be done for some hours. When, however, the nausea has subsided, water in small quantities may be given every few minutes. Hot water is preferable to cold, and the quantity may gradually be increased if no ill effects are seen. As has been said before, the administration of the enema and leaving 500 c.c. of salt solution in the abdomen will lessen the thirst very considerably. For the pain, if severe, a small dose of morphine or codeine may be given hypodermically. It is much better to avoid opiates whenever possible, and their routine use is to be condemned. Besides augmenting the nausea, in many patients they are apt to retard the opening of the bowels. Rubbing with chloroform liniment will often relieve the severe backache, and a change of position is always grateful. With the abdominal dressing described above there is no risk in moving the patient from one side to the other.

It is advisable to have the patient urinate naturally, and unless there is some contraindication, such as trauma to the bladder wall during the operation, from eight to ten hours may be allowed to pass without an evacuation of urine. After this time, if her efforts to void naturally have failed, she should be catheterized with the usual aseptic precautions. This should not be repeated unless it is absolutely necessary. If she have much distress referable to the bladder, it may be emptied earlier.

Most of the discomfort incident to abdominal operations is due to the tympanites, which is usually worse in those cases in which the structures have been adherent, and in which there has been much handling of the bowels. It is also frequently due to neglect in properly emptying them before the operation. This complication can be relieved very often by passing the long rectal tube and applying heat to the epigastrium. Tincture of capsicum in three-minim doses may be administered after the cessation of the nausea. In neurotic women a good deal of discomfort is usually the rule.

The patient generally feels much easier as soon as the bowels have been well moved. Eighteen or twenty hours after the operation two grains of calomel may be given. Eight or ten hours later a turpentine enema will often produce a satisfactory evacuation; if ineffectual it may be repeated in four hours, or a glycerin enema may be given instead. If there be still no results small doses of magnesium sulphate may be given.

The temperature, pulse rate, and number of respirations should be taken every three hours at first, and later every four or six hours, according to the progress made by the patient. A careful chart should be kept so that her condition from time to time may be readily ascertained.

In the matter of diet nothing but water had better be given by mouth until the bowels have been moved, but nutrient enemata consisting of peptonized milk, with the whites of two eggs and twenty grains of table salt, may be administered every three hours. As soon as the bowels have moved satisfactorily milk with lime water or carbonated water, albumin water or broth may be retained if given in small quantities at first. After the first three or four days, if satisfactory progress is being made, the patient may take soft food, and after about two weeks an ordinary light diet may be ordered.

Where there is no suspicion that suppuration is occurring in the abdominal wound, the dressing need not be disturbed for ten days; but if through-and-through sutures have been used for the abdominal incision, as in cases in which speed in closing the wound has been necessary, or if unabsorbable sutures have been employed for the skin alone, an earlier examination is advisable, and if any redness be found around the suture the offender had better be removed. All of them can be taken out as a rule on the seventh day. If the incision be firmly united, a small pad of gauze over it will be sufficient; transverse strips of plaster may be used to hold this in place, and at the same time prevent any stretching of the newly formed scar tissue. The scultetus bandage is worn until the patient is out of bed, after which a special elastic abdominal supporter should be provided. If no complications occur, the patient may sit up in bed on the sixteenth or eighteenth day after the operation, and get out of bed on the nineteenth or twenty-first day. Undoubtedly in many cases a shorter time than this is sufficient, but it is far better to be on the safe side.

Mortality.—The mortality depends upon a number of factors, such as the skill and experience of the operator, his facilities for carrying out an aseptic technique, and also the care of the patient after the operation. Granted that these have been all that could be desired and that the cases are uncomplicated, the percentage of deaths from the operation should be almost nothing. It is very difficult to determine the real mortality since statistics are notoriously misleading.

The results are steadily improving. A few references to the mortality in the early days of the operation have already been made, and half a century ago it was over fifty per cent. Owing to an aseptic technique, and to our knowledge gained by experience, the average mortality in cases subjected to operation for ovarian tumors at the present day is below ten per cent. Individual operators will have far better results than this. Lawson Tait a number of years ago reported a series of 139 ovariotomies without a death, and the results to-day are better than at that time. Even in cœliotomies for all sorts of pelvic diseases, including pelvic abscess, ectopic gestation, etc., records of series of over 100 consecutive cases without a death have been reported. The author has recently had two such series, one of 108, the other of 114 consecutive successful operations in a hospital practice, in which all conditions, including pus cases in a large proportion, were encountered.

The average skilful operator, taking cases as they come, and having every facility for good work, should have a mortality of not over three to four per cent. in ovariotomy.

Hunter Robb.

OVARY (ANATOMICAL). See *Sexual Organs, Female.*

OVULATION. See *Menstruation.*

OVUM.—(Greek ᾠόν, Latin *ovum*, an egg.)

The *ovum*, or egg proper, is a cell capable under certain conditions of giving rise by subsequent cell divisions to a complete multicellular organism. This definition applies to the female germ cells of plants as well as to

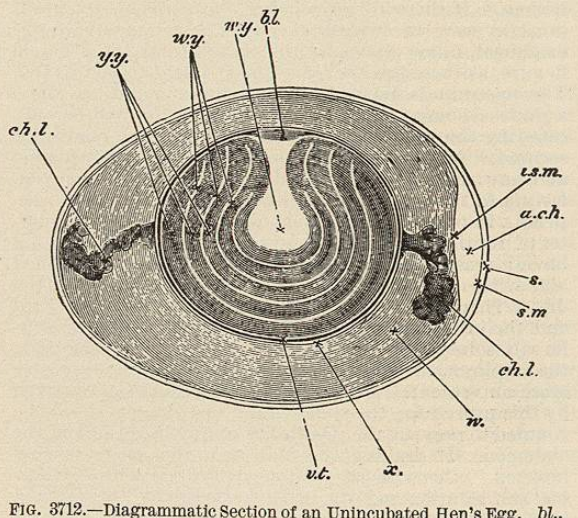

FIG. 3712.—Diagrammatic Section of an Unincubated Hen's Egg. *bl.*, Blastoderm; *w.y.*, white yolk; *y.y.*, yellow yolk; *v.t.*, vitelline membrane; *w*, albumen; *ch.l.*, chalaza; *a.ch.*, air chamber; *i.s.m.*, inner shell membrane; *s.m.*, outer shell membrane; *s*, shell. (From Balfour, modified from Allen Thomson.)

those of animals. Frequently the terms ovum and egg are used loosely, however, not only to include the envelopes surrounding the egg proper, but even to designate the embryo and its fœtal membranes.

