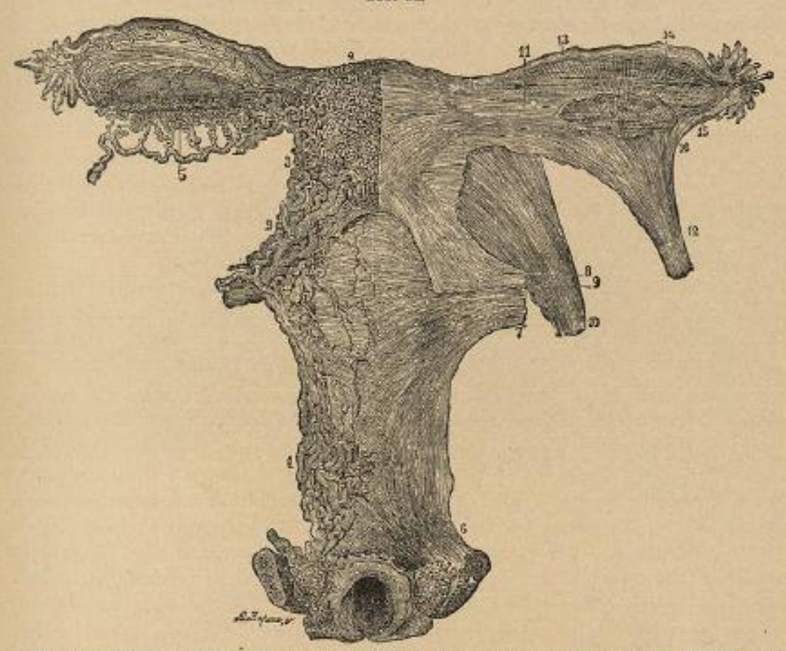
to Farre, eighteen or twenty according to Bankes[1]), which are tortuous in their course. They are arranged in a pyramidal form, the base of the pyramid being toward the Fallopian tube, its apex being lost on the surface of the ovary. They are formed of fibrous tissue, and lined with pavement epithelium. They have no excretory duct or communication with either the uterus or ovary, and their function, if they have any, is unknown

A number of muscular fibres are also found in this situation, lying between the meshes of the connective tissue. They have been particularly studied by Rouget, who describes them as interlacing with each other, and forming an open network, continuous with the muscular tissues of the uterus (Fig. 32). They are divisible into two layers, the anterior of which is continuous with the muscular fibres of the anterior surface of the uterus, and goes to form part of the round ligament; the posterior arises from the posterior wall of the uterus, and proceeds transversely outward, to become attached to the sacro-iliac synchondrosis. A continuous muscular envelope is thus formed, which sur-

[1] Bankes: On the Wolffian Bodies.

rounds the whole of the uterus, Fallopian tubes, and ovaries. Its function is not yet thoroughly established. It is supposed to have the effect of retracting the stretched folds of peritoneum after delivery, and more especially of bringing the entire generative organs into harmonious action during menstruation and the sexual orgasm; in this way explaining, as we shall subsequently see, the mechanism by which the fimbriated extremity of the Fallopian tube is said to grasp the ovary prior to the rupture of a Graafian follicle.

FIG. 32.



Posterior view of muscular and vascular arrangements. *Vessels.*—1, 2, 3. Vaginal, cervical, and uterine plexuses. 4. Arteries of body of uterus. 5. Arteries supplying ovary. *Muscular fasciculi.*—6, 7. Fibres attached to vagina, symphysis pubis, and sacro-iliac joint. 8. Muscular fasciculi from uterus and broad ligaments. 9, 10, 11, 12. Fasciculi attached to ovary and Fallopian tubes. (After ROUGET.)

The round ligaments are essentially muscular in structure. They extend from the upper border of the uterus, with the fibres of which their muscular fibres are continuous, transversely, and then obliquely downward, until they reach the inguinal rings, where they blend with the cellular tissue. In the first part of their course the muscular fibres are solely of the unstriped variety, but soon they receive striped fibres from the transversalis muscles, and the columns of the inguinal ring, which surround and cover the unstriped muscular tissue. In addition to these structures they contain elastic and connective tissue, and arterial, venous, and nervous branches; the former from the iliac or cremasteric arteries, the latter from the genito-crural nerve.

According to Ranney,[1] the principal function of these ligaments is to draw the uterus toward the symphysis pubis during sexual intercourse, and thus to favor the ascent of the semen.

