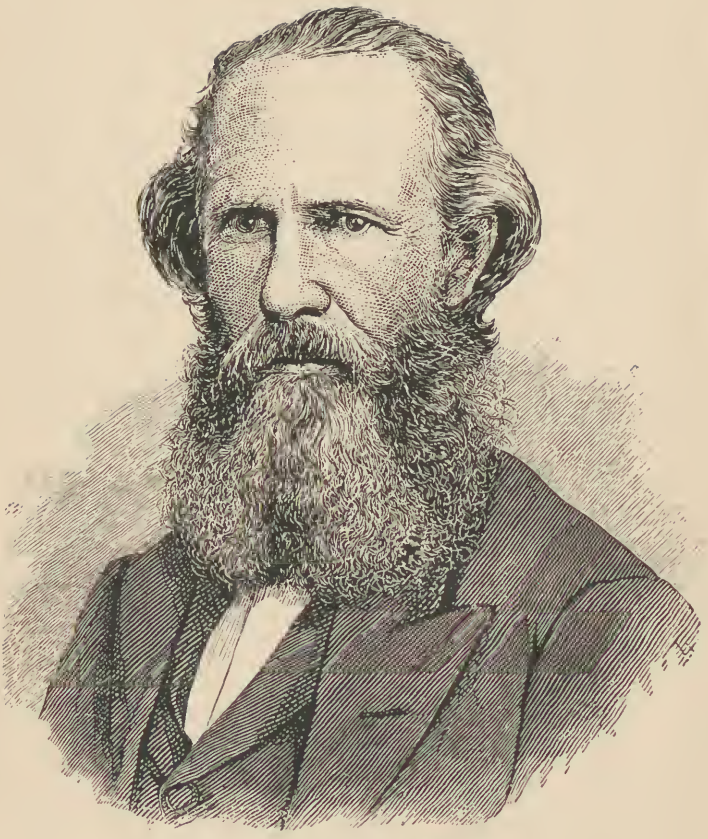

R. T. TRALL, M.D.

SEXUAL PHYSIOLOGY

AND

HYGIENE

By R. T. TRALL, M. D.

REVISED AND GREATLY ENLARGED

M. L. HOLBROOK CO.
46 EAST 21st STREET
NEW YORK

L. N. FOWLER & CO.
7 IMPERIAL ARCADE, LUDGATE CIRCUS
LONDON

1895.

Preface to the Revised Edition.

This work comes again before the public in a new and greatly enlarged edition, with additional chapters on several important subjects, especially the Hygiene of Menstruation, the Sexual Relation of Plants, Hygiene of Lactation, Hereditary Transmission, especially the transmission of acquired character, which has occupied so much of the attention of biologists of late; a chapter on the Philosophy of Love, a chapter on the Evolution of the Marriage Relation, a new chapter on Sexual Hygiene and Health of the Organs of Reproduction, and much other new matter to bring it up to the advancing knowledge of our time.

While it claims to be, so far as anatomical and physiological problems are concerned, scientific, embracing all the discoveries of this rapidly advancing age, so far as they come within the scope of its plan and purpose, its style, arrangement and application are addressed to the popular rather than to the professional reader. Its sole object is to impart instruction to the great mass of readers on those subjects which have hitherto been to them, in great part, a sealed book.

So far as the author is aware, this was the first attempt to popularize, in a scientific work, the subject of Sexual Physiology. The public has too long ignored as indelicate, or as too intricate and mysterious to be comprehended except by those who are educated in all the branches of the medical profession, those subjects which lie at the foundation of their earthly well-being.

There may be some who think the subject of Sexual Physiology too indelicate for popular study. There was a time when the subject of anatomy was considered improper, and it was unsafe for a man to devote his life to dissection and anatomical study. That day is past, and the benefits to the world from a knowledge of anatomy have been immense; the benefits to the race from a perfect knowledge of Sexual Physiology will be far greater; and while we may respect the feelings of those who prefer ignorance to knowledge on this subject, yet we must insist that it is one of the noblest studies, and brings us nearer than any other to the Creative Power, a study which, thoughtfully investigated, tends to make man wiser and better.

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CHAPTER I.

MALE ORGANS OF GENERATION.

THE VISCERA OF THE MALE PELVIS, OF THE URINARY BLADDER, PROSTATE GLAND, VESICULÆ SEMINALES AND THE RECTUM, OR LOWER PART OF THE BOWEL.

The cut and explanations given on the next page show the relation between the pelvic viscera and the generative organs.

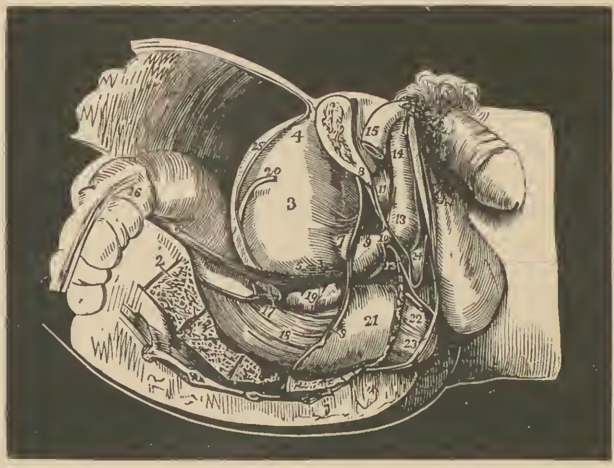
The male organs of generation are the penis and testes, with their appendages.

THE PENIS.—The penis is the organ of copulation, and is divided by anatomists into a root, body and extremity, or glans penis.

The *root* is broad and firmly connected to the rami of the pubes by two fibrous processes, termed the *crura*, and to the front of the symphysis pubis by a fibrous membrane, the *suspensory ligament.*

The *extremity*, or *Glans Penis*, resembles an obtuse cone, with a vertical slit in its apex, termed the *meatus urinarius*, orifice of the urethra. At the back part of this orifice is a fold of mucous membrane, passing backward to a depressed raphe, termed the *frœnum preputii.* The rounded projecting border of the base of the glans is termed the *corona glandis;* behind the corona is a deep constriction, the *cervix.* On each of these parts are

FIG. 1.



SIDE VIEW OF THE VISCERA OF THE MALE PELVIS.

1. Divided surface of the os pubis. 2. Divided surface of the sacrum. 3. Body of the bladder. 4. Its fundus; from its apex is seen passing upward the ureters. 5. Base of the bladder. 6. Ureter. 7. Neck of the bladder. 8, 8. Pelvic fasciæ. 9. Prostate gland. 10. Membranous portion of the urethra. 11. Triangular ligament. 12. One of Cowper's glands lying beneath the membranous portion of the urethra. 13. Bulb of corpus spongiosum. 14. Body of corpus spongiosum 15. Right crus penis. 16. Upper part of the first portion of the rectum. 17. Recto-vesical fold of peritoneum. 18. Second portion of the rectum. 19. Right vesicula seminalis. 20. Vas deferens. 21. The rectum covered by the descending layer of the pelvic fascia. 22. Part of the levator ani muscle investing the lower part of the rectum. 23. External sphincter ani. 24. Interval between the superficial perineal fascia and triangular ligament.

numerous lenticular glands, the *glandulæ Tysonii* seu *odoriferæ,* which secrete a sebaceous matter of a peculiar odor.

The *body* of the penis is covered by integument remarkable for its thinness and the absence of adipose tissue. When erect it becomes somewhat triangular in form, with rounded angles, the broadest side, called the *dorsum*, being upward. At the neck of the glans the integument leaves the surface of the penis and becomes folded on itself, forming the *prepuce*.

The penis is composed of erectile tissue inclosed in three cylindrical fibrous compartments. Two of these compartments, the *corpora cavernosa*, are arranged side by side along its upper part ; the third, the *corpus spongiosum*, is placed below and incloses the urethra.

The *Corpora Cavernosa* consist of two fibrous cylindrical tubes forming the chief part of the body of the organ, separated by a *fibrous septum*.

The *Corpus Spongiosum* is situated in a groove on the under surface of the corpora cavernosa, and, like the corpora cavernosa, is largely composed of erectile tissue, which consists essentially of an intricate venous plexus capable of receiving a large amount of blood in states of excitement or congestion. The arteries of the penis are derived from the internal pudic ; its nerves from the internal pudic nerve and the hypogastric plexus. The organ has two sets of lymphatic vessels, one superficial and the other deep.

The male *Urethra* extends from the neck of the bladder to the meatus urinarius. Its length in the

FIG. 2.

BLADDER AND URETHRA.

1. Interior of bladder. 2. Urethra, its spongy portion. 3. Corpus Cavernosum. 4. Fossa navicularis. 5, 5. Glans penis. 6, 6. Septum of corpus cavernosum. 7. Crus penis. 8, 8. Prostate gland. 9, 9. Cowper's gland. 10, 10. Ureters. 11. Meatus urinarius. 12. Orifices of ureters. 13. Orifices of ducts of Cowper's gland.

adult is usually eight or nine inches; its course has a double curve in its flaccid state, but in the erect condition it forms a single curve, the concavity of which is directed upward. It is divided into three portions, the prostatic, membranous and spongy.

The *Prostatic portion* is the widest and most dilatable part, and passes through the prostate gland. It is about an inch and one quarter in length. Upon the floor of the canal is a narrow ridge, the *veru montanum* or *caput gallinaginis*, formed of mucous membrane and its subjacent tissue. When distended it serves to prevent the passage of the semen backward into the bladder. A fossa or depression on each side of the veru montanum is called the *prostatic sinus*, the bottom of which is perforated with numerous apertures, the orifices of the prostatic ducts.

The *Membranous portion* of the urethra extends between the apex of the prostate and the bulb of the corpus spongiosum.

The *Spongy portion* is the longest part of the urethra, and is contained in the corpus spongiosum. It is about six inches in length, and extends from the membranous portion to the meatus urinarius.

The *Meatus Urinarius* is a vertical slit about three lines in length, and is the most contracted part of the urethra.

The *Urethra* is composed of three coats, a mucous, muscular and erectile.

The *Prostate Gland* is a small glandular body surrounding the neck of the bladder and commencement of the urethra. In shape and size it very much resembles a horse-chestnut. Its secretion is a milky fluid, having an acid reaction, and presenting, on microscopic examination, molecular matter. This gland is frequently enlarged, and its ducts filled with concretions, especially in old age.

Cowper's Glands are two lobulated bodies of a yellowish color, about the size of peas, situated beneath the forepart of the membranous portion of the urethra, between the two layers of the deep perineal fascia, and lying close behind the bulb. The excretory duct of each gland is nearly an inch in length, and passes obliquely forward beneath the mucous membrane, opening by a minute orifice on the floor of the bulbous portion of the urethra. They diminish in size in advanced age. These glands and the prostate are accessory organs, and produce mucous mainly.

The *Testes* are the glandular organs which secrete the semen. They are situated in the scrotum, being suspended by the spermatic cord. Lying upon the posterior border of each testis is a narrow, flattened body, termed the *epididymis*. Attached to the upper end of the testis, or the epididymis, is a small, pedunculated body, the use of which is unknown.

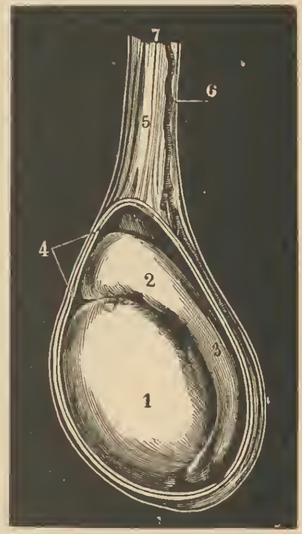
The *Scrotum*, which contains the testes and part of the spermatic cord, is a cutaneous pouch, divided into two lateral halves, by a medium line or raphe, and consisting of two layers, the integument and the dartos muscle.

The *Tunica Vaginalis*, the serous covering of the testis, is a pouch of serous membrane, derived from the peritoneum during the descent of the testis in the fœtis, from the abdomen into the scrotum.

The *Tunica Albuginea* is the fibrous covering of the testis. It surrounds the glandular structure of the organ, and, at its posterior and upper border, is reflected into the interior of the gland, forming an incomplete vertical septum, called the *corpus Highmorianum* or *mediastinum testis.*

The *Tunica Vasculosa*, or *pia mater testis*, is the vascular layer of the testis, consisting of a plexus of blood vessels, held together by delicate areolar tissue.

FIG. 3.



THE TESTIS IN SITU.

1. Testis. 2. Head of epididymis. 3. Body of same. 4. Tunica vaginalis, parietal layer. 5. Cremaster. 6. Artery of spermatic cord. 7. Spermatic cord. 8. Tail of epididymis.

STRUCTURE OF THE TESTES. The testes are compound tubular glands with numerous lobules, estimated at 250 to 400. Each lobule is of a conical shape, the base being directed toward the circumference of the organ, the apex toward the mediastinum. The tubes may be separately unraveled, by careful dissection under water. Their diameter

FIG. 4.

TESTICLE AND EPIDIDYMIS OF THE HUMAN SUBJECT.

a. Testicle. *b*, *b*, *b*, *b*. Lobules of the testicle. *c*, *c*. Vasa recta. *d*, *d*. Rete testis. *e*, *e*. Vasa efferentia. *f*, *f*, *f*. Cones of the globus major of the epididymis. *g*, *g*. Epididymis. *h*, *h*. Vas deferens. *i*. Vas aberrans. *m*, *m*. Branches of the spermatic artery to the testicle and epididymis. *n*, *n*, *n*. Ramification of the artery upon the testicle. *o*. Deferential artery. *p*. Anastomosis of the deferential with the spermatic artery.

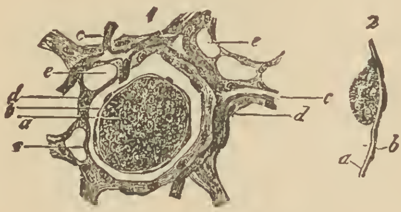
varies from one two-hundredth to one one-hundred-and-fiftieth of an inch. They consist of a basement membrane, lined by epithelium, consisting of nucleated granular corpuscles, and are inclosed in a delicate plexus of capillary vessels. In the apices of the lobules the tubuli become convoluted, and unite together so as to form 20 to 30 larger ducts, of

Fig. 5.