Historical.—Although a hen's egg has been probably one of the most familiar of objects since long before man

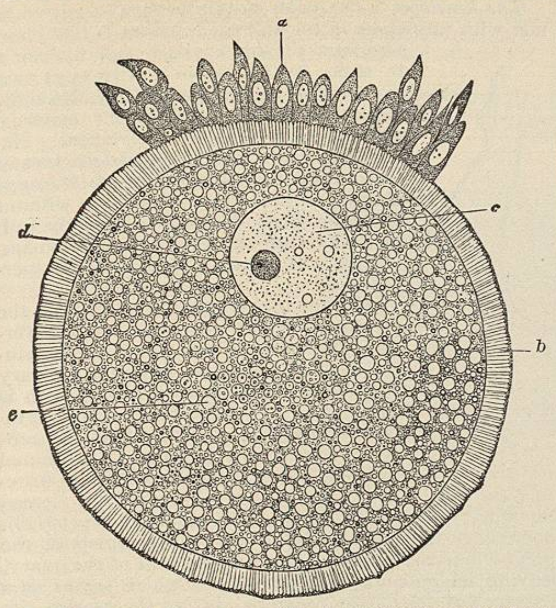

FIG. 3713.—Rabbit's Ovum, from a Graafian Follicle measuring 2 mm. *a*, Discus proligerus; *b*, zona radiata; *c*, nucleus; *d*, nucleolus; *e*, yolk-granule in the cytoplasm. Highly magnified. (From Waldeyer.)

ever thought of domesticating wild animals, it remained for the anatomists of the nineteenth century to discover its true nature; and although investigators of this subject were never before so active as during the last decade, and have carried on their work with a refinement of technique not dreamed of in earlier years, there is still a great deal to be learned.

Modern embryological observations may be said to have begun with William Harvey, who published his results in 1651. The best microscope that he could obtain was a simple lens, and with this he was able to make out the general outline of a chick embryo during the second day of incubation. His view of the ovum was that it consisted of a fluid matrix in which the embryo appeared by a process of spontaneous generation. The female sexual product was supposed at that time to be a fluid secreted by the "testes muliebres," the term "ovarium" not having been invented by Stenson until some years later.

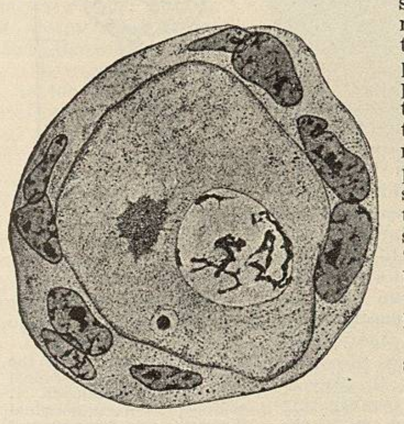

FIG. 3714.—Graafian Follicle and Ovum from the Ovary of a Rabbit Four Weeks Old. On the left of the egg nucleus is the attraction sphere containing two centrosomes and below is a small yolk nucleus. Highly magnified. (After Winiwarter.)

Regnier de Graaf published in 1677 a description of the follicles, which have since borne his name. He found that they contained a fluid which was capable of being coagulated by heat into a firm, white substance. He discovered also that in the Fallopian tubes of a rabbit killed seventy-two hours after coitus there were to be found a number of eggs which were vesicles and contained a fluid that could be coagulated by heat, like the white of egg, and, moreover, these corresponded in number to the empty follicles found in the ovaries of the same subject. He concluded, therefore, that the Graafian follicles were ova. But the chain of evidence was not complete because all trace of the eggs was lost between the time of coitus and the end of the third day, and, more-

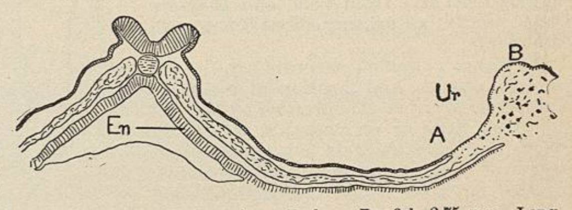

FIG. 3715.—Cross Section of an Embryo Dogfish 2.75 mm. Long. *A–B*, Blastodermic rim containing all the germ cells; *En*, endoderm. × 38. (After Woods.)

over, the blastoderms in the Fallopian tubes were not so large as the empty follicles. During the same year, 1677, Leeuwenhoek announced the discovery of spermatozoa, and there followed a long dispute as to whether the spermatozoon is the true germ and the egg a matrix

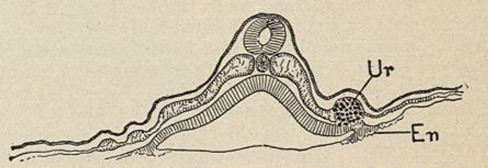

FIG. 3716.—Cross Section of an Embryo Dogfish, 3.5 mm. Long. *En*, Endoderm; *Ur*, germ cells. × 38. (After Woods.)

for its nutrition, or whether the germ dwells originally in the egg itself (see article *Evolution*).

It was not until 1827 that Carl Ernst von Baer was able to show that the Graafian follicle is not the ovum; but that the ovum is a minute body embedded in the follicular epithelium. And it was not until 1838 that Schwann was able to declare the egg to be a cell with the same fundamental structure as the other cells of the body.

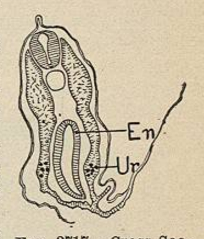

FIG. 3717.—Cross Section of an Embryo Dogfish, 5 mm. long. *En*, Endoderm; *Ur*, germ cells. × 38. (After Woods.)

Morphology.—The ovum is usually a more or less spherical body, but may be flattened or elongated, as is the case with most insect eggs.

The protoplasmic contents of the egg consist of a nucleus and a mass of cytoplasm, as in all cells, and, in addition, the cytoplasm usually contains a greater or less amount of yolk, or *deutoplasm*.

The cytoplasm of the eggs of echinoderms and other invertebrates has been shown to have a distinctly vesicular, or foam-like, structure, and it is probable that all eggs will show a similar structure. It is within the vesicles of the foam that the deutoplasm is deposited, sometimes in the form of clear oil globules, as in some worms and fishes, more often as more or less opaque yolk granules. In the hen's egg there are two principal kinds of yolk granules, the yellow and the white. The white granules are gathered together in the form of a small flask-shaped body, extending from the centre of the ovum to the upper pole, and the yellow yolk forms concentric layers surrounding this and alternating with thinner layers of white yolk (Fig. 3712). These may be seen in a carefully made section of a hard-boiled egg. Where the white yolk approaches the surface there is in the unfertilized egg a portion of the cytoplasm comparatively free from yolk and containing the nucleus.

The size of the egg, the position of the nucleus, and the subsequent course of development, especially in the early stages, depend to a large extent upon the presence or absence of a burden of food yolk within the cytoplasm of the ovum. For example, the eggs of reptiles and birds are heavily charged with yolk and are very large, while all mammals, except the Monotremes, have eggs almost free from yolk, and they are very minute, measuring about 0.2 mm. in diameter.