The vesico-uterine ligaments are two folds of peritoneum passing in front from the lower part of the body of the uterus to the fundus of the bladder.

The utero-sacral ligaments consist of folds of peritoneum of a crescentic form, with their concavities looking inward; they start from the lower part of the posterior surface of the uterus, and curve backward to be attached to the third and fourth sacral vertebræ. Within their folds exist bundles of muscular fibres, continuous with those of the uterus, as well as connective tissue, vessels, and nerves. The experiments of Savage, as well as of other anatomists, show that these ligaments have an important influence in preventing downward displacement of the womb.

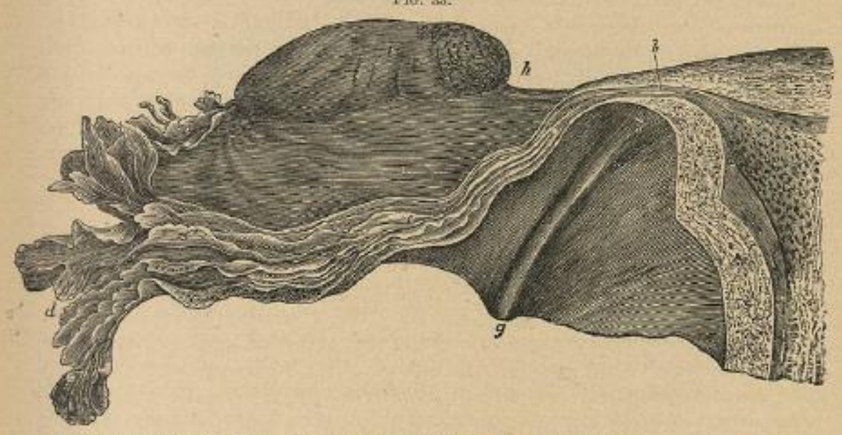
During pregnancy all these ligaments become greatly stretched and unfolded, rising out of the pelvic cavity and accommodating themselves to the increased size of the gravid uterus; and they again contract to their natural size, possibly through the agency of the muscular fibres contained within them, after delivery has taken place.

The Fallopian tubes, the homologues of the vasa deferentia in the male, are structures of great physiological interest. They serve the double purpose of conveying the semen to the ovary, and of carrying the ovule to the uterus. From the latter function they may be looked on as the excretory ducts of the ovaries; but, unlike other excretory ducts, they are movable, so that they may apply themselves to the part of the ovaries from which the ovule is to come; and so great is their mobility that there is reason to believe that a Fallopian tube may even grasp the ovary of the opposite side. Each tube proceeds from the upper angle of the uterus at first transversely outward, and then downward, backward, and inward, so as to reach the neighborhood of the ovary. In the first part of its course it is straight, afterward it becomes flexuous and twisted on itself. It is contained in the upper part of the broad ligament, where it may be felt as a hard cord. It commences at the uterus by a narrow opening, admitting only the passage of a bristle, known as *ostium uterinum*. As it passes through the muscular walls of the uterus, the tube takes a somewhat curved course, and opens into the uterine cavity by a dilated aperture. From its uterine attachment the tube expands gradually until it terminates in its trumpet-shaped extremity; just before its distal end, however, it again contracts slightly. The ovarian end of the tube is surrounded by a number of remarkable fringe-like processes. These consist of longitudinal membranous fimbriæ, surrounding the aperture of the tube, like the tentacles of a polyp, varying considerably in number and size, and having their edges cut and subdivided. On their inner surface are found both transverse and longitudinal folds of mucous membrane, continuous with those lining the tube itself (Fig. 33). One of these fimbriæ is always larger and more developed than the rest,

[1] Amer. Journ. Obstet., 1883, vol. xvi. p. 225.

and is indirectly united to the surface of the ovary by a fold of peritoneum proceeding from its external surface. Its under surface is grooved so as to form a channel, open below. The function of this fringe-like structure, as has been supposed, is to grasp the ovary during the menstrual nisus; and the fimbria which is attached to the ovary would seem to guide the tentacles to the ovary which they are intended to seize. It has never, however, been demonstrated that this grasping of the ovary actually occurs. One or more supplementary series of fimbriæ sometimes exist, which have an aperture of communication with the canal of the Fallopian tube, beyond its ovarian extremity. His has recently shown that the fimbriated extremity of the tube, after running over the upper part of the ovary, turns down along its free border; so that its aperture lies below it, ready to receive the ovule when expelled from the Graafian follicle.[1]

FIG. 33.