FROM THE TESTIS OF A CALF.

a. Seminiferous tubules in profile; *b.* in transverse section. *c.* Blood vessels. *d*, Lymphatics.

Fig. 6.



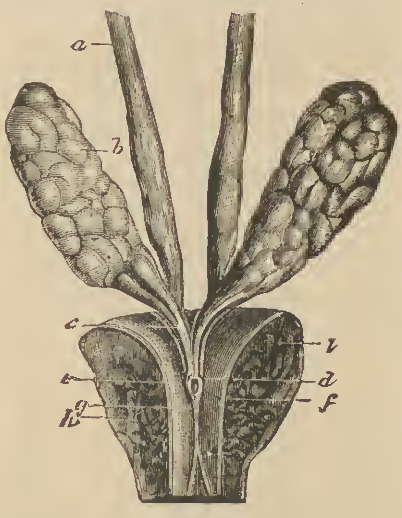
FROM THE TESTIS OF A CALF.

1. Transverse section of a seminiferous tubule. *a*, *b*. Walls of the latter. *c*. Capillary network. *d*. Connective-tissue framework. *e*. Lymphatic canals. 2. Side view of the wall of a seminiferous tube. *a*, *b*. Wall.

about one-fiftieth of an inch in diameter, which, from their straight course, are called *vasa recta*.

The *Vasa Recta* enter the fibrous tissue of the mediastinum, and pass upward and backward, forming a network of tubes with very thin parieties, constituting the *rete testis.* The vessels of the rete testis terminate at the upper end of the mediastinum in a number of ducts, varying from 12 to 20, which are termed *vasa efferentia.* They carry the seminal fluid from the testis to the epididymis.

FIG. 7.



VAS DEFERENS, VESICULÆ SEMINALIS AND EJACULATORY DUCTS.

a. Vas deferens. *b.* Seminal vesicle. *c.* Ejaculatory duct. *d.* Termination of the ejaculatory duct. *e.* Opening of the prostatic utricle. *f*, *g.* Veru montanum. *h*, *l.* Prostate.

The *Vas Deferens,* the continuation of the epididymis, is the excretory duct of the testis. It ascends along the inner side of the testis and epididymis, through the spermatic canal, to the internal abdominal ring. Its walls are thick and dense, but its canal is very small, measuring but half a line.

The *Spermatic Cord* is composed of arteries, veins, nerves, lymphatics and the vas deferens, connected by areolar tissue, and invested by its proper coverings. It extends from the internal abdominal ring to the back part of the testicles. The left cord is usually longer than the right, which occasions the left testicle to hang somewhat lower than the right.

FIG. 8.

VASA DEFERENTIA AND VESICULÆ SEMINALES.

1. Base of bladder. 2. Line of reflection of peritoneum. 3. Triangular space. 4. Vas deferens. 5. Vas deferens dissected. 6. Vesicula seminalis duct. 7, 7. Ureters. 8. Vesicula seminalis unraveled duct. 9. Right ejaculatory duct. 10. Urethra. 11. Prostate gland.

VESICULÆ SEMINALES. The Seminal Vesicles are two membranous pouches between the base of the bladder and the rectum. They serve as reservoirs for the semen, and secrete a fluid which is mixed with that of the testicles.

Each vesicula consists of a single tube coiled upon itself, and giving off several irregular diverticula.

The *Ejaculatory Ducts*, one on each side, are formed by the junction of the duct of the vesicula seminalis with the vas deferens.

The *Semen* is a thick whitish fluid, having a peculiar odor. It consists of a fluid portion called the *liquor seminis*, and solid particles termed seminal granules and spermatozoa.

The *Seminal Granules* are round corpuscles, measuring one four-thousandth of an inch in diameter.

The *Spermatozoids* are the essential elements of impregnation, and deserve more than a brief notice.

FIG. 9.

HUMAN SPERMATOZOA.
a. View of the broad surface. *b*. In profile.

They were discovered in the male semen, in 1677, by a German student named Von Hammen, and he first showed them to Leeuwenhoek, who made as thorough a study of them as he could with the imperfect microscopes of that period.

For a long time the spermatozoa were regarded as living animalcules, though at present they are considered as peculiar anatomical elements composed of protoplasm, endowed with life and capable of motion. They are very similar in form in different animals.

We shall describe them as they are found in man.

If we place a minute quantity of the seminal fluid taken from the seminal vesicles of a healthy man who has died suddenly, or of ejaculated semen, on a glass slide, cover it with a thin piece of glass and place it under a microscope we will find innumerable bodies moving over the field of the microscope with a serpentine, wriggling motion, with considerable apparent rapidity. They present a flattened conical head and a long filamentous tail. If the glass be kept warm this motion continues for some time, but finally ceases, when they are supposed to be dead, in which condition they would be incapable of fecundating the ovum, even if it were possible to bring them in contact with it. Under favorable conditions, and especially in the generative passages of the female, these movements no doubt continue for several days.

FIG. 10.

SPERMATOZOA OF THE SHEEP.

a. Head. *b*. Middle portion. *c*. Tail.

FIG. 11.

SUPPOSED MODE OF FORMATION OF SPERMATOZOA IN THE MAMMAL.

1. Head. 2. Middle portion. 3. Terminal filament.

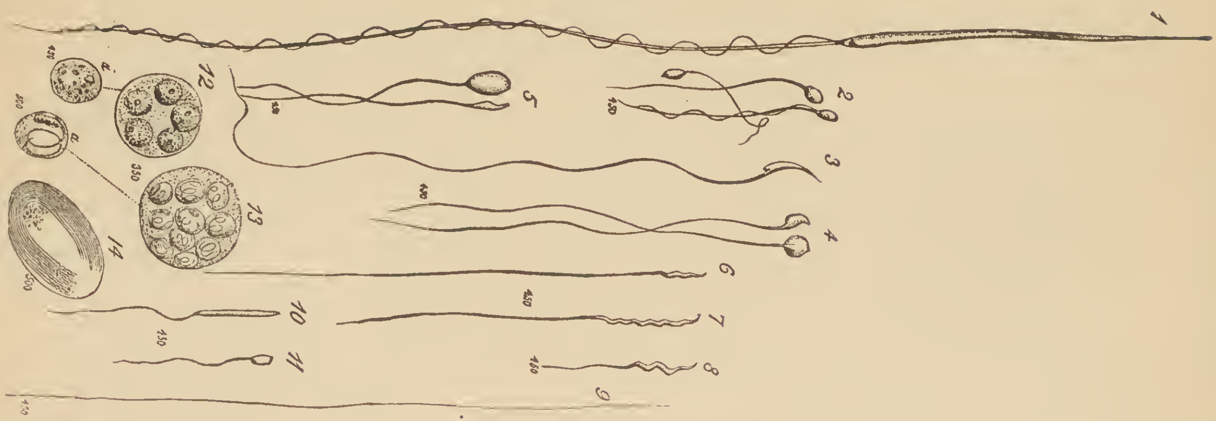
Microscopic examinations reveal a very distinct reticular structure in the spermatozoids. The head is about one five-thousandth of an inch long, one eight-thousandth of an inch broad, and one twenty-five-thousandth of an inch thick. The tail is about one five-hundredth of an inch in length.

Water arrests their movements speedily; but they may be restored by strong saline fluids. All the alkaline animal fluids seem to favor their powers of motion, while even very dilute acids act on them most unfavorably. Cold also suspends their motion, but warmth restores it.

Before the male has reached the age of puberty the seminal tubules are smaller than in the adult. They are lined with rows of epithelia, or cells, in the same manner as the uriniferous tubules of the kidney. As puberty approaches the tubules enlarge and the cells expand in size. The capillary blood vessels form a network around the tubules and supply the epithelia with nourishment. It is from these epithelia that the spermatozoids are developed. The manner of their formation is not yet fully explained; but my own researches with the microscope go to show that a single epithelia enlarges and divides, throwing off a portion of itself, which soon takes the form in which we find them in the seminal fluid. It is, so to speak, reproduction by division; a method almost universal in the lowest forms of life and retained here in perfection.

The seminal fluid with its varied contents is found during adult life, and sometimes in advanced

FIG. 12.



SPERMATOZOA OF VARIOUS ANIMALS, ETC.

1. Spermatozoa, Triton Crestatus; 2. Human, one of which exhibits the so-called spermatozoal membrane; 3. of a rat; 4. of a field-mouse; 5. of a rabbit; 6. of a goldfinch; 7. of a blackbird; 8. of a woodshrike; 9. of a coleopterous insect; 10. of a frog; 11. of a perch; 12. spermatic cyst of a rabbit with five globules; *a*, separate globule; 13. spermatic cyst of the common creeper-bird containing a bundle of spermatozoa; *a*. separate globule; 14. spermatic cyst of creeper-bird containing a bundle of spermatozoon.

The larger figures show the number of times the spermatozoa are magnified.

age, to contain spermatozoids; but in old persons and in those of middle age who have been addicted to excesses they may be absent. In 1852 Duplay examined the seminal fluid of a number of old men and found spermatozoids in about half of them, though they were rather scanty in number. M. A. Dieu also examined 156 men of advanced years. In 25 persons 60 years old he found 68 per cent. contained spermatozoids; in 76 persons 70 years old he found them in 59 per cent.; in 51 men between 80 90 years old he found them in 48 per cent.; four who were over 90 gave negative results. The highest age which gave positive results was 86; but older persons have, we believe, become parents. These observations were made by examining the contents of the generative passages shortly after death, which, probably, would not give the best results.

If sexual intercourse is very frequent the spermatozoids diminish in number and may be absent altogether. The same is true when a person has been exhausted by disease or starvation. Not many years ago I had an opportunity to examine the seminal fluid from a drunken man who had lived a life of sensuality. He was finally sent to the hospital in a broken-down and exhausted condition. The spermatozoids were very few in number, and had little living matter in them. If such men propagate their species they beget idiots and invalids.

From a chemical point of view the spermatozoids are very rich in lime. They withstand for a long time putrefaction, and are not easily soluble in mineral acids, but they yield slowly to caustic alkalies. Owing to the large amount of mineral matter in them they preserve their form when subjected to a red heat, just as a piece of paper does when laid on glowing coals, if the motion of the air about it is very slight. The dry substance of the spermatozoa contains over four per cent. of a yellow matter like butter, probably containing phosphorus and other allied substances. The pure seminal fluid of the horse contains 18 per cent. of solid matter; that of the bull, 17.94 per cent.; that of man, 10 per cent.

Number of Spermatozoa.—The number of spermatozoa in different animals is enormous. Lode, of Vienna, has made some estimates, with the following results:

In dogs, it was found that a withdrawal of seminal liquor, continued for several consecutive days was accompanied by a steady diminution of spermatozoa in the otherwise very variable number ejaculated, the third day scarcely showing more than one half of the original amount. If the withdrawals of seminal liquor are performed within a few hours, a decrease of seminal corpuscles is much more rapid, the third withdrawal already showing an infinitely small number; in the fourth withdrawal the corpuscles are sometimes entirely undemonstrable.

But withdrawals performed about two days after such rapid withdrawals within a few hours have taken place, constantly showed an enormous increase in the number of spermatozoa, which often reaches five and eight fold, and usually at least twice the original numbers. This reveals a very rapid reproduction of the semen, being accomplished under normal circumstances, according to the author's calculations, within a period of three or four days. The average quantity of ejaculations was found by the author to be 950 cubic millimeters, the average number of seminal corpuscles, 81,738.

The average mass of seminal liquor in man amounts to nearly four times as much as in the dog; the quantity of all spermatozoa present in one ejaculation amounting to 226,257,000 against 55,778,000 in the dog.

After the extirpation of one testicle there is no functional hypertrophy of the other; withdrawal of the semen showed there was about one half of the number of spermatozoa found when both testicles were in place.

The following calculation is of interest as showing the proportion between ovula and spermatozoa in man. Of the 72,000 ovula contained in the ovaries of an 18 year old girl only about 200 per ovary, or a total of 400, according to Hensen's statements, reach development. The seminal production in man presents far more imposing figures. Supposing the weekly production to be equal to the above average quantity of 226,257,000, as ascertained by observation, from the 25th to the 55th year of life, the number of seminal corpuscles produced would reach the number of 339,385,500,000. There would be, consequently, 4,713,700 spermatozoa in man for every single ovule in woman, and as many as 848,463,750 spermatozoa to one ovule reaches development—a ratio probably never attained in any of the known plants whose favorable economy was so highly admired by Darwin.

A HYGIENIC HINT.—Although nature is very lavish in the number of spermatozoa which she produces, yet, as seen from the foregoing, a temporary absence or scarcity of them may occur whenever excessive sexual intercourse is indulged in. During this period not only is the number of these elements less, but their character is also deteriorated. They may have vitality sufficient to impregnate the ovum, but not sufficient to produce the finest forms of embryo and of children. Offspring begotten from them must, in most cases, be less highly endowed than when the elements are normal. This may explain why children are often inferior to their parents. The inference is that those who wish their progeny to be superior should keep themselves in condition to furnish fine material for their generation.

The question may be asked, how many spermatozoa are required to impregnate an ovum. It has been satisfactorily shown in the lower forms of life, which can be studied under the microscope, that only one is necessary. It has not been shown that more than one may not enter into the process. Possibly several do. In the higher forms of life—in animals and in man—no direct observation is possible. For this reason we must content ourselves with such knowledge as has been gathered by studying creatures of low development.

CHAPTER II.

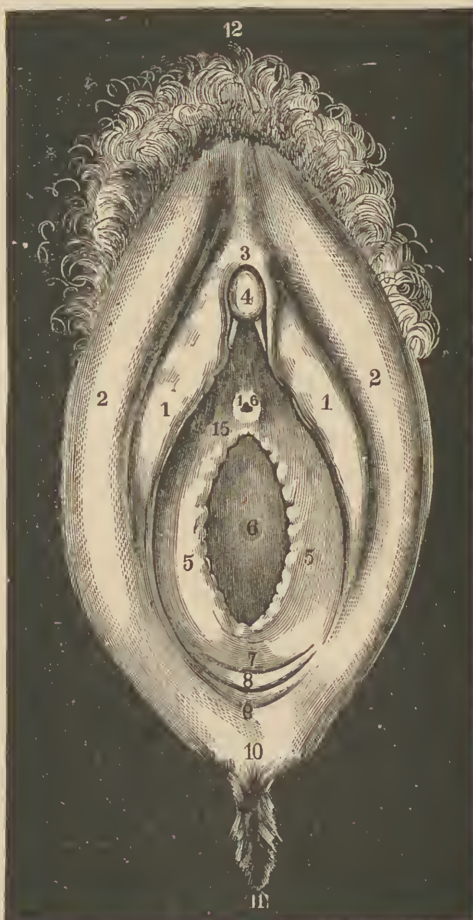
FEMALE ORGANS OF GENERATION.