Eggs are classified according to the absence, presence, and position of the yolk, into three groups: (1) *Alecithal* eggs, having very little or no yolk; (2) *telolecithal* eggs, in which there is a large accumulation of yolk at one pole; and (3) *centralecithal* eggs, in which the accumulation of yolk is at the centre and is surrounded on all sides by a purely protoplasmic layer. Eggs of this type are especially characteristic of the arthropods. In telolecithal eggs the pole that is the richer in yolk is called the *vegetative* pole. The nucleus lies nearer the opposite, or *animal* pole, and the purely protoplasmic portion surrounding the nucleus may be confined to a very small area, the *germinal disc*, near the surface, as in the hen's egg.

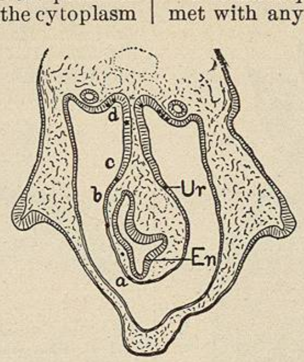

FIG. 3718.—Section of the Ventral Portion of an Embryo Dogfish, 15 mm. Long. *En*, Endoderm; *Ur*, germ cells. × 38. (After Woods.)

The nucleus is usually a spherical body surrounded by a delicate nuclear membrane, and is still frequently called by the old name, *germinal vesicle*, although it presents all the ordinary features of a cell nucleus (Fig. 3714), including linin network, chromatin granules, and nucleolus, the latter is called in the older books the *germinal spot* (see article *Cell*). The condition usually described is but one stage of a pretty definite series of changes which the chromatin and nucleolus undergo during the course of development of the ovum, and which will be referred to later.

In many eggs there may be seen near the nucleus an "attraction sphere" of finely granular protoplasm surrounding a very minute, darkly staining spot, the *centrosome*. The eggs of many animals of various groups contain also another body, often somewhat resembling a nucleus and hence called the *yolk nucleus* (Fig. 3714).

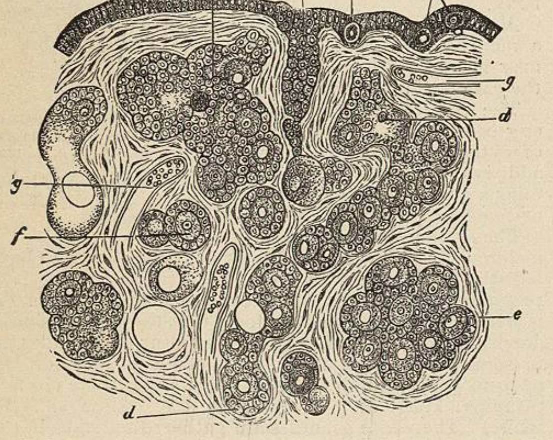

FIG. 3719.—Part of a Sagittal Section of an Ovary of a New-born Child. *a*, Ovarian epithelium; *b*, commencement of one of Pflüger's cords; *c*, *c*, "primitive ova" in the epithelium; *d*, *d*, and *e*, *e*, germinal involutions with developing ova and young follicles; *f*, young follicle; *g*, *g*, blood-vessels. Magnified. (From Waldeyer.)

It is also called, after the author who first described one of these bodies, the corpuscle of Balbiani. It is probable that the bodies classed together under this name are far from all having the same morphological or the same physiological significance.

The Envelopes.—The most primitive type of egg to be met with anywhere in the animal kingdom is that characteristic of the sponges and hydroids. In these groups we meet with eggs that are not only wholly naked, but also show the power, at least within the maternal body, of active amœboid movement. Naked eggs are found in representatives of other groups of cœlenterates; and the eggs of some echinoderms, at least, are without envelopes when discharged from the oviduct, although an envelope is formed immediately after the entrance of the spermatozoon.

In all the higher groups of animals the egg is provided with one or more coverings. These are divided into three principal classes. First we have the primary envelope or *vitelline membrane*, which is essentially a cell wall formed by the cytoplasm of the egg. This is found in representatives of all groups of the animal kingdom. It is generally thin and structureless, but it may consist of several layers or be pierced by radial pores forming a *zona radiata* (*b*, Fig. 3713). Sometimes the vitelline membrane is incomplete at the point where the egg is attached to the wall of the ovary, leaving an opening, the *microphyle*, which serves as a passageway for nutrient material during the ovarian life of the egg and later for the entrance of the spermatozoon.

The secondary envelope is found only in eggs that are surrounded in the ovary by a follicular epithelium, which gives rise to this envelope; and it is especially characteristic of the eggs of insects and mollusks. In these forms it is called a *chorion*, a term used also to designate a very different fœtal membrane of mammalia.

After leaving the ovary the egg may receive one or more *tertiary* envelopes, which are secreted by the walls of the oviduct or by glands connected with it. These envelopes may be protective or nutritive in function or both. For example, in the hen's egg (Fig. 3712), the ovum, commonly known as the "yolk," covered by a thin vitelline membrane, lies embedded in a mass of albumen that serves as food for the embryo chick. But at opposite poles of the ovum there are attached much denser strands of albumen, the *chalazæ*, that undoubtedly serve also as a sort of packing to prevent the ovum from coming into too close contact with the ends of the shell. Outside of the albumen are two shell membranes and then the hard calcareous shell. The egg when it emerges from the ovary is provided with only a vitelline membrane. The albumen, shell membranes, and shell are tertiary envelopes and are secreted in succession by the wall of the oviduct as the egg passes outward.

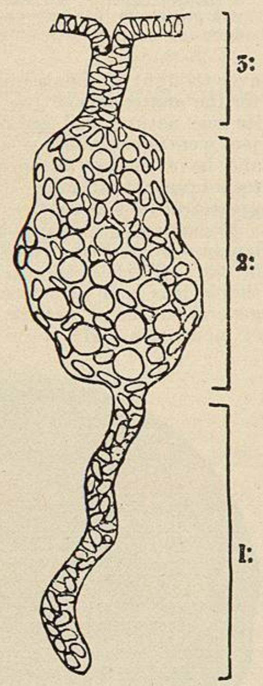

FIG. 3720.—Diagram of the Derivatives of the Germinal Epithelium in Mammalia. 1, Medullary cord; 2, germinal involution containing ova and follicle cells; 3, invaginated epithelium (Pflüger's cord) and covering epithelium. (After Winiwarter.)

The outer coverings of the eggs of the different groups of animals show much diversity of form and structure, and many of them present wonderful adaptive modifications. But to treat of this fascinating branch of the subject would carry one far beyond the possible limits of the present article.