Fallopian tube laid open. *a*, *b*. Uterine portion of tube. *c*, *d*. Plicæ of mucous membrane. *e*. Tubo-ovarian ligaments and fringes. *f*. Ovary. *g*. Round ligaments. (After RICHARD.)

The tubes themselves consist of peritoneal, muscular, and mucous coats. The peritoneum surrounds the tube for three-fourths of its calibre, and comes into contact with the mucous lining at its fimbriated extremity, the only instance in the body where such a junction occurs. The muscular coat is principally composed of circular fibres, with a few longitudinal fibres interspersed. Its muscular character has been doubted, but Farre had no difficulty in demonstrating the existence of muscular fibres, both in the human female and many of the lower animals. According to Robin, the muscular tissue of the Fallopian tubes is entirely distinct from that of the uterus, from which he describes it as being separated by a distinct cellular septum. The mucous lining is thrown into a number of remarkable longitudinal folds, each of which contains a dense and vascular fibrous septum, with

[1] His: Archiv für Anat. und Phys., 1881.

small muscular fibres, and is covered with columnar and ciliated epithelium. The apposition of these produces a series of minute capillary tubes, along which the ovules are propelled, the action of the cilia, which is toward the uterus, apparently favoring their progress.

The ovaries are the bodies in which the ovules are formed, and from which they are expelled, and the changes going on in them in connection with the process of ovulation, during the whole period between the establishment of puberty and the cessation of menstruation, have an enormous influence on the female economy. Normally, the ovaries are two in number; in some exceptional cases a supplementary ovary has been discovered; or they may be entirely absent. They are placed in the posterior folds of the broad ligaments, usually below the brim of the pelvis, behind the Fallopian tubes, the left in front of the rectum, the right in front of some coils of the small intestine. Their situation varies, however, very much under different circumstances, so that they can scarcely be said to have a fixed and normal position; most probably, however, as has been recently shown by His,[1] they are normally placed close below the brim of the pelvis, with their long diameters almost vertical, and immediately above the aperture of the distal extremity of the Fallopian tubes. In pregnancy they rise into the abdominal cavity with the enlarging uterus; and in certain conditions they are dislocated downward into Douglas's space, where they may be felt through the vagina as rounded and very tender bodies.

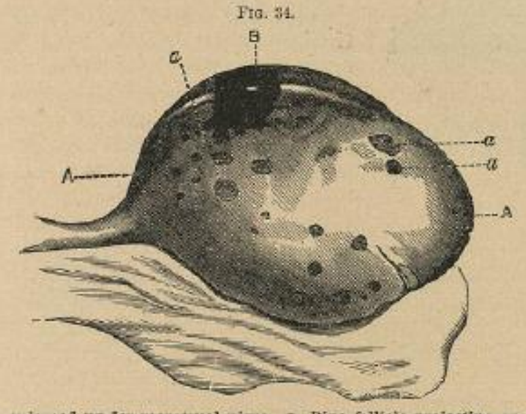
The folds of the broad ligament form for them a kind of loose mesentery. Each of them is united to the upper angle of the uterus by a special ligament called the utero-ovarian. This is a rounded band of organic muscular fibres, about an inch in length, continuous with the superficial muscular fibres of the posterior wall of the uterus, and attached to the inner extremity of the ovary. It is surrounded by peritoneum, and through it the muscular fibres, which form an important integral part in the structure of the ovaries, are conveyed to them. The ovary is also attached to the fimbriated extremity of the Fallopian tube in the manner already described.

The ovary is of an irregular oval shape (Fig. 34), the upper border being convex, the lower—through which the vessels and nerves enter—being straight. The anterior surface, like that of the uterus, is less convex than the posterior. The outer extremity is more rounded and bulbous than the inner, which is somewhat pointed and eventually lost in its proper ligament. By these peculiarities it is possible to distinguish the left from the right ovary, after they have been removed from the body. The ovary varies much in size under different circumstances. On an average, in adult life it measures from one to two inches in length, three-quarters of an inch in width, and about half an inch in thickness. It increases greatly in size during each menstrual period—a fact which has been demonstrated in certain cases of ovarian hernia, in which the protruded ovary has been seen to swell as menstruation commenced; also during pregnancy, when it is said

[1] Op. cit.

to be double its usual size. After the change of life it atrophies, and becomes rough and wrinked on its surface. Before puberty, the surface of the ovary is smooth and polished, and of a whitish color. After menstruation commences, its surface becomes scarred by the rupture of the Graafian follicles (Fig. 34, *a a a*), each of which leaves a little linear or striated cicatrix, of a brownish color; and the older the patient the greater are the number of these cicatrices.