The sexual organs of woman are the Mons Veneris, the Labia Majora and Minora, the Clitoris, which, with the orifice of the Vagina, constitute the Vulva or Pudendum, and the Vagina, Uterus, Fallopian Tubes and Ovaries.

The *Mons Veneris* is the prominence in front of the pubes, surmounting the vulva, and, at the period of puberty, covered with hair. It consists of a collection of adipose matter beneath the integument.

The *Labia Majora* are the longitudinal cutaneous folds extending from the mons veneris to the perineum, and inclosing the urino-sexual opening. They are formed externally of integument covered with hair, and internally of mucous membrane. Their junction above and below constitute the *anterior* and *posterior commissures.* The interval between the posterior commissure and the anus is called the *perineum.* Within the posterior commissure is a small transverse fold called *frænulum pudendi* or *fourchette*, and which is commonly rup-

FIG. 13.



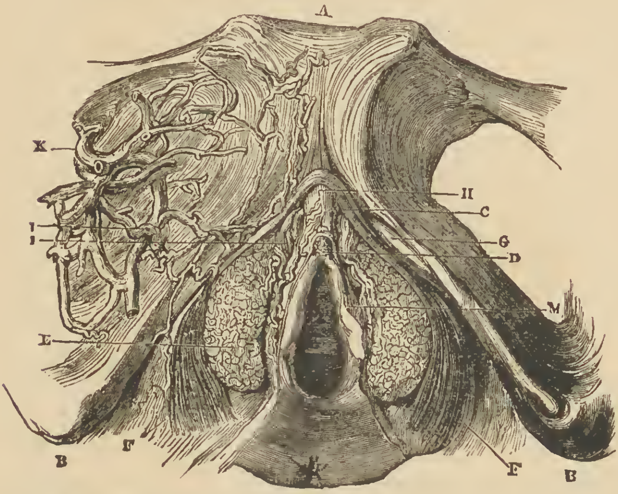
THE VULVA.

1, 1. Labia minora, or Nymphæ. 2, 2. Labia majora. 3. Clitoris prepuce. 4. Glans clitoris. 5, 5. Caruncula myrtiformes. 6. Orifice of vagina. 7. Fourchette. 8. Fossa navicularis. 9. Posterior commissure. 10. Perineum. 11. Anus. 12. Mons veneris. 15. The vestibule. 16. Meatus urinarius.

tured in the first parturition. The labia are analagous, in structure, to the scrotum in the male.

The *Labia Minora*, or *Nymphæ*, are two small folds of mucous membrane within the labia majora, extending from the clitoris downward and outward for about an inch and half on each side of the

FIG. 14.



ANOTHER VIEW, DISSECTED, SHOWING EXTERNAL ERECTILE ORGANS.

A. Pubis. B, B. Ischium. C. Clitoris. D. Gland of the clitoris. E. Bulb. F. Constrictor muscle of the vulva. G. Left pillar of the clitoris. H. Dorsal vein of the clitoris. I. Intermediary plexus. J. Vein of communication with the obturator vein. K. Obturator vein. M. Labia minora.

orifice of the vagina, on the sides of which they are lost. They are provided with numerous large mucous crypts which secrete sebaceous matter in abundance. Though anatomists and physiologists say little or nothing of the function of the nymphæ, the structure and situation seem very clearly to indicate that it is to press the clitoris more firmly upon the dorsum of the penis in the act of coition, and also, perhaps, to compress, in some degree, the male organ. Sexual pleasure, therefore, especially on the part of the female, if this view be correct, is, to a great extent, dependent on the vigor and integrity of its tissue.

The *Clitoris,* the analogue of the male penis, is an erectile structure, and the principal organ of sexual pleasure in the female, for which purpose it is profusely supplied with nerves. It is situated a little back of the meatus urinarius, beneath the anterior commissure, and is partly hidden between the anterior extremities of the labia minora. Its body is short and concealed beneath the labia; its free extremity, termed *glans clitoridis,* is a small rounded tubercle, consisting of spongy erectile tissue, and is highly sensitive. Like the penis, it is provided with two small muscles, the *erectores clitoridis,* and a suspensory ligament. The triangular smooth surface between the clitoris and the entrance of the vagina, and bounded on each side by the nymphæ, is the *vestibule.*

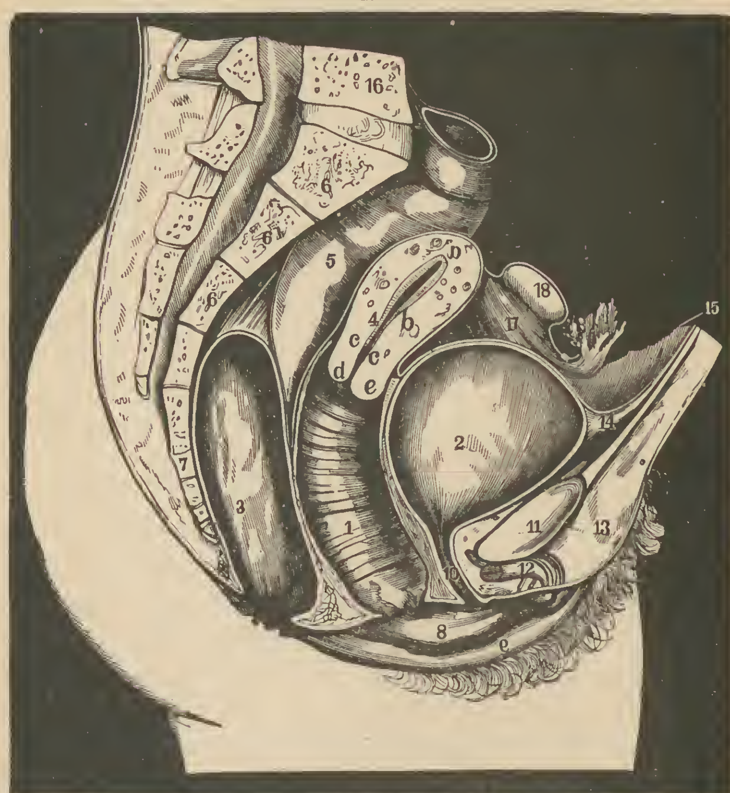
The *Meatus Urinarius,* or orifice of the urethra, is situated at the posterior part of the vestibule, about an inch below the clitoris and near the margin of the vagina. It can readily be distinguished by the prominent elevation of mucous membrane which surrounds it.

The *Hymen* is a thin fold of mucous membrane extending across the lower part of the orifice of the vagina. Occasionally the hymen forms a circular septum closing the orifice of the vagina, constituting what is termed *imperforate hymen*, preventing the discharge of the menstrual fluid, and proving a successful barrier to sexual intercourse and pregnancy. The hymen is, however, often destroyed by disease, and is occasionally absent altogether. Its presence is not a proof of virginity, nor is its absence any evidence of unchastity. The rudimentary condition of the hymeneal membrane, as well as its rupture, explain certain small rounded elevations which surround the opening of the vagina, the *carunculæ myrtiformes*.

The *Glands of Bartholine*, analogues of Cowper's Glands in the male, are round oblong bodies, of a reddish-yellow color, one of which is situated on each side of the commencement of the vagina. Each gland is of the size of a horse-bean, and opens by means of a long single duct upon the inner side of the nymphæ, external to the hymen. A plexus of veins inclosed in a thin layer of fibrous membrane, constituting two oblong bodies about an inch in length, extend from the clitoris along either side of the vestibule, termed by KOBELT, who considers them analagous to the bulb of the corpus spongiosum in the male, the *bulbi vestibuli*. In front of these bodies is a smaller plexus of veins called the *pars intermedia*.

The *Bladder* is situated in the anterior part of the

FIG. 15.



VISCERA OF THE FEMALE PELVIS.

1. Vagina. 2. Bladder. 3. Interior of rectum. 4. The Uterus: *a*, fundus; *b*, cervix; *c*, *c*, os uteri; *d*, posterior portion; *e*, anterior portion. 5. Rectum, here covered by peritoneum. 6, 6, 6. Sacrum. 7. Coccyx. 8. Labia minora. 9. Labia majora. 10. Urethra. 11. Symphysis pubis. 12. Clitoris. 13. Mons Veneris. 14. Ureter. 15. Section of peritoneum. 16. Last lumbar vertebra. 17. Broad ligament. 18. Ovary.

pelvis, with the os pubis in front and the uterus behind. It is larger in the female than in the male, and very broad in its transverse diameter.

The *Urethra* is a narrow membranous canal, about one and a half inches in length, extending from the neck of the bladder to the meatus urinarius. Its diameter, when undilated, is about a quarter of an inch. It consists of three coats, muscular, erectile and mucous.

The *Vagina* is a membranous canal in the center of the pelvis, extending from the vulva to the uterus. Its direction is curved forward and downward. Its length is about four inches along its anterior wall, and five or six inches along its posterior wall. It is narrow and constricted at its commencement, but becomes dilated near its uterine extremity. It is attached to the neck of the uterus a little above the os uteri, so that the mouth of the womb projects a short distance into the vaginal canal. It is one of the chief supports of the uterus, and its weakness and relaxation is one of the principal causes of prolapsus and other uterine displacements. Its structure consists of an external muscular coat, a layer of erectile tissue, and an internal mucous coat or lining; the erectile tissue is more abundant at the lower than at the upper part of the vagina. Its posterior surface is connected with the anterior wall of the rectum, for the lower three-fourths of its extent, the upper fourth being separated from that tube by the recto-uterine fold of peritoneum, which forms a *cul de sac* between the vagina and rectum.

The *Mucous Membrane* of the vagina is continuous, above, with that which lines the inner surface of the uterus, and below, with the integument which covers the labia majora. Along the anterior and posterior walls its inner surface presents a longitudinal ridge, called the *column of the vagina*, and numerous transverse ridges or rugæ extend outward from the column on each side. These rugæ are more prominent near the orifice of the vagina, especially in females before childbirth. They serve to facilitate the dilation of the part during parturition. The mucous membrane is covered with conical and filiform papillæ, and provided abundantly with mucous glands and follicles, which are especially numerous in its upper part, and around the cervix uteri.

The *Uterus* is properly the organ of gestation. Its office is to retain and support the fecundated ovum during the development of fetal life. In the virgin state it is pear-shaped, occupying the cavity of the pelvis between the bladder and rectum, measuring two and a half or three inches in length, two inches in breadth at its upper part, about one inch in thickness, and weighing from one ounce to two ounces and a half. Its upper broad extremity is called the *fundus*, and its lower rounded and constricted portion the *cervix* or neck. The *body* of the organ gradually narrows from the fundus to the cervix. At its vaginal extremity is a transverse aperture called the *os uteri*, or mouth of the womb, bounded by an anterior lip which

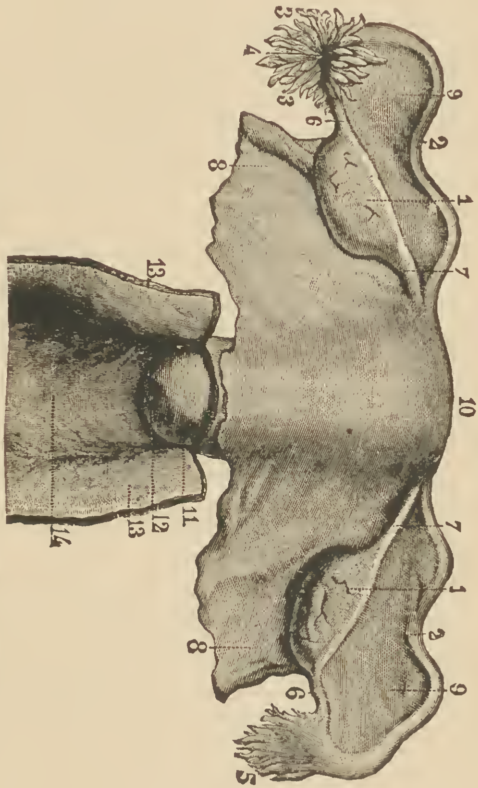


FIG. 16.

UTERUS, FALLOPIAN TUBES AND OVARIES; POSTERIOR VIEW.

1. Ovaries. 2, 2. Fallopian tubes. 3, 3. Fimbriated extremity of the left Fallopian tube seen from its concavity. 4. Opening of the left tube. 5. Fimbriated extremity of the right tube, posterior view. 6, 6. Fimbriæ which attach the extremity of each tube to the ovary. 7, 7. Ligaments of the ovary. 8, 8, 9, 9. Broad ligaments. 10. Uterus. 11. Cervix uteri. 12. Os uteri. 13, 13, 14. Vagina.

is thick, and a posterior one, long and narrow.

There are six ligaments of the uterus, all of which are formed of peritoneum. The *two anterior liga-*

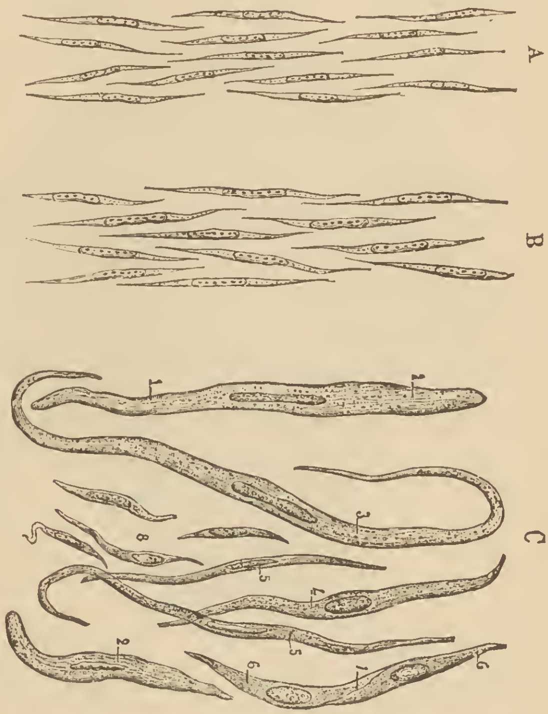
ments (vesico-uterine) are two semi-lunar folds extending between the neck of the uterus and the posterior surface of the bladder. The *two posterior ligaments* (recto-uterine) extend between the sides of the uterus and rectum. The *two lateral* or *broad ligaments* form a septum across the pelvis, dividing the cavity into two portions, the anterior of which contains the bladder, urethra and vagina; the posterior part contains the rectum.