Early Development.—In the sponges, some cœlenterates, and some of the lower worms the development of eggs is apparently not localized, but may occur in various parts of the body. In the higher forms, on the contrary, the germ cells always undergo their development in certain well-defined regions or organs known in the female as the *ovaries;* and in all animals possessing a distinct body cavity, or cœlom, the cells of the ovary are originally continuous with the peritoneal epithelium. In vertebrates the portion of peritoneum containing the primitive germ cells, the *germinal epithelium*, is in the dorsal part of the body cavity, usually on the inner side of the Wolffian body near the mesentery. In the development of the ovary the germinal epithelium thickens, and the connective tissue beneath it also grows outward into the body cavity, so that the two together form an elevation upon the Wolffian body known as the *genital ridge*. From this the definitive ovary is formed.

We have called attention elsewhere to the very early appearance of distinctly germ cells in the worm Ascaris (see article *Heredity*). It has been shown recently that in vertebrates the germ cells may appear at a considerably earlier stage than had been thought possible.

Minot in 1894 and Rabl in 1896 had shown that what appeared to be germ cells, or primitive ova, may be seen in early stages of the embryo lying in positions far distant from the genital ridge. More recently (in 1902) Woods has published the results of his studies upon the embryos of the common marine dogfish, *Squalus acanthias*, in which he has been able to trace the history of the germ cells back to a mass of seemingly indifferent cells forming the rim of the blastoderm (see article *Area Embryonalis*). At first these cells are all alike, but in an embryo of 2.75 mm. length they have become differentiated into somatic cells and so-called primitive ova, that is, primitive germ cells which may become finally either ova or spermatozoa (Fig. 3715). The germ cells retain their primitive embryonic character, while the somatic cells begin to change into forms characteristic of epithelium, mesenchyma, and the like.

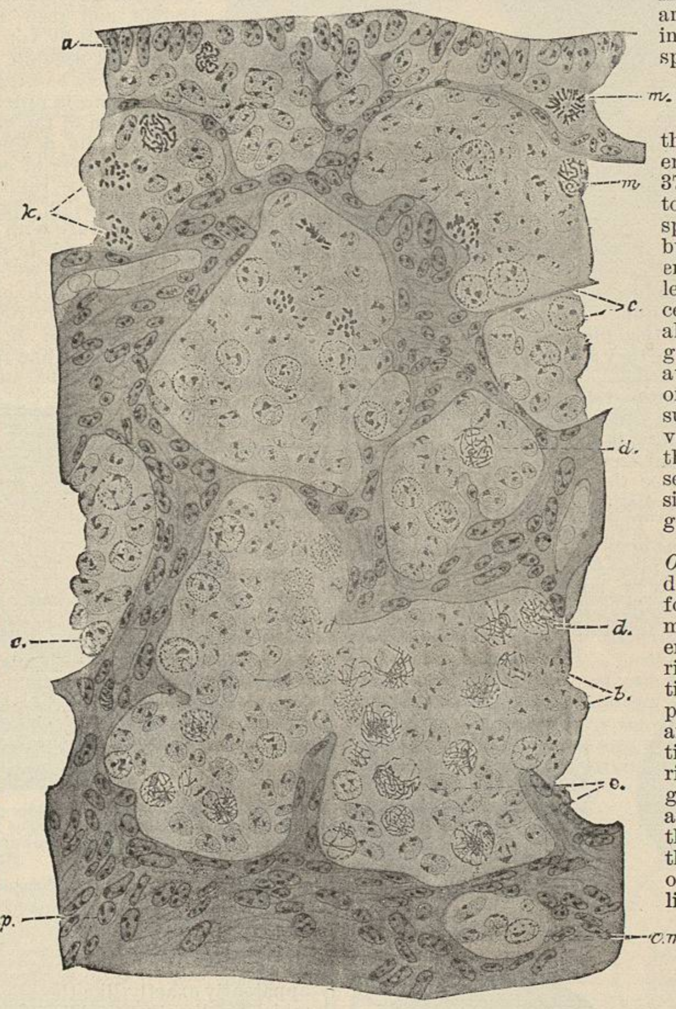

FIG. 3721.—Part of a Section of the Ovary of a Rabbit Half a Day after Birth. *a*, Covering epithelium; *b*, protobrochal nuclei of oögonia and follicle cells; *c*, deutobrochal nuclei; *d*, leptotænian nuclei; *e*, synapsis stage; *m*, oögonia in mitosis; *k*, nuclei undergoing degeneration; *c.m.*, medullary cord; *c.m.p.*, medullary connective tissue. × 450. (After Winiwarter.)

At a little later stage when the embryo is beginning to fold off from the blastoderm, the germ cells are found in a compact mass in the mesoderm near where it joins the endoderm (*Ur*, Figs. 3716 and 3717).

From this point the germ cells begin to migrate, apparently by their own amœboid movements, toward the region of the future genital ridge. When the embryo is between 6 and 8 mm. long the unsegmented mesoderm divides into two sheets with the body cavity between. After this the germ cells are practically all found in the inner sheet, or splanchnopleure, which forms the mesodermal portion of the wall of the gut and the mesentery. In an embryo of 15 mm. (Fig. 3718) germ cells are still to be found in the splanchnic peritoneum, but by the time the embryo has reached a length of 19 mm. these cells have very nearly all congregated in the genital region. While at present this is the only case on record of such a migration in a vertebrate, it is probable that more extended research will reveal many similar cases among this group.

Development of the Ovary.—As has been indicated, the ovary is formed by the enlargement and further differentiation of the genital ridge. In it we may distinguish two principal parts—the cortical layer and the medullary portion. The cortex is derived from the primitive germinal epithelium, and from it are formed the peritoneal, or epithelial, covering of the ovary, the Graafian follicles, and the definitive ova. The medullary portion is derived from the underlying mesenchyme cells, which form the connective-tissue stroma and the blood-vessels of the ovary, and within it are embedded the nerve fibres that supply these vessels. In the mammalia the medullary portion contains also during the early stages a large number of strands of cells of a more or less epithelial character, forming what are called the *medullary cords*, and these have given rise to a considerable amount of discussion. For it has been seen that in the embryo these medullary cords may sometimes be found in contact with the glomerulæ of the Wolffian body, and it has been supposed that they were formed by outgrowths from the renal tissue into the ovary. Moreover, there are indications that ova may be developed in the medullary cords, and, if this were generally true and the cords have the origin supposed, the ova of mammals would have an entirely different origin from those of other vertebrates—from the renal epithelium instead of from the lining of the body cavity. This difficulty seems to have been cleared up very satisfactorily by the recent work of

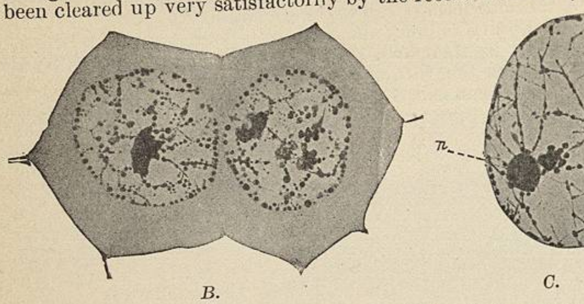

FIG. 3722.—Nuclei from the Ovary of a Human Fœtus of about Seven Months. *B*, Two oögonia with protobrochal nuclei; *C*, nucleus of an oöcyte of the first order in the deutobrochal stage; *n*, nucleolus. × 1700. (After Winiwarter.)

von Winiwarter (1900). In his study of embryo rabbits he finds that the medullary cords are not formed as outgrowths of the glomerulæ, but are the first ingrowths of the germinal epithelium. They penetrate first the stroma of the ovary and then push through the hilum into the Wolffian body, where they may come into contact secondarily with the glomerulæ.