Fig. 34.



A A. Ovary enlarged under menstrual nisus. B. Ripe follicle projecting on its surface. *a a a* Traces of previously ruptured follicles.

The structure of the ovary has been made the subject of many important observations. It has an external covering of epithelium, originally continuous with the peritoneum, called by some the germ-epithelium, in consequence of the ovules being formed from it in early fœtal life. In the adult it is separated from the peritoneum at the base of the organ by a circular white line, and it consists of columnar epithelium, differing only from the epithelium lining the Fallopian tubes, with which it is sometimes continuous through the attached fimbria uniting the tube and the ovary, in being destitute of cilia. Immediately beneath this covering is the dense coat known as the *tunica albuginea*, on account of its whitish color. It consists of short connective-tissue fibres, arranged in laminæ, among which are interspersed fusiform muscular fibres. At the point where the vessels and nerves enter the ovary this membrane is raised into a ridge, which is continuous with the utero-ovarian ligament, and is called the *hilum*. The tunica albuginea is so intimately blended with the stroma of the ovary as to be inseparable on dissection; it does not, therefore, exist as a distinct lamina, but is merely the external part of the proper structure of the ovary, in which more dense connective tissue is developed than elsewhere.

On making a longitudinal section of the ovary (Fig. 35), it will be seen to be composed of two parts, the more internal of which is of a reddish color from the number of vessels that ramify in it, and is called the *medullary* or vascular zone; while the external, of a whitish

tint, receives the name of the *cortical* or parenchymatous substance. The former consists of loose connective tissue interspersed with elastic, and a considerable number of muscular fibres. According to Rouget[1] and His[2] the muscular structure forms the greater part of the ovarian stroma. The latter describes it as consisting essentially of interwoven muscular fibres, which he terms the "fusiform tissue," and which he believes to be continuous with the muscular layers of the ovarian vessels. The former believes that the muscular fasciculi accompany the vessels in the form of sheaths, as in erectile tissues. Both attribute to the muscular tissues an important influence in the expulsion of the ovules, and in the rupture of the Graafian follicles. Waldeyer and other writers, however, do not consider it to be so extensively developed as Rouget and His believe. The cortical substance is the more important, as that in which the Graafian follicles and ovules are formed. It consists of interlaced fibres of connective tissue, containing a large number of nuclei. The

FIG. 35.

Longitudinal section of adult ovary. (After FARRE.)

FIG. 36.

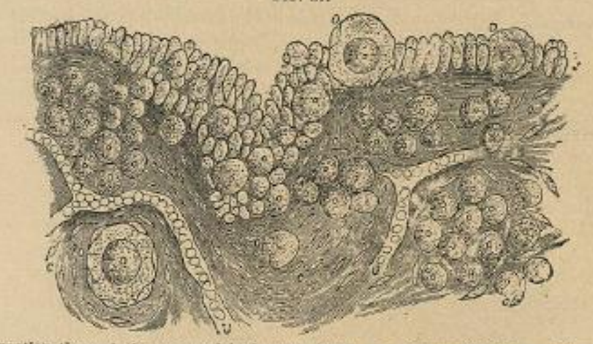
Section through the cortical part of the ovary. *e*. Surface epithelium. *s s*. Ovarian stroma. 1 1. Large-sized Graafian follicles. 2 2. Middle-sized; and 3 3. Small-sized Graafian follicles. *o*. Ovule within Graafian follicle. *v v*. Bloodvessels in the stroma. *g*. Cells of the membrana granulosa. (After TURNER.)

muscular fibres of the medullary substance do not seem to penetrate into it in the human female. In it are found the Graafian follicles, which exist in enormous numbers from the earliest periods of life, and in all stages of development (Fig. 36).

[1] Journal de Physiol. t. p. 737.
[2] Schultze's Arch. f. mikroscop. Anat., 1865.