The *Cavity of the Uterus* is comparatively very small, the upper portion, corresponding to the body of the organ, being triangular, with a small opening at its inferior extremity, the *ostium internum* (internal orifice), which leads to the cavity of the cervix. Each wall of the uterine canal presents a longitudinal column, from which extend small oblique columns somewhat resembling branches from the stem of a tree, hence this arrangement is termed *arbor vitæ uterinus.* After parturition these folds are much less distinct.

The *structure* of the uterus consists of three coats, the external of which is serous, the middle muscular and the internal mucous. The chief bulk of the organ is constituted of its muscular coat, which is remarkably firm and dense. In the impregnated state the muscular tissue becomes more developed and disposed in three distinct layers.

The muscular walls of the uterus are composed of fibers of the involuntary variety, arranged in several layers. These fibers are spindle-shaped, always nucleated, the nucleus presenting one or two large granules, which have been taken for nucleoli. They are closely bound together, so that they are isolated with great difficulty. In addition

FIG. 17.



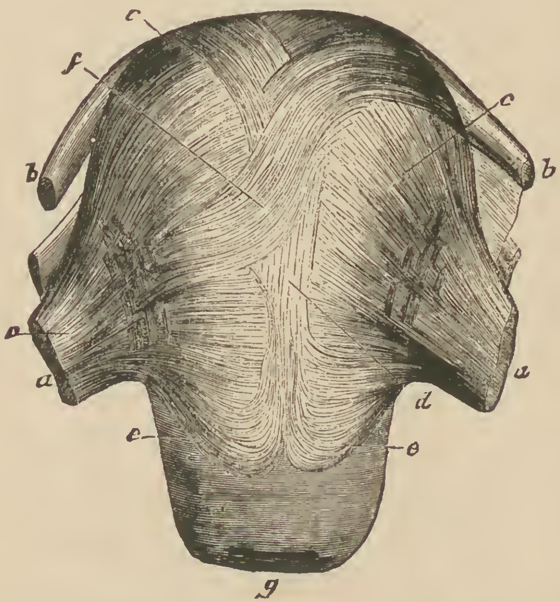
MUSCULAR FIBERS OF THE UTERUS.

A. Fibers of the uterus of the fetus at term. B. Of a woman 20 years of age. C. Of a woman just delivered.

to an amorphous adhesive substance between the muscular fibers, we find numerous rounded and spindle-shaped cells of connective tissue of the variety called embryonic, and a few elastic fibers.

The muscular tissue of the uterus is remarkable from the fact that the fibers enlarge immensely during gestation, becoming, at that time, ten or fifteen times as long and five or six times as broad as they are in the unimpregnated state.

FIG. 18.

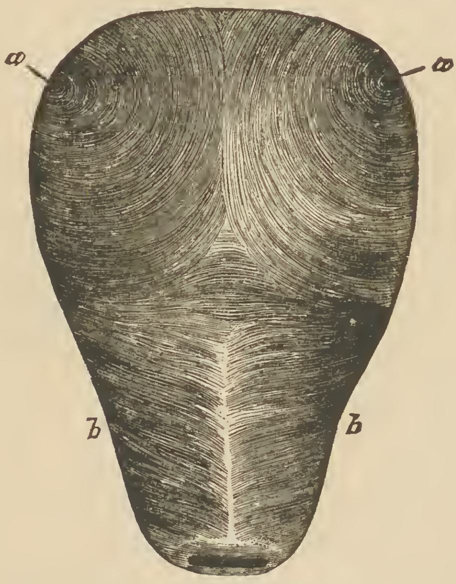


SUPERFICIAL MUSCULAR FIBERS OF THE ANTERIOR SURFACE OF THE UTERUS.

a, *a*, Round ligaments. *b*, *b*. Fallopian tubes. *c*, *c*, *e*, *e*, Transverse fibers. *d*, *f*. Longitudinal fibers.

The *Mucous Membrane* of the uterus is continuous through the Fallopian tubes with the peritoneum, and through the os uteri with the mucous coat or lining of the vagina. Around the os uteri are numerous mucous follicles and glands. Small vesicular elevations are often found within the os and cervix uteri, caused by the closure of the mouths of of these follicles, and their distension with their proper secretions. They are termed the *ovula Nabothi* (ovula of Naboth).

FIG. 19.



INNER LAYER OF MUSCULAR FIBERS OF THE UTERUS.

a, *a*. Rings around the openings of the Fallopian tubes. *b*, *b*. Circular fibers of the cervix.

The *arteries* of the uterus are remarkable for their tortuous course and frequent anastomoses in the substance of the organ. The *veins* are very large, and correspond in arrangement with the arteries. In the impregnated state the veins are termed the *uterine sinuses,* which consist of the lining membrane of the veins attached to the walls of canals extending through the substance of the uterus and terminating in uterine plexuses.

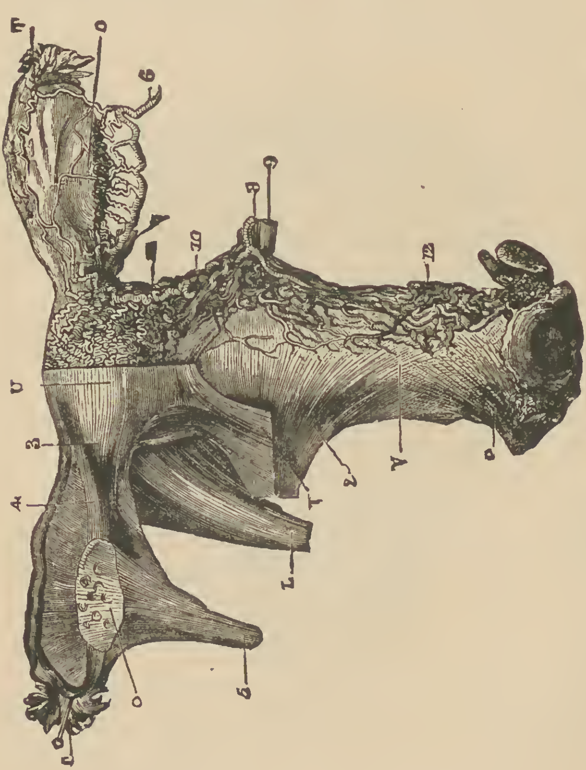


FIG. 20.—BLOOD VESSELS OF THE UTERUS AND OVARIES; POSTERIOR VIEW. T, T. Fallopian tubes. O, O. Ovaries. U. Uterus. V. Vagina. P. Pubis. L. Anterior round ligament. 1, 2. Muscular fibers of the vagina. 3, 4. Ligament of the ovary. 5. Superior round ligament. 6. Ovarian artery. 7. Ovarian vein. 8. Uterine artery. 9. Uterine vein. 10, 11. Uterine plexus. 12. Vaginal plexus.

During the menstrual period the uterus is enlarged and more vascular; and during pregnancy it increases in weight to two and sometimes three pounds. After parturition it soon returns to nearly its former size, weighing only from two to three ounces.

The *appendages* of the uterus are the Fallopian tubes, the ovaries and their ligaments, and the

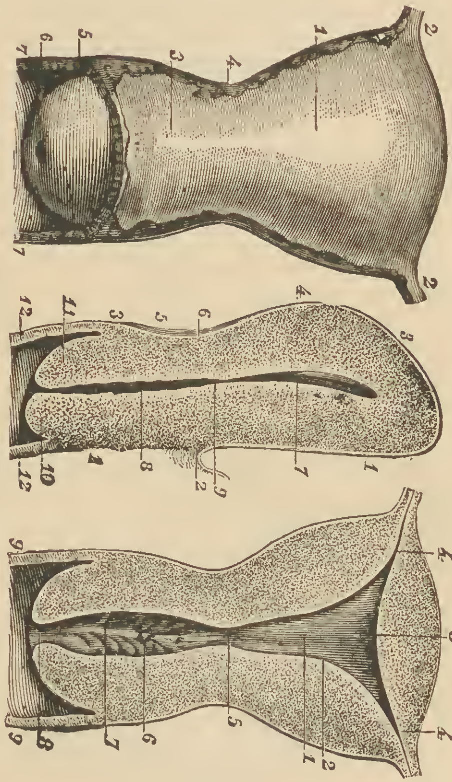


FIG. 21.—VIRGIN UTERUS.

A. Anterior view. 1. Body. 2,2. Angles. 3. Cervix. 4. Site of the os internum. 5. Vaginal portion of the cervix. 6. External os. 7,7. Vagina.

B. Median section. 1,1. Profile of the anterior surface. 2. Vesico-uterine *cul de sac*. 3,3. Profile of the posterior surface. 4. Body. 5. Neck. 6. Isthmus. 7. Cavity of the body. 8. Cavity of the cervix. 9. Os internum. 10. Anterior lip of the os externum. 11. Posterior lip. 12,12. Vagina.

C. Transverse section. 1. Cavity of the body. 2. Lateral wall. 3. Superior wall. 4,4. Cornua. 5. Os internum. 6. Cavity of the cervix. 7. Arbor vitæ of the cervix. 8. Os externum. 9,9. Vagina.

round ligaments. They are inclosed between two folds of peritoneum, which constitute the broad ligaments.

The *Fallopian Tubes*, or oviducts, each of which is about four inches in length, extend from each

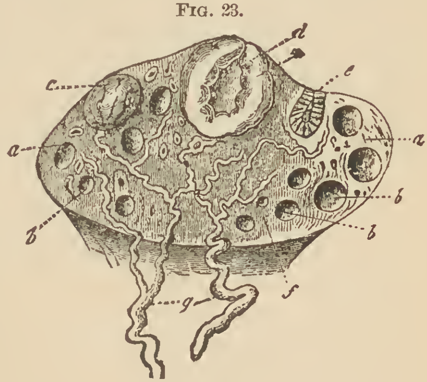
FIG 22.

FALLOPIAN TUBE, DISSECTED, SHOWING FIMBRIATED EXTREMITY AND THE ENTRANCE OF THE TUBE INTO THE UTERUS.

superior angle of the uterus to the ovaries; their office is to convey the ova from the ovaries to the cavity of the uterus. Each tube consists of a serous, muscular and mucous coat. Its canal is exceedingly small, hardly admitting a fine bristle. Its uterine orifice which is very contracted, is termed the *ostium internum*, and its external orifice the *ostium abdominalis*. Near the ovary the tube widens into a trumpet-shaped extremity. Its ovarian orifice is surrounded by fringe-like processes termed *fimbriæ*, and one of these processes is connected with the ovary. This part of the tube is called its *fimbriated extremity*; it has also been termed *morsus diaboli*, from the manner in which it closes around and embraces the ovary during sexual excitement.

The *Ovaries* are oval-shaped, and in structure quite analogous to the male testicles. Each ovary is about an inch and a half long, three-quarters of an inch in width, about one-third of an inch in thickness, weighs from one-eighth to one-fourth of an ounce and is connected by its anterior margin with the broad ligament; by its inner extremity to the uterus by the *ligament of the ovary*,

FIG. 23.



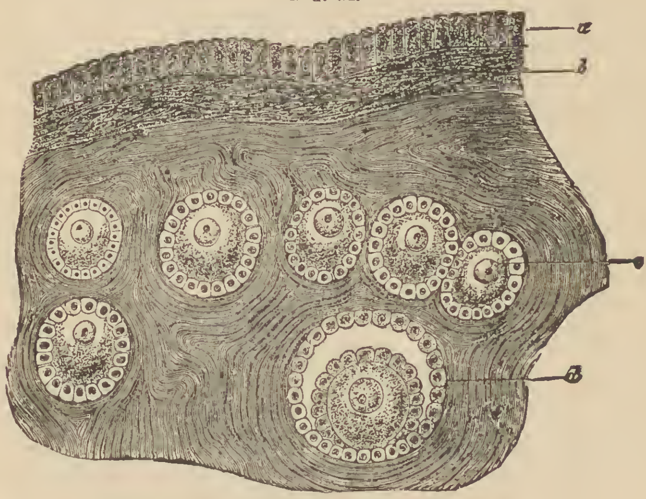
THE OVARY.

a. Stroma. *b*. Mature Graafian follicle. *c*. A larger one. *d*. A fresh *corpus luteum* with thick lining. *e*. An old corpus luteum. *g*. Veins with their first branches; *f*. within the organ.

and by its outer end to the fimbriated extremity of the Fallopian tube by a short ligamentous cord.

In *structure* the ovary is composed of a spongy fibrous parenchyma or stroma, containing a number of small cells traversed by blood vessels, and inclosed in a capsule, one of which, the *external* or

FIG. 24.