In the ovary of an embryo rabbit taken from the uterus twenty-three days after coitus, von Winiwarter distinguishes two principal parts in the primitive cortex. The outer one is the germinal envelope, which is continuous over the whole surface of the ovary and may be subdivided into a superficial distinctly epithelial layer and a deeper germinal layer. The inner part of the cortex is made up of the germinal involutions (*boyaux germinatifs*), which are simply thickenings of the germinal layer separated from one another by strands of the connective-tissue stroma of the medullary portion of the ovary. In their deepest parts the involutions are not yet sharply

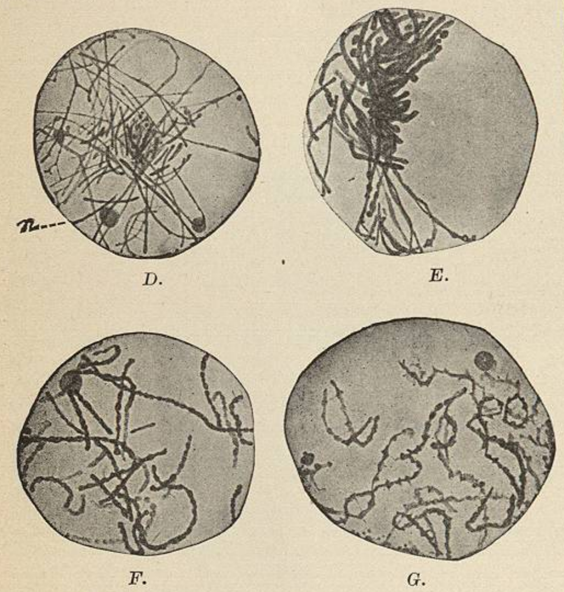

FIG. 3723.—Nuclei from the Ovary of a Human Fœtus of about Seven Months. Consecutive stages in the development of the oöcyte: *D*, leptotænian; *E*, synapsis; *F*, pachytænian; *G*, diplotænian; *n*, nucleolus. × 1700. (After Winiwarter.)

separated from the medullary cords, with which they were originally continuous. In the subsequent stages, by the combined ingrowth of the germinal layer and outgrowth of the connective tissue, the involutions become more separated from one another and from the outer epithelium, until in a new born child or a rabbit five weeks after birth the involutions are connected with the epithelium only by narrow cords of cells, the so-called egg tubes of Pflüger (Fig. 3719) (*Pflügerschen Schläuche*). Von Winiwarter's conception of the relations of these structures of the ovarian cortex is shown diagrammatically in Fig. 3720.

Development of the Definitive Ova.—The development of the ova in the later embryonic and early post-natal stages of mammalia (rabbit and man) has been described with great detail by von Winiwarter, and we will follow his account, except so far as it may be necessary to supplement it by reference to other forms in order to complete our general description of the later stages.

During its development the ovary is covered by a layer of epithelial cells with nuclei elongated at right angles to the surface. These nuclei (*a*, Fig. 3721) have a finely reticular structure with a few irregularly placed masses of chromatin. In an embryo rabbit of twenty-three days practically the whole cortex is composed of similar cells. Those beneath the epithelium differ only in having nuclei a little more rounded and more coarsely reticular (*b*, Fig. 3721 and *B*, Fig. 3722). This is the *protobrochal* (πρῶτος, first, and βρόχος, mesh) stage in the development of the nuclei and the cells are *oögonia.*

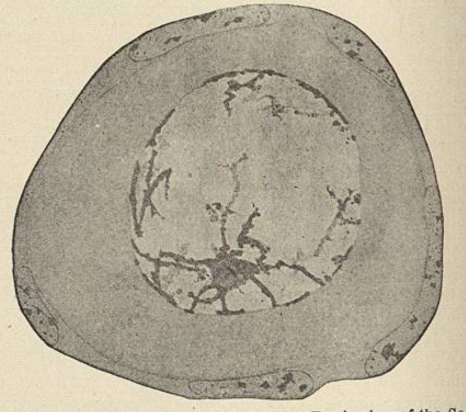

FIG. 3724.—Oöcyte of the First Order at the Beginning of the Second Period, from a Young Rabbit. The follicle cells are few and much flattened. × 1700. (After Winiwarter.)

That they are in process of rapid multiplication is shown by the presence of numerous mitotic figures among them (*m*, Fig. 3721). A large number of the protobrochal nuclei remain unchanged and the cells finally form the Graafian follicles (Fig. 3714). Others which are at first apparently exactly like them belong to the true oögonia, which finally cease dividing and begin to enlarge. They then become the *oöcytes of the first order.*

The ovarian history of the oöcytes may be divided into two stages: first, before the formation of the Graafian follicles; and, second, after that event. During the first stage the nucleus of the oöcyte undergoes a curious series of transformations.

The nuclei gradually enlarge and become globular in shape. At the same time the chromatin becomes more coarsely reticular, forming the *deutobrochal* stage (δεύτερος, second), and one or two nucleoli appear within the nucleus (*c*, Fig. 3721 and *C*, Fig. 3722). In the next stage (*d*, Fig. 3721 and *D*, Fig. 3723), the chromatin ceases to have a reticular appearance and is in the form of slender threads distributed evenly throughout the nucleus in more or less parallel pairs. From this the nucleus passes gradually into the synapsis stage (συνάπτω, to reunite, to condense), in which the chromatin threads are withdrawn from the greater part of the nucleus and are condensed into a tangled mass, generally near one side of the nucleus (*e*, Fig. 3721 and *E*, Fig.

3723). When the tangle is unravelled, the chromatin emerges as a thick, beaded cord without any appearance of doubling (*F*, Fig. 3723). Whether this is really a single filament or is composed of several, is difficult to determine. In the next stage, however, the chromatin is distinctly divided into segments which are double, often forming rings or figure eights (*G*, Fig. 3723). Finally, when the oöcyte becomes surrounded by the follicle cells, the nucleus resumes a coarsely reticular structure (Fig. 3724). It will be noticed that during these stages the nucleus has increased very much in size (compare Figs. 3722 and 3724).