The Graafian Follicles.—According to the researches of Pflüger, Waldeyer, and other German writers, the Graafian follicles are formed in early fœtal life by cylindrical inflections of the epitheliai covering of the ovary, which dip into the substance of the gland. These tubular filaments anastomose with each other, and in them are formed the ovules, which are originally the epithelial cells lining the tubes. Portions become shut off from the rest of the filaments, and form the Graafian follicles. The ovules, on this view, are highly developed epithelial cells, originally derived from the surface of the ovary, and not developed in its stroma. These tubular filaments disappear shortly after birth, but they have recently been detected by Slavyansky[1] in the ovaries of a woman thirty years of age. These observations have been modified by Dr. Foulis.[2] He recognizes the origin of the ovules from the germ-epithelium covering the surface of the ovary, which is itself derived from the Wolffian body. He believes all the ovules to

FIG. 37.



Vertical section through the ovary of the human fœtus. *g g*. Germ-epithelium, with *o o*. Developing ovules in it. *s s*. Ovarian stroma containing *c c c*. Fusiform connective-tissue corpuscles. *v v*. Capillary bloodvessels. In the centre of the figure an involution of the germ-epithelium is shown; and at the left lower side a primordial ovule, with the connective-tissue corpuscles ranging themselves round it. (After FOULIS.)

be formed from the germ-epithelium corpuscles. Some of these, which are differentiated from the rest by their greater size, rounded shape, and large nuclei, become imbedded in the stroma of the ovary by the outgrowth of processes of vascular connective tissue, fresh germ-epithelial corpuscles being constantly produced on the surface of the organ up to the age of two and a half years, to take the place of those already imbedded in its stroma. He believes the Graafian follicles to be formed by the growth of delicate processes of connective tissue between and around the ovules, but not from tubular inflections of the epithelium covering the gland, as described by Waldeyer (Fig. 37). This view is supported by the researches of Balfour,[3] who arrives at the conclusion that the whole egg-containing part of the ovary is really

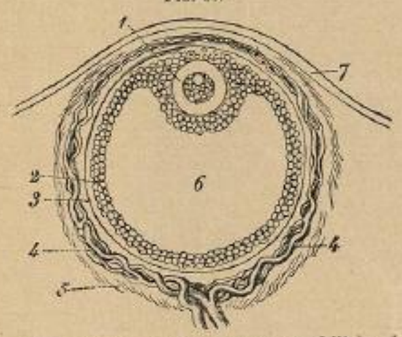
[1] Annales de Gynéc., Feb. 1871.
[2] Proceedings of the Royal Soc. of Edinb., April, 1875, and Journ. of Anat. and Phys., vol. xiii. 1879.
[3] F. M. Balfour: "Structure and Development of Vertebrate Ovary." Quarterly Journal of Microscopical Science, vol. xviii., 1878.

the thickened germinal epithelium, broken up into a kind of meshwork by growths of vascular stroma. According to this theory, Pflüger's tubular filaments are merely trabeculæ of germinal epithelium, modified cells of which become developed into ovules.

The greater proportion of the Graafian follicles are only visible with the high powers of the microscope, but those which are approaching maturity are distinctly to be seen by the naked eye. The quantity of these follicles is immense. Foulis estimates that at birth each human ovary contains not less than 30,000. No fresh follicles appear to be formed after birth, and as development goes on, some only grow, and, by pressure on the others, destroy them. Of those that grow, of course only a few ever reach maturity; they are scattered through the substance of the ovary, some developing in the stroma, others on the surface of the organ, where they eventually burst, and are discharged into the Fallopian tube.

A ripe Graafian follicle has an external investing membrane (Fig. 38), which is generally described as consisting of two distinct layers: the external, or *tunica fibrosa*, highly vascular, and formed of connective tissue; the internal, or *tunica propria*, composed of young connective tissue, containing a large number of fusiform or stellate cells, and forming a basement membrane to the epithelial layer which lies internal to it. These layers, however, appear to be essentially formed of condensed ovarian stroma. Within this capsule is the epithelial lining called the *membrana granulosa*, consisting of columnar epithelial cells, which, according to Foulis, are originally formed from the nuclei of the fibro-nuclear tissue of the stroma of the ovary, but which, according to Waldeyer and Balfour, are formed from the germinal epithelium itself. At one part of the circumference of the ovisac is situated the ovule, around which the epithelial cells are congregated in greater quantity, constituting the projection known as the *discus proligerus*. The remainder of the cavity of the follicle is filled with a small quantity of transparent fluid, the *liquor folliculi*, traversed by three or four minute bands, the retinacula of Barry, which are attached to the opposite walls of the follicular cavity, and apparently serve the purpose of suspending the ovule and maintaining it in a proper position. In many young follicles this cavity does not at first exist, the follicle being entirely filled by the ovule. According to Waldeyer, the liquor folliculi is formed by the disintegration of the epithelial cells, the fluid thus produced collecting, and distending the interior of the follicle.