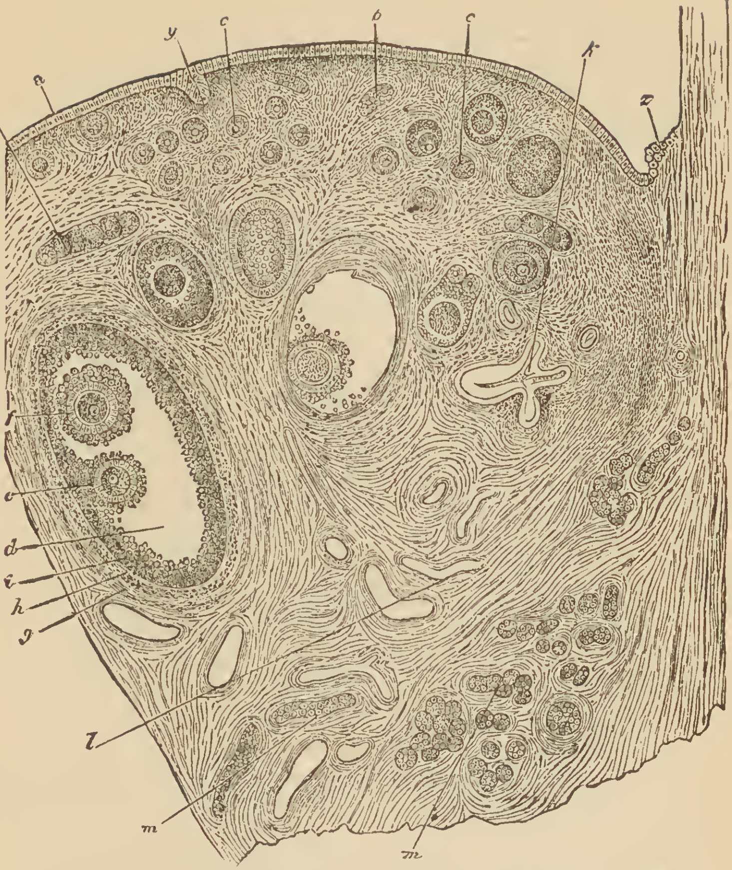


OVARY OF THE RABBIT.

a. Germinal epithelium (supposed *serosa*). *b*. Cortical or external fibrous layer. *c*. Youngest follicles. *d*. A somewhat better developed and older one.

serous, is derived from the peritoneum; the other, the *internal* or *fibrous*, termed also *tunica albuginea* and *tunica propria*, is analogous to the fibrous coat of the testis. The inner surface of the fibrous tunic blends with the substance of the ovary. The parenchyma is very abundantly supplied with blood

Fig. 25.



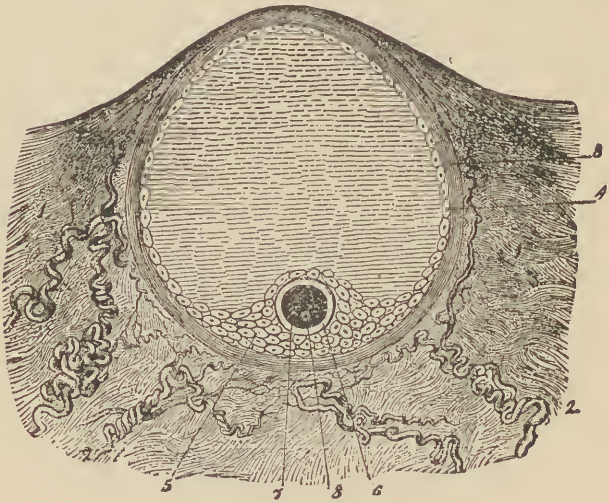
PORTION OF A SAGITTAL SECTION OF THE OVARY OF AN OLD BITCH.

a. Ovarian epithelium. *b*, *b*. Ovarian tubes. *c*, *c*. Younger follicles. *d*. Older follicle. *e*. Discus proligerus, with the ovum. *f*. Epithelium of a second ovum in the same follicle. *g*. Fibrous coat of the follicle. *h*. Proper coat of the follicle. *i*. Epithelium of the follicle (membrana granulosa). *k*. Collapsed, atrophied follicle. *l*. Blood vessels. *m*, *m*. Cell-tubes of the parovarium, divided longitudinally and transversely. *y*. Tubular depression of the ovarian epithelium in the tissue of the ovary. *z*. Beginning of the ovarian epithelium close to the lower border of the ovary.

vessels. In the meshes of its substance are many small round, transparent vesicles in different stages of development, which are the *ovisacs* containing the *ova,* and are termed *Graafian vesicles.*

In women who have not borne children, they vary in number from 10 to 20; in size, they vary

FIG. 26.



GRAAFIAN VESICLE.

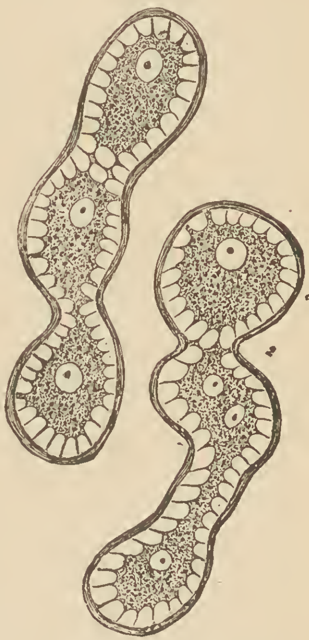
1, 1. Stroma of ovary. 2, 2. Convoluted corkscrew blood vessels. 3. Fibrous wall. 4. Membrana granulosa. 5. Cumulus proligerous. 6. Zona pellucida. 7. Vitellus of ovum. 8. Germinal vesicle and spot.

from that of a pin's head to that of a pea. Some physiologists, however, think, as Dr. M. BARRY has apparently shown, that numerous microscopic ovisacs exist in the stroma of the ovary, few of which produce ova.

During their early development the Graafian vesicles are deeply seated in the substance of the organ; enlarging as they approach the surface, they form, when mature, small projections on the exterior of the ovary beneath the peritoneum.

Each *Ovisac, Follicle,* or *Graafian Vesicle,* consists of an external membrane and fluid contents. The membrane has an external coat, the *tunica fibrosa, theca folliculi* of VON BAER, which is highly vascular; and an inner lining, *epithelium,* which consists of polygonal cells with large nuclei, and fatty granules. After death the cells very soon lose their definition, when the epithelium assumes the appearance which has caused it to be denominated *membrana granulosa,* meaning a granular layer with numerous nuclei.

FIG. 27.



CHAINS OF FOLLICLES FROM THE OVARY OF A CALF.

1. Containing ova in process of development. 2. Showing gemmation to form Graafian follicles.

The membrana granulosa forms a uniform lining to the ovisac, excepting on the side nearest the surface of the ovary, where the cells are accumulated into a small eminence called *cumulus proligerus* or *germinal eminence.*

The *Ovulum* (the future ovum), which is a minute globular nucleated vesicle, is contained in this germinal eminence. The contents of the ovisac, *liquor folliculi*, are a clear, yellowish fluid resembling serum, and a few free nuclei detached from the epithelium.

The *Ovum* is exceedingly minute, measuring from one two-hundred-and-fortieth to one one-hundred-and-twentieth of an inch in diameter, consisting externally of an transparent envelope, the *zona pellucida* or *vitelline membrane,* and internally of the yelk or *vitellus,* a small vesicular body, imbedded in the substance of the yelk, is the *germinal vesicle,* and this contains a minute substance called the *germinal spot.* The germinal vesicle is a fine transparent membrane, about one seven-hundredth of an inch in thickness; the germinal spot is opaque, of a yellow color, and measures one three-thousand-six-hundredth to one two-thousand-four-hundredth of an inch in diameter.

The development of the Graafian vesicles and ova continue uninterruptedly from infancy to the end of the fruitful period. The ova are immature and incapable of impregnation before puberty.

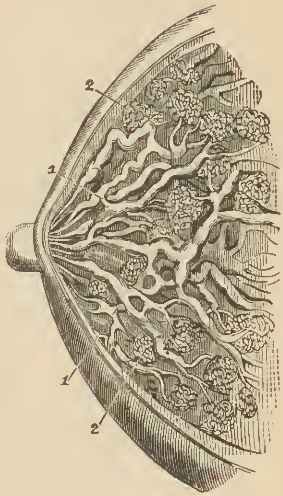
The Graafian vessels gradually approach the surface of the ovary, whence the ovum and fluid contents of the vesicles are passed into the Fallopian tube. In most mammalia the maturation and discharge of ova occur at regular periods, which are indicated by a peculiar discharge, or by a hemorrhage from the vagina. In the human female the process of ovulation occurs once in about 28 days, and is usually attended with more or less hemorrhage. This process of ovulation is properly menstruation, although the term menstruation is frequently erroneously applied to the hemorrhage itself. Sexual desire is always greater in females during the menstrual period, which usually extends through about one-third of each month; and it is during this period that the female is most liable to impregnation. There are many cases, however, in which, from disease or debility of the uterine system, the process of ovulation occupies one-half, and in a few cases two-thirds of the time of each month, rendering the female liable to become pregnant during that length of time.

The *Corpus Luteum* is a small yellowish body perceived in the ovarium after the rupture of the Graafian vesicle and the escape of its ovum. Its existence was formerly, but erroneously, regarded as an evidence of previous pregnancy. A corpus luteum may be found in every follicle from which an ovum has been discharged, but its appearance and the changes it undergoes will be different in cases of impregnation or non-impregnation. The corpus luteum of pregnancy has been termed *true*, while that of the unimpregnated state has been called *false*. The *true corpora lutea* are of large size, often as large as a mulberry, of a rounded form, projecting from the surface of the ovary. The false *corpora lutea* are of small size, do not project from the surface, and do not, in the early period of their existence, contain any central cavity as do the true. The corpora lutea which are independent of pregnancy, disappear in the course of one or two months, leaving scarcely a perceptible trace of their existence, while the true corpora lutea are said to retain their obvious vascular and plicated structure to the second or third month of pregnancy, when they slowly diminish in size, and some months after parturition are entirely obliterated or reduced to very small whitish or dark-colored masses termed *corpora albicans vel nigrum.*

The *Mammary Glands* (*mammæ*) belong to the reproductive system. Their office is to supply the offspring with food in a fluid form, until its teeth are sufficiently developed to enable it to masticate solid aliment. They exist in a rudimentary state in the male, and when excited by peculiar circumstances, have been known to secrete milk. They have sometimes become enlarged after the loss or atrophy of the testicles. They are situated in the pectoral region, corresponding to the interval between the sixth and seventh ribs, and extending from the side of the sternum (breast bone) to the axilla or armpit. They are of small size before puberty, but enlarge as the generative organs become more developed. They increase in size during pregnancy, enlarge rapidly soon after delivery and become atrophied in old age.

Near and a little below the center of each mamma, its outer surface presents a small conical prominence, the *mammilla* or *nipple*, which is surrounded by an *areola* having a colored tint. Before impregnation the color is of a crimson or delicate pink; after impregnation it deepens, and assumes a brownish hue, which, after the birth of a child, continues through life. The nipple consists of numerous vessels, which form a kind of erectile tissue, intermixed with muscular fibers.

Fig. 28.

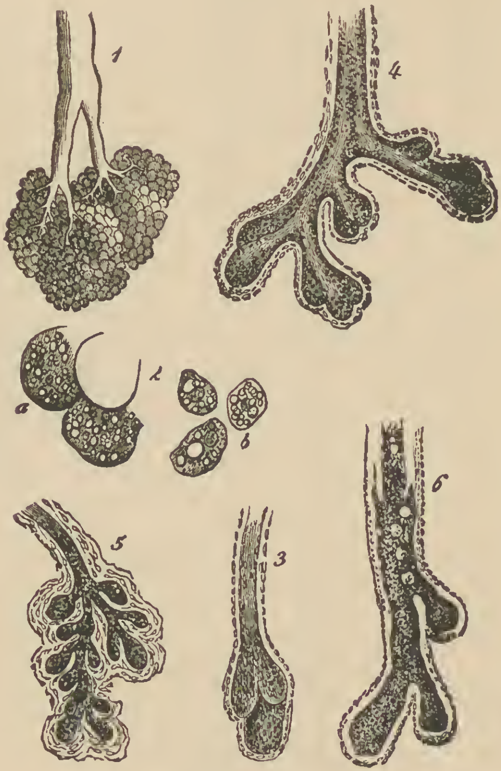


SECTION OF MAMMARY GLAND.
1, 1. Galactophorous ducts. 2, 2. Lobuli.

The *areola* is provided with *sebaceous glands*, which secrete a substance of a fatty consistence for the protection of the delicate integument around the nipple. During the nursing period these glands are greatly enlarged in size, and appear like pimples projecting from the skin.

The mamma is a conglomerate gland composed of *lobes*, *lobules* and *gland vesicles*. The lobes, 15 to 25 in number, have each a separate system of lobules and gland vesicles, and a distinct excretory duct. The lobes are irregular in form and size, and made up of smaller lobes (lobules) and the lobules of other lobules still smaller, the smallest

Fig. 29.

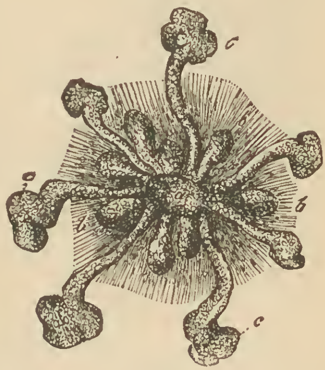


THE MAMMARY GLAND.

1. A lobule, from the interior of the gland of a pregnant woman. 2. *a*, Vesicle; *b*. Gland-cells. 3. Ducts from an infant. 4. Galactophorous duct from a boy nine years old. 5. The same from a girl of 15. 6. The same from a grown man.

lobules consisting of round or pyriform gland vesicles. The gland vesicles are about one two-hundredth of an inch in diameter; they are constituted of a structureless membrane (*membrana propria*) lined with an *epithelium* of nucleated cells. They communicate with an excretory duct, and the excretory ducts of all the lobules unite to form a common excretory duct for each lobe, the *ductus lactiferous* or *ductus galactophorous*. This duct passes beneath the areola, dilates into an elongated sac or ampulla, *saculus* or *sinus lactiferus*, and at the base of the mammilla contracts in size, and bends outward to that process, terminating at its extremity by a small aperture. There are 15 to 25 ducts in the nipple, corresponding with the number of lobes composing the gland.

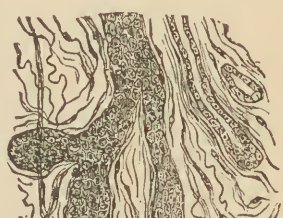
FIG. 30.



MAMMARY GLAND FROM A MATURE FETUS.

a. Central knobbed mass with smaller internal. *b* and *c*, larger external buds.

FIG. 31.



DEGENERATED MAMMARY GLAND.

From a woman 90 years of age.