In the embryo rabbit of twenty-three days there are already a considerable number of oöcytes in the deutobrochal stage lying in the deep parts of the genital involutions. In the newly born rabbit the oöcytes are much more numerous, and those in the deepest parts of the ovarian cortex have reached the synapsis stage (*e*, Fig. 3721). The earlier stages (*c*, *d*, Fig. 3721) may be seen lying nearer to the periphery. The Graafian follicles begin to be formed in a rabbit when about ten days old; but they are already present in a human fœtus of seven months.

The egg follicle has a different structure in each group of vertebrates. In mammalia it is at first a single layer of flattened cells (Fig. 3724). But these cells soon increase in number until they form several layers surrounding the oöcyte. Then a fissure appears filled with fluid which incompletely separates the follicular cells into an outer and an inner sphere. The outer one is the so-called *tunica granulosa*, and the inner one, which surrounds the egg, is the *discus proligerus* and is continuous with the granulosa on one side, usually the side toward the centre of the ovary (Fig. 3726). This is now a typical Graafian follicle. In the mean time the connective-tissue stroma has so in-

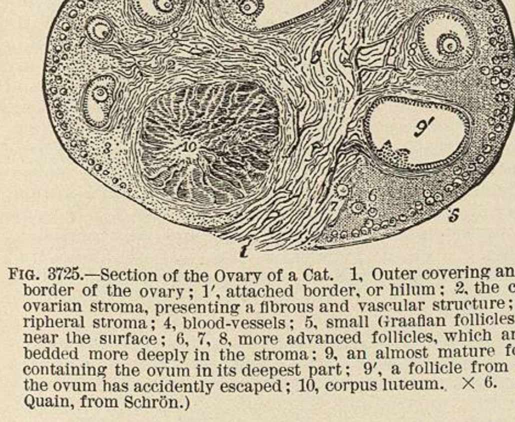

FIG. 3725.—Section of the Ovary of a Cat. 1, Outer covering and free border of the ovary; 1′, attached border, or hilum; 2, the central ovarian stroma, presenting a fibrous and vascular structure; 3, peripheral stroma; 4, blood-vessels; 5, small Graafian follicles lying near the surface; 6, 7, 8, more advanced follicles, which are embedded more deeply in the stroma; 9, an almost mature follicle, containing the ovum in its deepest part; 9′, a follicle from which the ovum has accidently escaped; 10, corpus luteum. × 6. (After Quain, from Schrön.)

vaded the germinal involutions as to isolate the follicles and form a connective-tissue capsule, the *theca folliculi*, around each one.

At the time of the first appearance of the follicle cells the outline of the oöcyte appears to be clearly defined, probably by a thin cell wall. When the discus proligerus is established the oöcyte is seen to be surrounded by a clear membrane, apparently containing extremely fine radial canals through which there is supposed to be protoplasmic connection between the oöcyte and the surrounding fol-

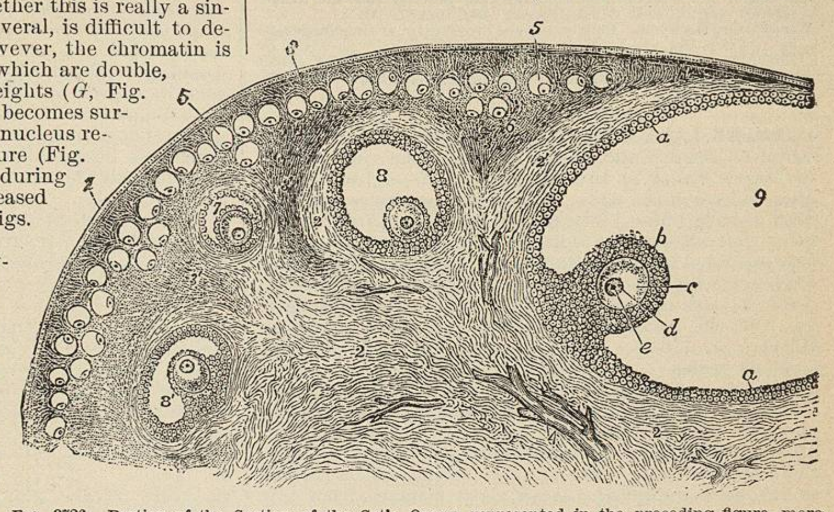

FIG. 3726.—Portion of the Section of the Cat's Ovary, represented in the preceding figure, more highly magnified. 1, Epithelium and outer covering of the ovary; 2, 2′, fibrous stroma; 3, 3′, less fibrous, more superficial stroma; 4, blood-vessels; 5, small Graafian follicles near the surface; 6, one or two more deeply placed; 7, one further developed, enclosed by a prolongation of the fibrous stroma; 8, a follicle further advanced; 8′, another, which is irregularly compressed; 9, part of the largest follicle; *a*, tunica granulosa; *b*, discus proligerus; *c*, ovum; *d*, germinal vesicle; *e*, germinal spot. (From Schrön, in Quain's Anatomy.)

licular cells. This membrane is the *zona radiata*, or *membrana pellucida.* Whether it is a true vitelline membrane formed by the oöcyte or a secondary envelope formed by the follicular cells is still a matter of dispute.

After the follicle is developed the egg not only continues to increase in size, but also begins to acquire yolk material or deutoplasm. This is small in amount in man and other mammals, but in most other vertebrates a comparatively large amount of yolk is formed.

The final discharge of the egg from the ovary in mammals is brought about by the bursting of the Graafian follicle. This allows the egg with the surrounding fluid to escape into the body cavity whence it enters the Fallopian tube. For the details of this process see article *Menstruation.*

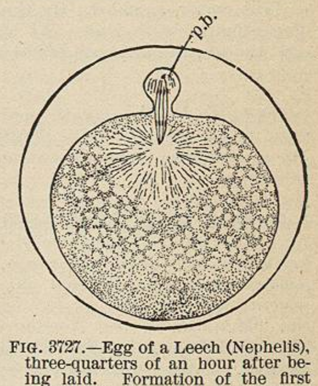

FIG. 3727.—Egg of a Leech (Nephelis), three-quarters of an hour after being laid. Formation of the first polar body. Magnified. (After Hertwig.)

Before the egg can be fertilized, however, it must pass through two cell divisions of a peculiar character, which constitute the process of *maturation.* During the period of growth the egg is an "oöcyte of the first order." At about the time the egg is discharged it undergoes a very unequal cell division, forming the *first polar body* and the "oöcyte of the second order." The latter soon undergoes another division into the *second polar body*, and the definitive, or *ripe ovum.* The details of the process of maturation will be considered in connection with a similar process in spermatogenesis under the title *Reduction Division.*

Robert Payne Bigelow.