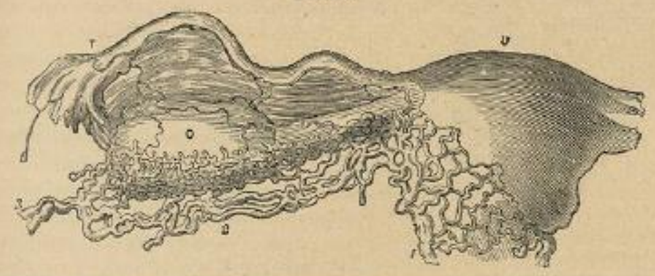
Fig. 38.



Diagrammatic section of Graafian follicle. 1. Ovum. 2. Membrana granulosa. 3. External membrane of Graafian follicle. 4, Its vessels. 5. Ovarian stroma. 6. Cavity of Graafian follicle. 7. External covering of ovary.

The Ovule.—The ovule is attached to some part of the internal surface of the Graafian follicle. It is a rounded vesicle about $\frac{1}{120}$ of an inch in diameter, and is surrounded by a layer of columnar cells, distinct from those of the discus proligerus, in which it lies. It is invested by a transparent elastic membrane, the *zona pellucida*, or vitelline membrane. In most of the lower animals the zona pellucida is perforated by numerous very minute pores, only visible under the highest powers of the microscope; in others there is a distinct aperture of a larger size, the micropyle, allowing the passage of the spermatozoa into the interior of the ovule. It is possible that similar apertures may exist in the human ovule, but they have not been demonstrated. Within the zona pellucida some embryologists describe a second fine membrane, the existence of which has been denied by Bischoff. The cavity of the ovule is filled with a viscid yellow fluid, the *yelk*, containing numerous granules. It entirely fills the cavity, to the walls of which it is non-adherent. It consists of primitive cell matter, called the protoplasm of the yelk, from which the embryo is developed, and of the granules, called the deutoplasm, which furnish the nutritive material for cell growth. In the centre of the yelk in young, and at some portion of the periphery in mature ovules, it situated the *germinal vesicle*, which is a clear circular vesicle, refracting light strongly, and about $\frac{1}{800}$ of a line in diameter. It contains a few granules, and a nucleolus, or *germinal spot*, which is sometimes double.

Fig. 39.



Bulb of ovary. U. Uterus. O. Ovary and utero-ovarian ligament. T. Fallopian tube. 1. Utero-ovarian vein. 2. Pampiniform ovarian plexus. 3. Commencement of spermatic vein.

From within outward, therefore, we find—

1. The *germinal* spot; round this
2. The *germinal* vesicle contained in
3. The *yelk*, which is surrounded by the
4. *Zona pellucida*, with its layers of columnar epithelial cells.

These constitute the ovule.

The ovule is contained in—

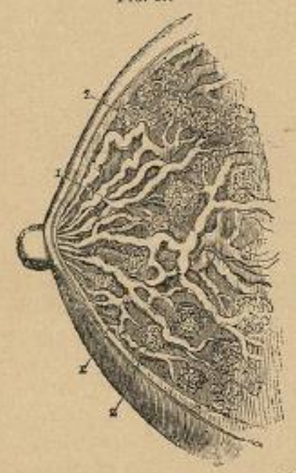
The *Graafian follicle*, and lies in that part of its epithelial lining called the—

Discus proligerus, the rest of the follicle being occupied by the *liquor folliculi*. Round these we have the epithelial lining or *membrana granulosa*, and the external coat, consisting of the *tunica propria* and the *tunica fibrosa*.

The vascular supply of the ovary is complex. The arteries enter at the hilum, penetrating the stroma in a spiral curve, and are ultimately distributed in a rich capillary plexus to the follicles. The large veins unite freely with each other, and form a vascular and erectile plexus, continuous with that surrounding the uterus, called the bulb of the ovary (Fig. 39). Lymphatics and nerves exist, but their mode of termination is unknown.