The *secretion of Milk* is effected by means of the formation of oil globules in the epitheleal cells of

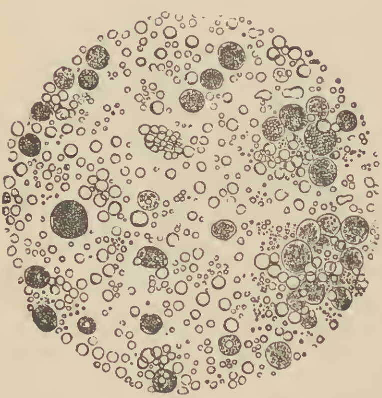
FIG. 32.

GLAND VESICLES.

From suckling woman, showing cells and capillary vessels, magnified.

the gland vesicles. As the epitheleal cells are perfected, they are pushed outward and displaced by a new formation of similar cells beneath them, and are thus carried forward into the lacteal ducts, where the cell bursts and discharges its oil globules, which have now become *milk globules,* after which the cell membrane and nucleus disappear. *Milk* is constituted of these milk globules suspended in a fluid, the *milk plasma.* Before conception the mammary glands secrete only a yellowish mucus; and at the commencement of lactation the milk is imperfect, or but slightly nutritious; in its composition are a number of cells filled with yellow fat globules, termed *colostrum corpuscles.*

FIG. 33.



MILK.

Milk globules and Colostrum corpuscles, the latter being the largest.

CHAPTER III.

THE ORIGIN OF LIFE.

Vital and Chemical Actions.—Organized or living beings are distinguished from the inorganic world by the nature or quality of the actions which they perform. The actions which take place in masses of matter are *mechanical*—mere changes of place. Particles of matter combine and separate, according to innate and reciprocal affinities, constituting *chemical* actions or changes. But in the organic domain all actions are in obedience to more complex laws, and entirely different from chemical or mechanical changes.

In the living system elements are *transformed* and *disintegrated.* The vegetable kingdom transforms simple or primary elements into its own tissues, structures and organs. But the animal kingdom can only employ, in the construction, development and replenishment of its tissues, structures and organisms, with the exception of atmospheric gases and water, only the proximate elements of the vegetable kingdom. While, therefore, the vegetable kingdom, so to speak, feeds on the animal kingdom, the animal kingdom, directly or indirectly, feeds on the vegetable kingdom. And this fact, which is but the statement of a law of Nature, points to important considerations in dietetics and agriculture.

It is true that masses of inorganic matter may increase or decrease in bulk; but it is by the accretion or separation of particles. In chemistry, acids and alkalies, for example, combine and form salts—a third substance unlike either of the ingredients, and the salts may be decomposed and the ingredients reproduced. There is nothing like nutrition, growth, development and disintegration in inorganic matter. But living organisms change and transform other elements and substances without being themselves changed. They convert food into bone, muscle, nerve, etc.; use them as force material, reduce them to ashes, and expel the ashes in the form of bile, sweat, feces, urine and carbonic acid gas, through the emunctories—the liver, skin, bowels, kidneys and lungs. Nothing analogous to these processes occurs in the organic world; nor can the chemical laboratory either construct a vital organ or tissue, or analyze it so as to determine of what elements or materials it was composed. The chemist can only give us the product of his analysis, and he only analyzes dead matter.

THE PROPERTIES OF LIVING MATTER.—The general properties of living matter are those of contraction or motion and reproduction. These properties are seen in every moving and growing organism, be it animal or vegetable. We consider matter alive only so long as it exhibits, or can exhibit, these properties; when the power to move, to grow and reproduce cease, we call it dead.

In speaking of motion we wish to convey a very different idea from what we understand by motion in other substances. The earth has its motions, and yet is not alive. Heat, light and electricity are forms of motion as seen in non-living matter. The motions of living matter are properties which it possesses from its nature. A living body moves by virtue of these properties. Its tissues have contractibility and irritability of a very different kind from the crystal. Living matter can go against gravity. Its motion is spontaneous or automatic. It may change its shape, we call this *amœboid* motion; it may change its place, we call this *locomotion;* it may increase in size, we call this *growth;* it may give birth to new individuals, we call this *reproduction.* When it ceases to grow, there is a period of action and reproduction, after which comes death.

The living matter of plants and animals are essentially the same, and the boundary between the animal and vegetable world has gradually faded away, so that in the lowest organisms it is difficult to say which belongs to one and which to to the other kingdom. It has been urged that vegetables live on inorganic matter and animals on organic, and that this distinguishes the one from the other. But we now know that animals of a high grade of organization may appropriate inorganic matter to a small extent, and it is not known to what degree the lower forms of animal life may do this. We also know that there are plants which are carniverous and capable of absorbing nourishment from flesh foods.

The chemical composition of living matter is complex. Carbon, hydrogen, oxygen, nitrogen, united with a large proportion of water, form its chief constituents, to which a small amount of sulphur may be added. No living matter has yet been found destitute of any of the first four of these elements. By virtue of its constant loss on account of its activity, new matter must as continually be supplied, which can be converted into the same substance. If the living matter increases beyond the loss, there is growth; if the loss is greater than the supply, then there is a diminution of weight, and, finally, death. This happens in old age when the living matter of the body is almost nothing.

Living matter depends on moisture for its activities. A certain amount of drying arrests its property of motion. In the lower forms of life, however, it may become perfectly dry and dessicated and yet recover its life when moistened. It is also intimately related to heat. All vital activity, growth and nutrition cease both above and below certain temperatures. The action of heat and cold destroy and coagulate the structure of the protoplasm, without which life is impossible. A mass of living matter is simply an organized machine of great complexity, the results of the working of which depend on its structure and upon the energy supplied to it from either within or without.

Origin of Living Matter.—The origin of living matter is shrouded in mystery. There was a time when our globe was a fiery ball, like a huge glowing spark from the sun, careering through space, and for countless ages so hot that no life was possible upon its surface. Little by little it radiated its heat into space and became cool enough for low forms of organisms. When the earth was first fit for living beings there could have been no living thing upon it. There were rocks, solid and disintegrated; water; air rich in plant food; a warm and brilliant sun—a world only waiting to become a garden—but no life.

Living matter must have appeared at a very remote time, since we find its remains far down in ancient rocks. How did it make its appearance? According to an opinion advanced by Sir William Thompson, it may have been by the accidental falling on our planet of a "moss-grown fragment from the ruins of another world." We know that the meteorites that fall on the earth contain fossil plants, dead, of course; but at some time a fresh fragment may have come with living matter upon it. This theory, however, shirks the question of the origin of life and gives the honor to some other globe; puts it back farther and farther until it is lost in the darkness of the past.

Darwin says, speaking of the probable commencement of life on the globe: "I believe that animals have descended from at most only four or five progenitors, and plants from an equal or less number. Analogy would lead me one step further, namely, to the belief that all animals and plants have descended from some one prototype. There is grandeur in this view of life, with its several powers having been originally breathed by the Creator into a few forms or into one, and that whilst this planet has gone cycling on according to the laws of gravity from so simple a beginning, endless forms most beautiful and most wonderful have been and are being evolved."

Herbert Spencer teaches distinctly that living matter must have been at first formless; that multiplication probably took place as in the lowest forms of living matter to-day; and adds, "Every kind of being is conceived as a product of modifications wrought by insensible gradations on a pre-existing kind of being, and this holds fully of the commencements of organic life, or of all subsequent developments." He also says, "that the formation of living matter and the evolution of life in its lowest forms may go on on the globe in its present condition; yet it is more likely that its first appearance took place at a time when the heat of the earth's surface was falling through those ranges of temperature at which the higher forms of life are unstable."

The opinions of Professor Huxley and Professor Tyndal do not differ much from that of Spencer. They teach that living matter came into being originally as the result of natural causes, that is, by the unhindered play of affinities operating on matter of a certain kind in solution, after it had acquired a certain degree of complexity, very similar to the way that crystalline matter comes into being at the present time; but they insist that we have no evidence, as yet, that such processes occur to-day.

Bastian, who, during the present century, has been the most able advocate of spontaneous generation, believes that the lowest forms of life come into being spontaneously to-day as readily as in former times, whenever the proper material at the proper temperature is found in solution, as in the warm water of our brooks and pools in summer, when they are rich in vegetable infusions. He says, "Living matter is constantly being formed *de novo* in obedience to the same laws and ten dencies as those which determine all the more simple chemical combinations. The qualities which we summarize under the word 'life' are in all cases due to the combined molecular actions and properties of the aggregate that displays them, just as the properties which we include under the word magnetism are due to particular modes of arrangement that have been assumed by the molecules of iron. Living matter is especially characterized by the complexity of its molecules and their state of continual internal movement, and it is to this molecular inability which makes an aggregate of living matter, in the form of a simple organism, very prone to undergo changes in its intimate constitution either spontaneously or under the the effect of external forces. Some new conditions may not visibly affect it; others may cause its death and still bring about a modification of its constitution."

For the purposes of this work, however, it makes little difference which of the theories prevail. We know that life originates from life, and that it has not yet been proved that it originates in any other way. If it should be proved at some future time, it will only add another glory to the world and, make the universe grander then we supposed it to be. On the other hand, it is quite sufficient to account for all the life on the globe; that far back in its history living matter came into being; and it matters little whether its first appearance was in a single minute speck in a favored locality, or spontaneously over the entire earth.

CHAPTER IV.

SEXUAL GENERATION.

Reproduction in plants and animals goes on by two principal methods with many modifications. One method is called *sexual* and the other *asexual.* The former is by the conjunction of two individuals of different sexes; the latter is without such conjunction, and will be explained first.

The method by which the multiplication of individuals takes place asexually proceeds in two ways, one is by the division of one organism into two parts: each of these again dividing into two others, and so on; this method is termed reproduction by *fission.* The other mode of increase consists in the formation of a bud at some part of the body of the plant or animal. The bud gradually develops to the form of the parent from which it springs; its *petiole,* or stem, slowly disappears, and the bud, finally liberated, becomes an independent being, resembling in every particular the parent from which it came. This is called reproduction by gemmation.

Reproduction by fission is next illustrated by what takes place in the infusoria. It may occur by longitudinal division, as in the *vorticella*, or by transverse, as in the *stentor*, or by both methods, as in the *chilodon, paramecium*, etc. The joints of the tape worm multiply by division, and when sufficiently developed become free. Some of the worms have a modified form of reproducing by fission. Müller observed this first and considered it accidental; but more recent researches show it to have far more significance than he supposed. There are some animals which may be divided artificially, and each part will produce a head and tail and enlarge until a perfect organism is the result. All are familiar with the reproduction of plants by artificial division, as, for instance, the willow, a branch of which removed from the parent tree and set in a moist place grows into an independent tree. Reproduction by buds is very common in both the vegetable and animal kingdoms. There are modifications of these methods, as, for instance, when a plant reproduces by a bulb or a tuber, and, also, where only a single cell is detached from the parent and develops into its likeness.

Generation by fission and gemmation are not confined to the simplest forms of life, but both modes of multiplication are common, not only in plants, but among animals of considerable complexity of structure.

In all these cases of reproduction by division there is no influence from other living matter.

The segment does not need fructification, being perfect of itself. This method, common as it is in the lower forms of life, becomes more and more rare among the higher animals and ceases altogether in the highest.

Throughout almost the entire series of animal and vegetable beings we find, in connection with the process of asexual generation, another method in which the development of the germ into an organism resembling the parent depends on the influence exerted by living matter different from the germ, and this brings us to the subject of sexual generation. In the lowest organisms *sexual* generation is absent, or, at least, it has not been observed. In the highest organisms a sexual generation is wanting. In many of the lower forms of life asexual generation is the predominant mode of reproduction, while sexual generation occasionally takes place. In many of the higher, on the contrary, sexual generation is most common, while asexual takes place exceptionally.

The simplest form of sexual generation consists in the coalescence of two similar masses of living matter, derived from different parts of the same organism, or from two organisms of the same species. The reunited mass after the fusion develops into a new being. In most cases, however, there is a marked difference in the two factors in the process, and we call one factor the male and the other the female element. The female element is larger than the male and undergoes but little change of form. In all the higher plants and animals it is a nucleated organized lump or mass of living protoplasm, to which a small amount of nutriment for the first stage of development—which we call the yelk—may be added. The male element, on the other hand, is comparatively small. It may be conveyed to the female element in various ways, as all who have observed carefully the structure of the flowers of plants, and the very interesting manner in which the male and female elements are brought in contact, know.

In true sexual generation in the higher animals two special organs are required: a female organ for producing an ovum or egg, and a male organ for producing the spermatozoa. Each form of generative apparatus consists of two parts, of which one is a formative organ, in the female termed the ovarium, and in the male the testis, in which the reproductive cells are formed, and which are essential, and an efficient duct by which the products of secretion are carried off. The male and female organs may exist in separate individuals or coexist in the same individual, giving rise to what is known as hermaphroditism.

The following brief outline of reproduction in the classes of the animal kingdom, beginning with the lowest, will be of interest.

The *protozoa* reproduce by all three modes: fission, gemmation and an impregnated ova; but fission is the principal method, and it is only in the infusoria that we have undoubted evidence of true sexual generation.

In the *echinodermata*, fission has been observed in some classes, which have at the same time sexual organs combined in the same individual. In the other classes the sexes are separate, and generation only takes place by the union of the germs or ova and spermatozoa.

In the *annelida*, sexual generation occurs, and there is also sometimes multiplication by fission. In the lower *mollusca*, generation takes place by gemmation and true generation. In the higher mollusca, multiplication occurs only by true generation.

In the *articulata*, insects and crustaceans, generation is sexual, and, except in one class, the cirrhopoda, the sexes are separate.