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OWENS LAKE.—Inyo County, California. This second dead sea in California is located at the southern end of Owens Valley in Inyo County. It is eighteen miles long and ten miles wide. Its surface embraces one hundred square miles. The waters are remarkably rich in saline and alkaline ingredients. The following analysis was made by Professor Phillips, of London, in 1883: One United States gallon contains: Sodium chloride, gr. 2,450.81; sodium carbonate, gr. 797.01; sodium sulphate, gr. 2,427.69; potassium sulphate, gr. 29.77; potassium silicate, gr. 116.23; organic matter, gr. 14.11. Total, 5,835.62 grains.

We are informed by Dr. I. J. Woodin, of Independence, Cal., that numerous fresh-water springs are found along the shores of the lake, some of which are cold and others boiling hot. At the southwest end of the lake there is a valuable white sulphur spring which has not so far been improved. At a short distance from this spring is a mountain formed in great part of sulphur, of which Dr. Woodin sends us a handsome specimen, composed probably almost entirely of the pure element. The aspect of the country is mountainous, the elevation of the lake being three thousand feet above the Pacific. The region offers many attractions as a health resort, and it will no doubt soon be developed.

James K. Crook.

OWOSSO SPRING.—Shiawassee County, Michigan.
Post-Office.—Owosso.

Access.—Owosso is a station on the Detroit and Milwaukee Railroad, seventy-nine miles northwest from Detroit.

The following analysis was made by a chemist whose name has been lost: One United States gallon contains: Calcium bicarbonate, gr. 25.67; magnesium bicarbonate, gr. 19.09; iron bicarbonate, gr. 15.92; sodium chloride and potassium chloride, gr. 2.10; alumina and silica, gr. 0.62. Total, 63.40 grains.

This water, as shown by the analysis, is very heavily impregnated with iron. As the name of the analyst is not known, the analysis is not reliable.

James K. Crook.

OXALIC ACID.—Oxalic acid, having no medicinal virtues, is not official in the United States Pharmacopœia. Its importance depends entirely upon its toxicological relations.

E. C.

OXALIC ACID, POISONING BY.—The salt obtained by evaporation of the juice of *Oxalis acetosella,* and now known as *binoxalate of potash, salt of sorrel,* or *salt of lemon,* was known at least as early as the middle of the seventeenth century, as Duclos makes mention of it in the "Memoirs of the Academy for 1668." A century later (in 1773) oxalic acid was obtained from this salt by Savary. Subsequently Scheele showed the oxalic acid obtained from sorrel to be identical with the *acid of sugar* obtained by Bergman, in 1776, by the action of nitric acid upon sugar.

The first case of poisoning by oxalic acid, of which we find record, occurred in England in 1814 (*Lond. Med. Repository,* i., 382). In this case the acid was taken in mistake for Epsom salt, a mistake which has subsequently become the most frequent cause of oxalic-acid poisoning.

Attempts at homicide by oxalic acid are of rare occurrence, owing to the difficulty of disguising the taste. Christison mentions one as having occurred in England in 1827, and others have been subsequently reported from the same country, the acid having been mixed with gin, coffee, sugar, tea, or buttermilk.

Notwithstanding the very extensive use of oxalic acid and the oxalates in the arts of dyeing, calico-printing, etc., they are as yet innocent of industrial poisoning.

As many articles of vegetable diet—beet, spinach, rhubarb, sorrel, etc.—contain oxalates, their use in excessive quantity has been supposed by some to be attended with some danger of poisoning. As, however, the amount of hydropotassic oxalate present is only 0.75 per cent. (= 3 grains per ounce) in fresh sorrel (Mitscherlich), and much less in the other vegetables, their use in any reasonable quantity may be regarded as unattended with danger.

A more probable cause of poisoning is to be found in the adulteration of citric acid with oxalic acid, and the use of the adulterated product in the manufacture of medicinal effervescent drinks or of cheap "lemonade."

Poisoning by oxalic acid and the oxalates is of very rare occurrence in France, while in England, Germany, and the United States several cases occur annually. The reason for the greater frequency of oxalic poisoning in the last-named countries is to be found in the very extensive use in them of oxalic acid and salt of lemon for household purposes, to clean metallic vessels and to remove ink and fruit stains from fabrics, as well as in the popular habit of "taking a dose of salts" at certain times of the year. Oxalic acid and magnesium sulfate resemble each other very closely in appearance, and hence the former is frequently taken by mistake for the latter.

Symptoms.—Oxalic acid is both a corrosive and a true poison, one or the other action predominating according to the size of the dose and the degree of concentration of the solution. If it be taken in the solid form or in concentrated solution, as is usually the case, the symptoms of corrosion are the first to appear and may be the only ones observed. But if the poison be taken in dilute solution the symptoms of corrosion may be entirely absent.

In a typical case of oxalic-acid poisoning, the dose being in the neighborhood of 15 gm. (℥ ss.), taken in concentrated solution, the patient experiences the first effects of the poison either immediately, during the act of swallowing, or within a few moments. In exceptional cases the first appearance of symptoms has been delayed ten or twenty minutes, although larger doses were taken.

The strongly acid taste is observed and is followed by a sense of heat in the mouth, throat, and stomach. This rapidly increases in intensity until it becomes an intense, burning pain. In some cases the pain is accompanied by a sense of constriction of the throat and of impending suffocation. The act of swallowing is performed with difficulty, and later the voice becomes fainter and husky, and sometimes completely extinguished. Within ten or fifteen minutes violent and persistent vomiting begins in almost every case. The vomited matters are most frequently of a "coffee-ground" character, and separate on standing into two layers: the upper a clear, yellowish, and strongly acid liquid; the lower a thick, red-brown sediment of altered blood. Occasionally true hæmatemesis is observed. In cases in which the poison has been taken in small quantity and in dilute solution, the vomited matters may be free from blood. In some cases persistent vomiting and pain, and later persistent purging of a bloody material are the only symptoms, and they may continue, with or without intermission, for five, six, or seven days. Death finally occurs from exhaustion in from five to ten days.

When very large doses have been taken (30–60 gm. = ℥ i.–ij.), the patient, after vomiting, may go into a state of collapse and die within five minutes.

The lips, mouth, and fauces are, shortly after the poison has been taken in solution, reddened, swollen, and painful. Later they become paler, and finally, sometimes within an hour, of a dirty, ashen-white hue, either throughout or in patches. The tonsils and uvula are much swollen. There is severe thirst.