The Mammary Glands.—To complete the consideration of the generative organs of the female, we must study the *mammary glands*, which secrete the fluid destined to nourish the child. In the human subject they are two in number, and instead of being placed upon the abdomen, as in most animals, they are situated on either side of the sternum, over the pectorales majora muscles, and extend from the third to the sixth ribs. This position of the glands is obviously intended to suit the erect position of the female in suckling. They are convex anteriorly, and flattened posteriorly where they rest on the muscles. They vary greatly in size in different subjects, chiefly in proportion to the amount of adipose tissue they contain. In man, and in girls previous to puberty, they are rudimentary in structure; while in pregnant women they increase greatly in size, the true glandular structures becoming much hypertrophied. Anomalies in shape and position are sometimes observed. Supplementary mammæ, one or more in number, situated on the upper portion of the mammæ are sometimes met with, identical in structure with the normally situated glands; or, more commonly, an extra nipple is observed by the side of the normal one. In some races, especially the African, the mammæ are so enormously developed that the mother is able to suckle her child over her shoulder.

FIG. 40.



1. Galactophorous ducts. 2. Lobuli of the mammary gland.

The skin covering the gland is soft and supple, and during pregnancy often becomes covered with fine white lines, while large blue veins may be observed coursing over. Underneath it is a quantity of connective tissue, containing a considerable amount of fat, which extends between the true glandular structure. This is composed of from fifteen to twenty lobes, each of which is formed of a number of lobules. The lobules are produced by the aggregation of the terminal acini in which the milk is formed. The acini are minute cul-de-sacs opening into little ducts, which unite with each other until they form a large duct for each lobule; the ducts of each lobule unite with each other, until they end in a still larger duct common to each of the fifteen or twenty lobes into which the gland is divided, and eventually open on the surface of the nipple. These terminal canals are known as the *galactophorous ducts* (Fig. 40). They become widely dilated as they approach the nipple, so as to form reservoirs in which milk is stored until it is required, but when they actually enter the nipple they again contract. Sometimes they give off lateral branches, but, according to Sappey, they do not anastomose with each other, as some anatomists have described. These excretory ducts are composed of connective tissue, with numerous elastic fibres on their external surface. Sappey and Robin describe a layer of muscular fibres, chiefly developed near their terminal extremities. They are lined with columnar epithelium, continuous with that in the acini; and it is by the distention of its cells with fatty matter, and their subsequent bursting, that the milk is formed.

The nipple is the conical projection at the summit of the mamma, and it varies in size in different women. Not unfrequently, from the continuous pressure to which it has been subjected by the dress, it is so depressed below the surface of the skin as to prevent lactation. It is generally larger in married than in single women, and increases in size during pregnancy. Its surface is covered with numerous papillæ, giving it a rugous aspect, and at their bases the orifices of the lactiferous ducts open. Here are also the opening of numerous sebaceous follicles, which secrete an unctuous material supposed to protect and soften the integument during lactation. Beneath the skin are muscular fibres, mixed with connective and elastic tissues, vessels, nerves, and lymphatics. When the nipple is irritated it contracts and hardens, and by some this is attributed to its erectile properties. The vascularity, however, is not great, and it contains no true erectile tissue; the hardening is, therefore, due to muscular contraction. Surrounding the nipple is the *areola*, of a pink color in virgins, becoming dark from the development of pigment cells during pregnancy, and always remaining somewhat dark after childbearing. On its surface are a number of prominent tubercles, sixteen to twenty in number, which also become largely developed during gestation. They are supposed by some to secrete milk, and to open into the lactiferous tubes; most probably they are composed of sebaceous glands only. Beneath the areola is a circular band of muscular fibres, the object of which is to compress the lactiferous tubes which run through it, and thus to favor the expulsion of their contents. The mammæ receive their blood from the internal mammary and intercostal arteries, and they are richly supplied with lymphatic vessels, which open into the axillary gland. The nerves are derived from the intercostal and thoracic branches of the brachial plexus.

The secretion of milk in women who are nursing is accompanied by a peculiar sensation, as if milk were rushing into the breast, called the "draught," which is excited by the efforts of the child to suck, and by various other causes. The sympathetic relations between the mammæ

and the uterus are very well marked, as is shown in the unimpregnated state by the fact of the frequent occurrence of sympathetic pains in the breast in connection with various uterine diseases; and, after delivery, by the well-known fact that suction produces reflex contraction of the uterus and even severe after-pains.