In the *vertebrate*, we have the most complex form of generation, and, except in a few genera of fishes, the sexes are always separate. The osseous and cartilaginous fishes present important differences in their reproductive organs and modes of reproduction. In the osseous fishes, the essential female organ, the ovary or roe, consists of a large membranous bag, usually in two lobes, but sometimes single. When extended with ova this organ fills the greater part of the abdominal cavity. The lining membrane is arranged in folds to give greater surface, and make the retention of the ova, until sufficiently ripe for expulsion, more easy; they then escape into the abdominal cavity and are expelled in enormous numbers through an opening between the anus and urinary canal. In most cases the eggs of fishes are impregnated after their expulsion; and in order that a sufficient number of them may be impregnated, the male secretion, or milt of fishes, which contains the spermatozoa is very abundant, being nearly equal to the roe of the female. In a very few classes of fishes the young are hatched in the ovary, and are of considerable size before they are born, and in these cases impregnation must have taken place internally. In the cartilaginous fishes, the sharks and rays, we have a higher type of generative organs. The eggs are always impregnated within the body of the female, the male having special organs by which sexual congress is effected. The ovaries of the female are in the form of two glandular bunches on either side of the spine. The eggs are of large size and few in number. As they escape from the ovary they pass into an oviduct, which secretes about them a horny shell, shaped like a pillow case, with long tendrils at each corner, which entwine about the seaweed in the water and thus maintain their position. As remarked, the shell is horny; were it brittle like an egg-shell it would soon be broken by the continuous beating of the waves. In order that the embryo may escape from this tough envelope, there is an opening at one extremity, and the slightest exertion of the living embryo within separates this opening, when the young escapes by its own efforts—a form of parturition which gives no pain, and is full of simplicity as well as interest, and gives us a grand impression of the curious ways in which nature provides for every emergency, and triumphs over the greatest obstacles.

In the *batrachia* or frogs, the sexes are more closely associated than in the osseous fishes, and the eggs are usually impregnated by the male as they escape from the female. In one batrachia, the Saurian toad, the impregnated eggs are seized by the male and deposited in a sort of pouch in the skin on the back of the female, where they develop until of considerable size; when they escape. It was formerly supposed that this was a true case of viviperous birth, until a careful study resulted in this discovery.

In the true reptiles the sexual organs are still more highly evolved, and the male has organs for the impregnation of the female by sexual congress, which now becomes essential to fecundation.

All reptiles are *oviperous*, though a few species retain the egg in a sort of cavity formed by a dilatation of the oviduct until they are considerably developed, when they are brought forth alive. The eggs of reptiles are quite large, and abundantly supplied with nutriment for the young animal. The shell is somewhat like parchment—soft and flexible, but very tough, and contains a very small portion of lime-salts. The eggs are usually deposited in warm, dry places, where the heat of the sun or the heat of putrefactive matter, as, for instance, dung-hills, will facilitate the development of the embryo. In a rough way reptiles have forestalled the invention of the incubator, now so extensively used in the hatching of chickens and other birds.

The reproductive power of different species of reptiles varies: Lizards lay from 8 to 12 eggs; serpents from 10 to 50; tortoises from 20 to 30; crocodiles from 20 to 60.

The reptile has little maternal instinct; but its dawn and slight development has been observed in crocodiles and lizards, which sometimes watch the places chosen for depositing the eggs, and the python in captivity surrounds its eggs and imparts to them such heat as its low temperature will permit.

In birds the generative organs present a clear analogy to the higher reptiles. There is only one ovary, and that is on the left side. There is, however, a rudimentary ovary on the right side which is atrophied. This is a curious instance of the violation of symmetry. It would be exceedingly difficult for birds so constantly on the flight to give birth to living young, and so incubation with them has its most perfect development: sufficient nutriment is stored up in the egg to develop the young bird, so that all which is required from the mother is a warm nest and animal heat for a not very extended period.

In *mammals*, a new organ for the first time appears for the secretion of milk to nourish the young, till they are sufficiently grown to live on the food of the adult. There is also a temporary placenta from which the fetus is nourished during its uterine existence.

The sexual organs and their modifications, which we have been considering, are all primary or leading sexual characters; but there are secondary sexual characters in animals and in man, which are necessary to reproduction, though not directly connected with it. For instance, the male possesses certain organs and instincts which the female is destitute of, or he has them developed in a higher degree in order that he may find her or maintain her securely. These instincts and organs vary in different animals, and are often complex, as is seen in the appendages at the apex of the abdomen of male insects. The female differs from the male in having an organ for nourishing its young. The marsupials have a sack in which to deposit them until sufficiently grown to go off by themselves. Some varieties of male fishes and frogs have a receptacle for receiving the ova of the female. The females of most bees have a special apparatus for collecting pollen, and their oviposita is modified into a sting with which to defend itself, its larva and the colony to which it belongs. These differences, however, are of small account compared with others; as any one may observe the greater size, strength and ferocity of the male, his weapons with which to punish his rival, his gaudy coloring, beautiful ornaments, gift of song, and such other characters. The females of certain flies have an apparatus for sucking blood, which the male has not. The males of certain moths have closed mouths and never feed. The female glow-worm has no wings, and this is also the case with some moths which never leave their cocoons. In some birds the male differs from the female; these differences are not always directly connected with reproduction, though they generally are. The male insect always requires more perfect wings and a better muscular development than the female, to secure and hold her, and the female requires better organs for securing food, as she must nourish her larva; the male dies after fecundating the female, and, consequently, organs for securing food which it never eats would be useless.

The Sexual Organs of Plants.—The flowers of the vegetable kingdom, whose fragrance pleases and whose beauty charms us, are nothing more nor less than their generative apparatus. And the various fruits which afford the animal kingdom and the human family so much substantial food and so many luxuries, are but the seeds which result from sexual congress and subsequent growth; the pulp in which the seeds are nourished and protected. Some plants, however, do not produce seeds or flowers. They are called *flowerless plants* (Cryptogamia). But they produce minute bodies termed *spores*, which answer the purpose of seeds. These bodies are of inconceivable minuteness, and in all probability, if our powers of vision, with microscopic assistance, were sufficient, we should be able to discover in them all the elements of the sexual organism which are so apparent in the flowering plant. Phenogamous, or *flowering plants*, produce blossoms and seeds, each seed consisting essentially of an ėmbryo or germ which has only to grow and unfold its parts to become a plant resembling its parent.

The essential organs of the sexual apparatus of plants are the *stamens* and *pistils*. The stamens are the male organs, and the pistils the female organs. They are in all respects analogous to their corresponding organs in the animal kingdom; and as reproduction from seeds and eggs is governed by the same laws and involves the same vital processes, a brief analysis of the sexual organism of plants cannot fail to be interesting as well as instructive.

The *Stamens* commonly consist of two parts, a *filament* and an *anther*. The filament is the stalk or stem of the stamen; and the anther is the small case or hollow body which surmounts the filament or is attached to its top. The anthers produce a powdery, dust-like substance (analogous to the semen) termed *pollen.*

FIG. 34.

STAMEN AND PISTIL.

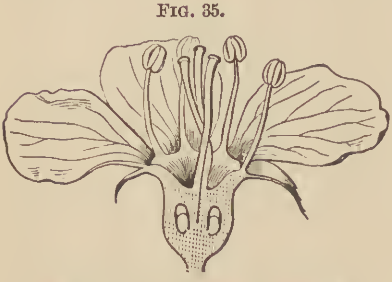
f. Filament. *a*. Anther discharging its pollen in the form of yellow dust. *ov*. Ovary. *st*. Style. *stg*. Stigma.

The *Pistils*, which occupy the central part of the flower, generally consist of three parts: the *ovary*, which becomes the seed vessel; the *style*, which is the upward prolongation of the ovary into a slender structure; and the *stigma*, which is the roughish, skinless upper extremity of the style.

In many plants the filament and style are wanting, but the anthers (corresponding to the testes of the male animal), and the ovary and stigma (corresponding to the ovary and vulva of the female animal), are always present.

The specific function of the stamens and pistils is the fertilization of the seed, which process is accomplished in the following manner. At the proper season, when the sexual organs have arrived at the period of maturity, the anthers discharge their pollen into the air, some of which falls,

FIG. 35.



SECTION OF HAWTHORN BLOSSOM.

or is wafted by the wind, upon the stigma, and insinuating itself between the cells of the organ, passes down the lower areolar structure of the style to the ovary.

Fig. 36.

SECTION OF CHERRY BLOSSOM.

Stamens and pistils vary much in number and in arrangement, with regard to the other parts of the flower. In the hawthorn (Fig. 35) there are four stamens and three pistils. In the cherry there is but a single pistil (Fig. 36), while the stamens are numerous. In the case of the hawthorn, for example, the calyx grows fast to the ovary, and all other parts of the blossom appear to grow on it. In the cherry, the stamen and petals are on the calyx.

Fig. 37.

PISTIL OF STONE-CROP.

Nor is there less variety in the form and arrangement of the individual stamens and pistils; in this respect again resembling the corresponding organs of the animal kingdom. Fig. 37 is a representation of a pistil of the stone-crop; its stigma gradually enlarges downward into the ovary, the ovary being divided to show some of the ovules within. Fig. 38 represents one of the ovules, or future seeds, highly magnified.

A grain of pollen, highly magnified,

from the anther of a mallow, is seen in Fig. 39.

It is curious to observe how both stamens and pistils answer to leaves, folded and rolled together. The stalk or filament of a stamen corresponds with the footstalk of a leaf, and the anther answers to the blade. In Fig. 40, the lower portion represents a short filament bearing an anther, which has its upper half cut away and the summit of a leaf above it. Besides this, for comparison, is the whole stamen of a lily. The halves of the anther answer to the halves of the blades of the leaf, one on each side of the midrib; the continuation of the filament which connects the two cells corresponds to the midrib. The anther generally opens along that structure which corresponds to the margins of a leaf.

FIG. 38.

OVULE MAGNIFIED.

FIG. 39.

POLLEN GRAIN

The structural arrangement and development of the sexual organs of plants, and particularly the fact that both stamens and pistils seem equally to answer to folded leaves, have a curious interest in connection with certain theories which have been entertained with regard to the law of sex; some physiologists supposing all human beings originally sexless, the sex being determined in some unknown man-

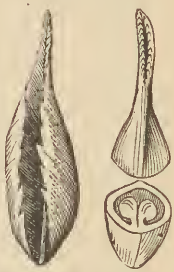
FIGS. 40 & 41.

PLAN OF A STAMEN.

ner in the process of growth; but this is doubtless erroneous.

Figs. 42 and 43 show how a simple pistil answers to a leaf. A simple pistil, regarded botanically, is made by the folding up inwardly of the blade of a leaf, the margins coming together and joining so as to constitute a hollow closed sac, which is the ovary; its tapering summit forms the style, and some portion of the margins of the leaf in this, destitute of skin, and of irregular rough surface, becomes the stigma. Here the ovules or seeds are attached to what answers to the united margins of the leaf. The particular part to which the ovules are attached is called the *placenta*.

FIGS. 42 & 43.



PLAN OF PISTIL.

All the following plants except the pine family have their ovules and seeds produced in a seed vessel of some sort, and are hence termed *angiospermous*. In pines, spruces, cedars, etc. (*gymnospermous* or *naked-seeded*), the pistil is an open leaf or scale, bearing ovules on its upper or inner surface. Each scale of a pine cone is an open pistil, and the ovules, instead of being inclosed in an ovary which forms a pod, are naked, and exposed to the pollen shed by the stamen-bearing flowers which falls directly upon them.

FIGS. 44 & 45.

PISTIL OF LARCH CONE.

Fig. 44 is a view of the upper side of an open pistil or scale from a forming larch cone at flowering time, showing the two ovules borne on the face of it, one on each side, near the bottom. Fig. 45 is the same grown larger, the ovules becoming seeds. When ripe and dry the scales turn back, and the naked seeds peel off and fall away.

THE SEXUAL RELATION OF PLANTS.—A microscopic examination of pollen shows quite a variation in their respective forms, as, for instance, some are spherical, others oval; some have smooth, others a rough or granulated surface; in some families the pollen is viscous or gummy, in others not. At the same time, each grain of pollen whose forms are quite variable presents a uniform organization. It is composed of two membranes. The external one is thicker and furnished with pores, and sometimes with more or less prominent appendages; the internal membrane is thin, transparent, and has no adhesion to the first. When submitted to the action of water the inner membrane swells, the outer bursts at some part of its surface, and through the opening thus formed there issues a tubular prolongation on one side which gives it a somewhat pear-like shape.

The pollen of many plants is highly inflammable; that is, if collected in quantities and thrown on a hot stove it will ignite very much as gunpowder does.

In former times advantage was taken of this fact, and the pollen of club-maples was collected and used to produce artificial lightning on the stages of theaters by igniting it on a hot fire-shovel.

Pollen germs have an independent life after they have been separated from the stamens on which they have been produced. If gathered and kept in a sealed paper or vial they retain their vitality for days or weeks, and advantage is taken of this fact to bring the grains of pollen from distant countries to fertilize plants when a new variety is desired by crossing.

The pistil of the flower is a most important organ. It is protected, in most cases, by the floral envelope and appendages, which last as long as it can be of any service, after which it withers and falls off.

The manner in which impregnation takes place has been most carefully studied. It was at first supposed that the pollen grains simply opened, and that the granules which they contain were absorbed by the stigma and went to form the embryo; but later it was discovered that all plants are fecundated by the pollen forming a sort of membranous tube which penetrates the stile. It is really a miniature vegetable growth, the pollen tube extending to and entering the ovary, where it is brought in contact with the ovule.

The birth of a seed is the result of this contact of the pollen with the ovule. Each seed must be impregnated with a separate grain of pollen. In the apple or grape there are often many seeds, and one grain of pollen is required for each. In an ordinary ear of corn there are a large number of seeds, and each has its own thread of silk extending beneath the husk, which shields the ovules arranged in rows around the central axis or cob from the outside world, in order to obtain pollen from the tassel when the grains are ripe. If any single silken thread fails to secure a grain of pollen there will be a blank in the row of seeds which is connected with this thread, and its ovule will not be fertilized.

Sometimes it happens that there is a season when too much wet or cold weather destroys the pollen or interferes with its free distribution. In this case the ears do not fill well, and there will be but few seeds in a whole ear. Other grains sometimes suffer in a like manner.

In the case of the poppy, the parsley and many plants in which a large number of seeds are produced, an equal number of grains of pollen are required. A capsule of the tobacco plant contains over 2,000 seeds, requiring an equal number of grains of pollen.

Plants seem to have some choice as to whether they shall be fertilized by this or that grain of pollen. Some sort of affinity operates even in the vegetable world.

The means by which fertilization takes place are full of interest. In wheat, rye and corn, and the plants which have no brilliant flowers, the wind plays an important role. This may be seen at the right season by observation. Go to a wheat field when the pollen is ripe, and gently jar a few stalks of wheat, and notice a cloud of it, looking like dust, floating away from the heads. The same may be observed in the grasses. The amount wasted is, of course, enormous. If there was not a great surplus only a few ovules would be fructified and produce seeds.