Soon the symptoms due to the true poisonous action of the acid are added to those caused by its immediate corrosive action upon the alimentary canal. The countenance is pale, anxious, and haggard, the upper lip trembling, the lower jaw relaxed. The surface is bathed in a cold, clammy perspiration. The fingers are semiflexed and rigid, and the nails blue. The eyes are glazed and the pupils contracted. There is sometimes persistent hiccough. The pulse is small and thready, sometimes intermittent or imperceptible. There are general numbness and a sense of tingling or cramps in the upper and lower extremities. Abdominal pain is no longer complained of, although the abdomen may remain tender to pressure; but the patient suffers violent lumbar pains, shooting down into the lower extremities. The respiration is quick and labored. The skin in some cases is marked with an exanthem resembling that of roseola. The urine is frequently retained, and that removed by the catheter contains albumin in large quantity, epithelium, granular or hyaline casts, and crystals of calcium oxalate. Sometimes, in cases of recovery, the urine remains purulent for several weeks.

Sometimes there are violent spasms of a tetanic character; more rarely delirium. In cases of recovery, spasmodic twitchings may continue for a month.

In exceptional cases (usually, though not always, cases in which a small dose has been taken) the patient rapidly becomes stupid, somnolent, and unconscious. This condition has been known to pass into one of coma, terminating in death (Tidy: *Lancet,* 1872, ii., 41).

Like the mineral acids and alkalies, oxalic acid may cause death secondarily, after partial recovery, by starvation, due to extensive destruction of gastric and intestinal mucous membrane. This was observed in an early case by Fraser (*Edinb. Med. Journ.,* xiv., 1818, p. 607), in which death by inanition followed in fourteen days from the effects of a dose of ℥ ss. (15.5 gm.) of the acid.

The immediate cause of death in oxalic-acid poisoning may be, therefore, either collapse, or paralysis of the heart, or inanition.

Duration.—The duration of a case of oxalic poisoning is usually short if it terminate in death; but if the patient recover the illness is generally protracted through several days. Of 22 cases ending in death, 9 died within half an hour, 3 in from one to twelve hours, 3 in from twelve to twenty-four hours, and 7 in from two to fourteen days. Of 14 cases terminating in recovery, in which the time of discharge is mentioned, 3 recovered within one day, 4 in from one to five days, 4 in from five to ten days, and 3 in from ten days to three months. The shortest recorded duration of a fatal case is three minutes, the longest fourteen days.

Lethal Dose.—The following tabulation of 51 cases will illustrate the difficulty of fixing this quantity definitely:

Quantity of Oxalic Acid Taken.	Recovery. Cases.	Death. Cases.
Undetermined	5	11
4.00 gm. = (ʒ i.)	1	1
7.75 gm. = (ʒ ij.)	3	1
11.66 gm. = (ʒ iij.)	1	1
15.50 gm. = (ʒ iv.)	6	2
23.33 gm. = (ʒ vi.)	0	2
27.22 gm. = (ʒ vij.)	0	1
31.00 gm. = (℥ i.)	7	7
38.85 gm. = (℥ i¼)	1	0
46.65 gm. = (℥ iss.)	1	0
	25	26

From this it will be seen that one-half of those who have taken over 4 gm. (ʒ i.) have died; and that the deaths and recoveries are nearly evenly balanced with all doses below 30 gm. (℥ i.).

Treatment.—The first indication, and one which admits of little delay, is the neutralization of the acid in such a manner as to bring about the formation of an insoluble oxalate, and thus prevent further corrosion and absorption. For this purpose the alkaline carbonates are useless, because, although they neutralize the acid and thus prevent further corrosion, the salts formed are soluble and as poisonous as the acid itself. The old direction to "scrape the wall" and administer the scrapings, was well enough so long as whitewashed walls were in vogue; but to administer the scrapings of a modern plastered wall is of no benefit, as the calcium sulfate so given is incapable of neutralizing oxalic acid, or of converting it into an insoluble salt. The best antidote is syrup of lime, or a similar preparation of magnesia. Precipitated chalk is more frequently available and may be given, as the corrosion is not sufficiently extensive to render the generation of gas dangerous. For the same reason the introduction of the stomach tube and lavage are not attended with the same degree of risk of perforation as exists in corrosion by the mineral acids. Emetics are rarely called for, as persistent vomiting is one of the most characteristic effects of the poison. In the rare cases, however, in which vomiting does not occur as a result of the poisoning, emetics may be given, but only after early neutralization of the acid. In no case should warm water be given with a view to producing emesis; and, until the acid has been neutralized, the amount of liquid of any kind taken by the patient should be as small as possible. Opium may be given to allay pain, and stimulants in the stage of collapse.

Post-mortem Appearances.—The lips, tongue, mouth, and œsophagus are of an opaque, yellowish-white color, sometimes marked with patches of a reddish hue. The stomach is contracted, and in many cases contains a thick, gelatinous, reddish-brown and acid liquid, somewhat similar to the "coffee-ground" material vomited during life. The peritoneal surface of the organ, as well as the mesentery and the greater portion of the peritoneal surface of the intestines, is marked by blood-vessels filled with dark, fluid blood. The mucous surface of the stomach is strongly corrugated, and in most cases presents a uniform, bright red color in the elevations and depressions, except in so far as it may have been changed to brown, or even black, by post-mortem action. In some cases the mucous surface is, either in part or in whole, pale, opaque, or translucent, and marked with a coarse, ramiform vascularity of the submucous tissue. The mucous membrane, where it remains, is soft, pulpy, and easily detached. Although perforation has been observed, it is of rare occurrence. Crystals of oxalic acid, or of hydropotassic oxalate are not frequently found in the stomach, although Lesser figures a case ("Atlas," t. viii., Fig. 1), in which the patient died within ten minutes; and the almost uniformly pale and much contracted stomach was found plentifully lined with crystals of hydropotassic oxalate. Microscopic crystals of calcium oxalate are, however, found in many cases in the stomach and intestines, particularly in cases in which death has followed, not within a few moments, but in the course of from three to six hours. A microscopic examination of a section of kidney reveals the presence of amorphous and crystalline oxalate in the tubules, even in rapidly fatal cases (Lesser, *loc. cit.,* Pl. vii., Fig. 3).

Analysis.—The parts to be examined are the stomach and intestines and their contents, the liver, kidneys, and urine, also vomited matters.

The contents of the stomach and the vomited matters are strongly acid in reaction, unless antidotes have been administered, in which case they may be neutral, or even alkaline.

In a systematic analysis the acid, or its salts, are to be found in the residue of the portion examined for prussic acid and other volatile poisons, or in the aqueous liquid which has been treated with solvents for the separation of glucosids and alkaloids. If oxalic acid or oxalates alone are to be sought for, the materials are to be treated directly as below.

It must be remembered that the acid sought may be present either in the free state, in combination as a soluble oxalate, or, in consequence of the administration of antidotes, as the insoluble calcium oxalate, or the very sparingly soluble magnesium oxalate.

The substance under examination, if acid, is to be first extracted with water, the solution filtered, the filtrate evaporated over the water-bath, the residue extracted