CHAPTER III.

OVULATION AND MENSTRUATION.

Functions of the Ovary.—The main function of the ovary is to supply the female generative element, and to expel it, when ready for impregnation, into the Fallopian tube, along which it passes into the uterus. This process takes place spontaneously in all viviparous animals, and without the assistance of the male. In the lower animals this periodical discharge receives the name of the œstrum or rut, at which time only the female is capable of impregnation and admits the approach of the male. In the human female the periodical discharge of the ovule, in all probability, takes place in connection with menstruation, which may therefore be considered to be the analogue of the rut in animals. Between each menstrual period Graafian follicles undergo changes which prepare them for rupture and the discharge of their contained ovules. After rupture certain changes occur which have for their object the healing of the rent in the ovarian tissue through which the ovule has escaped, and the filling up of the cavity in which it was contained. This results in the formation of a peculiar body in the substance of the ovary, called the *corpus luteum*, which is essentially modified should pregnancy occur, and is of great interest and importance. During the whole of the childbearing epoch the periodical maturation and rupture of the Graafian follicles are going on. If impregnation does not take place, the ovules are discharged and lost; if it does, ovulation is stopped, as a general rule, during gestation and lactation.

Theory of Menstruation.—This, broadly speaking, is an outline of the ovular theory of menstruation, which was first broached in the year 1821 by Dr. Power, and subsequently elaborated by Negrier, Bischoff, Raciborski, and many other writers. Although the sequence of events here indicated may be taken to be the rule, it must be remembered that it is one subject to many exceptions, for undoubtedly ovulation may occur without its outward manifestation, menstruation, as in cases in which impregnation takes place during lactation, or before menstruation has been established, of which many examples are recorded. These exceptions have led some modern writers to deny the ovular theory of menstruation, and their views will require subsequent consideration.

In order to understand the subject properly, it will be necessary to study the sequence of events in detail.

Changes in the Graafian Follicle.—The changes in the Graafian follicle which are associated with the discharge of the ovules comprise:

1. *Maturation.* As the period of puberty approaches, a certain number of the Graafian follicles, fifteen to twenty in number, increase in size, and come near the surface of the ovary. Amongst these one becomes especially developed, preparatory to rupture, and upon it for the time being all the vital energy of the ovary seems to be concentrated. A similar change in one, sometimes in more than one, follicle takes place periodically during the whole of the childbearing epoch, in connection with each menstrual period, and an examination of the ovary will show several follicles in different stages of development. The maturing follicle becomes gradually larger, until it forms a projection on the surface of the ovary, from five to seven lines in breadth, but sometimes even as large as a nut (Fig. 34). This growth is due to the distention of the follicle by the increase of its contained fluid, which causes it so to press upon the ovarian structures covering it that they become thinned, separated from each other, and partially absorbed, until they eventually readily lacerate. The follicle also becomes greatly congested, the capillaries coursing over it become increased in size and loaded with blood, and being seen through the attenuated ovarian tissue, give it, when mature, a bright-red color. At this time some of these distended capillaries in its inner coat lacerate, and a certain quantity of blood escapes into its cavity. This escape of blood takes place before rupture, and seems to have for its principal object the increase of the tension of the follicle, of which it has been termed the menstruation. Pouchet was of opinion that the blood collects behind the ovule, and carries it up to the surface of the follicle.

2. *Escape of the ovule.* By these means the follicle is more and more distended, until at last it ruptures (Plate III., Fig. 1), either spontaneously, or, it may be, under the stimulus of sexual excitement. Whether the laceration takes place during, before, or after the menstrual discharge is not yet positively known; from the results of post-mortem examination in a number of women who died shortly before or after the period, Williams believes that the ovules are expelled before the monthly flow commences.[1] In order that the ovule may escape, the laceration must, of course, involve not only the coats of the Graafian follicles, but also the superincumbent structures.

Laceration seems to be aided by the growth of the internal layer of the follicle, which increases in thickness before rupture, and assumes a characteristic yellow color from the number of oil-globules it then contains. It is also greatly facilitated, if it be not actually produced, by the turgescence of the ovary at each menstrual period, and by the contraction of the muscular fibres in the ovarian stroma. As soon as the rent in the follicular walls is produced, the ovule is discharged.

[1] Proceedings of the Royal Society, 1875.