Plants that have brilliant flowers are usually fertilized by insects. Many plants produce flowers that can be fertilized in no other way. The red clover is an example. When first introduced into Australia, there were no bees there, and no insects adapted to its needs; consequently it produced no seeds. Afterward, bees were introduced, and this difficulty was overcome. A large majority of flowering plants are so arranged that they cannot easily fertilize themselves, and must depend on insects. In this way in-and-in breeding is prevented. Others are arranged so that they may be self-fertilized. The kalmia or laurel is a most interesting example of the latter class. Its anthers grow attached to the petals of the flower at the end of rather long stamens, and the tension produced by the opening of the flower is so great that they are bent like bows. When the pollen is ripe, the anther becomes detached, and the elasticity of the bent stamen is so great that it throws the pollen in a beautiful minature cloud onto the pistil, which extends higher up in the center of the flower; but even here self-fertilization need not necessarily occur, for the wind and insects may also take a part in carrying the grains from one flower to another.

In order for the flower to secure the services of insects to do this necessary work, they must offer some inducement. They probably have no special admiration for the beautiful blossoms, as we have. These are only signals saying to the insect, "Come here!" They know from these signals, through instinct, or knowledge inherited or acquired, that there is food for them in the nectar or honey secreted at just the right time. If the insect gets the honey, her body will at the same time have adhere to it a great amount of pollen, and when she goes to the next flower, and crawls over and into it, she leaves some of the grains where they are wanted. The flower and the insect are each compensated and mutually benefited.

Mr. C. L. Allen, in a series of articles on the sexual relation of plants,* from which some of these facts are gathered, gives a graphic description of how the common eel-grass is fertilized:

"This grass belongs to the class *Diœcia;* that is,

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* See "The Mayflower" for 1894.

the sexes are produced on different plants. The female flowers are solitary, borne on long, slender stalks, finely twisted like a spiral spring. The plant is usually found in water from two to three feet in depth, the flowers being near the root. About the time of the opening of the flowers the spiral stem begins to unwind, and this elevates them up to the surface of the water, where they expand in the open air. The male flowers are produced in great numbers on short, upright stems, issuing, as we before said, from different plants. These flowers detach themselves about the time of the expansion of the female flowers, mounting up like little air-bubbles, and suddenly expanding when they reach the surface; then, without regard to wind or current, they float around among the female blossoms, thus bringing the stamens and pistils into immediate contact, and giving the anthers an opportunity to discharge their pollen over the stigma. When impregnation is secured, the uncoiled stalk of the female plant begins again to resume its spiral form, and gradually sinks down, as it gradually rose, to ripen its seed at the bottom of the water."

But why, many may ask, this very singular method of fertilization? It is to carry out an important law—to secure cross fertilization. The latter is necessary for the vigor and highest development of the plant. Many of these facts may be observed by any one living in the country, if he will take a little pains to cultivate the powers of observation, as there is abundant opportunity to do.

Plants generate heat during the period when they are ready for fertilization. This is difficult to demonstrate, except in the laboratory, with most delicate instruments. Bronguiart was the first to show it. The female organs registered 11° higher than at other times, and the male a still higher rise of temperature.

The odor of plants goes also along with the conditions for fertilization, and is highest when the plant is ready for this act, and soon ceases after it.

There are many curious and interesting facts relating to variations in the manner of reproduction in different animals, and more especially in insects. Reproduction in bees is interesting and instructive. The article "Bees" in The Encyclopedia Britannica furnishes the following account:

"The impregnation of the queen-bee was formerly involved in the deepest obscurity, and has given rise to a multitude of very fanciful opinions. Some have denied that any intercourse with the male was necessary for the fecundation of the eggs. Swammerdam supposed that the mere effluvia proceeding from the males, where they were collected in clusters, was sufficiently active to produce this effect by penetrating the body of the female. Huber proved by decisive experiment that no such consequence resulted from this effluvia. Maraldi imagined that the eggs were fecundated by the drones after being deposited in the cells, in the same way that the spawn of fishes is rendered prolific by the milt. Dr. Debraw, of Cambridge, gave an account, in a paper published in the Philosophical Transactions, of a milk-like fluid he had seen in the cells. But this appearance Huber showed to be a mere optical illusion arising from the reflection of light at the bottom of the cells. When the males are excluded from the hive the queen is as fertile and the eggs as prolific as when they are present. Hattorff supposed the queen to be capable of impregnating herself, an opinion which was supported by Schirach and Wilhelmi, and was even favorably received by Bonnet, as it in some measure accorded with his discoveries concerning the aphis. Linnæus was of opinion that an actual union between the sexes took place, and Reaumur fancied he had seen this happen within the hive. There is, however, great reason to think he was mistaken. It has since been clearly proved that copulation takes place in the air during flight, and if the queen is confined to the hive, either by bad weather or malformation or mutilation of her wings, although she may be surrounded by drones, she never becomes impregnated; and if she does not find a mate within three weeks of her birth, the power of sexual intercourse seems to become lost. If a hive containing a virgin queen be attentively watched on fine days, the queen will be observed preparing for her matrimonial flight, and after having attentively surveyed her home, so as to be able to recognize it again, she flies to a considerable height in the air; and if her errand is successful, in half an hour she returns to the hive with unequivocal proofs of the intercourse that has taken place, for she has, in fact, robbed the drone of the organs concerned in this operation; and the drone, thus mutilated, is left to perish on the ground. From its being necessary that the queen should fly to a distance in order to be impregnated, Huber infers the necessity of a great number of drones being attached to the hive, that there may be a sufficient chance of her meeting one of them during her aerial excursion.

"The phenomenon that sometimes occurs in a bee-hive, of the queen laying eggs that produced males only, had for ages puzzled philosophers without any satisfactory solution, and it was reserved for Dzierzon to promulgate a new and startling theory of reproduction, which, in the words of its distinguished author, is said to have 'explained all the phenomena of the bee-hive as perfectly as the Copernician hypothesis explains the phenomena of the heavens.' Dzierzon first expressed his views upon the reproduction of bees in the year 1845. The principal points of this theory may be shortly expressed thus:

"1st. That the queen (female bee), to become good for anything (*i. e.*, to breed *workers*), must be fertilized by a drone (the male), and the copulation takes place only out of doors; that drone eggs do not require fecundation, but that the co-operation of the drone is absolutely necessary when worker-bees are to be produced; that in copulation the ovaries are not fecundated, but the seminal receptacle, or spermatheca, a little vesicle or sac opening into the oviduct, which, in the young queen, is filled with a limpid fluid, is saturated with semen, after which it is more clearly distinguishable from its white color, and that the supply of semen received during copulation is sufficient for her whole lifetime. The copulation takes place once for all, and, as already stated, only in the open air; therefore no queen which has been lame in her wings from birth can ever be perfectly fertile, that is, capable of producing both sexes, as copulation never takes place in the interior of the hive.

"2d. All eggs which come into maturity in the ovaries of a queen-bee are only of one and the same kind, and when they are laid without coming in contact with the male semen, become developed into male bees. This theory of Dzierzon's has since been amply confirmed by numberless experiments, although what power the queen possesses, or how she exercises it, of determining what eggs shall receive fecundation and what not, is yet a mystery. Certain it is, that when the queen lays an egg in a drone cell, a drone is produced; and Von Siebold who made many most skilful microscopical examinations of eggs, affirms that among 52 eggs taken from worker cells, examined by him with the greatest care and conscientiousness, 34 furnished a positive result, namely, the existence of seminal filaments, in which movements could easily be detected in three eggs; and among 27 eggs from drone cells, examined with the same care and by the same method, he did not find one seminal filament in any single egg, either externally or internally. On the passage of the eggs from the ovary through the oviduct, they pass the opening of the spermatheca, from which some eggs receive a portion of the seminal fluid—these produce workers; other eggs pass without receiving the fluid—these produce drones. What it is that governs the disposition or non-disposition of the seminal fluid on the egg is unknown. It has been suggested that the smaller diameter of the worker cells exerts some mechanical pressure on the queen's organs, which may cause the seminal fluid to be extruded as the egg passes, while the drone cells being larger, this pressure is not by them exerted, and the egg passes unfecundated. If the spermatheca of an impregnated queen be examined under the microscope its contents will be found to contain many thousands of spermatozoa, the characteristic movements of which are visible. The contents of the spermatheca of a virgin or drone-breeding queen, if similarly examined, will be found to be a limpid fluid only, without a trace of spermatozoa, "The fact that the eggs of an unimpregnated queen will hatch and produce drones may be easily verified, and is now undisputed. By depriving a colony of its queen late in the year, a young queen will be reared; and the drones having been killed long before, no impregnation can take place, yet the queen will infallibly lay eggs which hatch into drones; these eggs are laid indiscriminately in drone and worker cells, the bees bred in the latter being stunted in their growth. If, now, the spermatheca be examined, no spermatozoa will be found present; the same result will take place in the summer, if the virgin be deprived of her wings and so made unable to fly.

"If the impregnation of the queen be delayed beyond, as elsewhere stated, the twenty-first day of her life, she becomes incapable of receiving impregnation, and begins soon after to lay the eggs of drones, and produces no other kind of eggs during her life. This very curious and unexpected fact was discovered by Huber, and has been satisfactorily established by his very numerous and varied experiments, although its explanation is perhaps attended with insuperable difficulties. The abdomen of a queen that is unimpregnated is much more slender than that of one which is completely fertile; but, on dissection, the ovaries are found expanded and full of ova.

"One of the most remarkable facts concerning the generation of bees is the existence, occasionally, of prolific workers, the discovery of which we owe to Reims. Although it was doubted by Bonnet, its reality has been fully confirmed by the researches of Huber and subsequent observers, and it explains what was before inexplicable—the production of eggs in hives absolutely destitute of a queen. It is also remarkable that the eggs thus produced are always those of drones; but this is explained by the fact that these fertile workers have not received, and are unable to receive, impregnation from the drone. The origin of these abnormal egg layers is accounted for from their having passed the larva state in cells contiguous to the royal ones, and from their having at an early period devoured some portion of the stimulating jelly which was destined for the nourishment of the royal brood, their ovaries thus received a partial development; or, when a colony is deprived of its queen late in the autumn, and an attempt to raise a queen from some unknown cause has failed, a larva has sufficiently advanced to develop into a fertile worker."

CHAPTER V.

PHYSIOLOGY OF MENSTRUATION.

From the period of *puberty*, which, in this climate, may be reckoned at the age of 15 in most cases, until the critical age, or *turn of life*, which occurs generally between the age of 45 and 50, varying several years according to constitutional vitality and habits of life, as the commencement of *menstruation* varies, one, two or three or even more years from the same causes, there is, with few exceptions, a periodical discharge of mucus and blood from the vagina. This discharge continues in a great majority of cases from three to six days, and recurs very nearly once in 28 days, or once in each lunar month, and continues as long as the female is capable of conceiving, or rather, as long as ova are developed. This discharge is termed *menses, catamenia, flowers*, etc., and the process *menstruation.* Many errors, however, are entertained on this subject. By some physiologists the menstrual flow is regarded as a secretion; and by others as a hemorrhage. The ancients regarded it as an excretion or purifying process, and many absurd and superstitious notions and practices resulted from this erroneous theory. A woman was regarded as "unclean" during menstruation; and among other absurd vagaries of those who adopted this view of the process, a woman was regarded as a *dangerous character* during her "monthly periods." It was even said that if, at this time, she should sit under an apple tree, all the fruit would be blasted, etc. We need not wonder at the exclusion of woman from "good society" on occasions, and the degradation which necessarily attached to the sex, because of this mistaken opinion of the nature of the process of menstruation.

Menstruation is Ovulation.—As we have already seen, when the sexual apparatus is sufficiently developed, a germ-cell, egg or ovum, is evolved from its ovarian bed, passed along the channel of the Fallopian tube into the uterine cavity, and, unless impregnated in its course by meeting and mingling with the sperm-cell, or semen, of the male, and fixed upon the wall of the utero-Fallopian canal, it is expelled through the vaginal passage—a process to be repeated monthly.

This process is usually, though not always, attended with a discharge of blood. Menstruation may occur without the discharge of a drop of blood. Many cases are on record in which women are said to have conceived without menstruating. Some women are said to menstruate during pregnancy, and Dr. Good, in his Study of Medicine, relates the case of a woman who menstruated *only* during pregnancy, thus acting by the rule of contrary. Some women are supposed to have menstruation return years after the critical age, and very frequently it is stated in some medical journal that some female child menstruates. Women sometimes, while nursing an infant, find themselves pregnant, without having had any appearance of the menstrual flux since the birth of the last child. This happens, in some cases, in three, and in very rare cases, in two months after delivery. At Barnum's Baby Show, at the American Museum, several years ago, among the sights was a little girl not quite three years of age who regularly menstruated.

In all of these cases hemorrhage has been mistaken for menstruation. The menstrual blood was long regarded, and still is by some authors, as a secretion. Dr. Good, who regards it as a secretion, terms it "a species of blood thrown off from the common mass." This is not the manner in which secretions are effected. A secretion is a *formation*. not a mere separation. And, besides, the blood of menstruation does not differ from ordinary venous blood in any essential particular. Its non-coagulability is owing to the partial decomposition it undergoes after being effused from its proper vessels ; and the more slowly it is discharged, and the longer it remains in the passages, the more will its congulability be diminished or destroyed.

Cases of *Menorrhagia*, in which the hemorrhage occurs irregularly, or once in two or three weeks, are often miscalled *excessive menstruation.* They are cases of hemorrhage as much as is nose-bleeding or hæmoptysis. Indeed, Madame Bovin, of Paris, who had facilities for investigating this subject never enjoyed by her male cotemporaries, has demonstrated conclusively that the catamenia is nothing more nor less than a discharge of ordinary blood.

Rationale of the Menses.—Why should there be hemorrhage as an accompaniment or incident of menstruation? A reference to the nature of the process will set this matter in its true light. All organs whose functions are performed periodically—for examples: the ovaries during ovulation, the male organs during coition, the breasts during lactation, and the stomach during digestion—have a special determination of blood and nervous influence to the part when the function is to be exercised. This is clearly for the purpose of supplying the part with the material requisite for the proper performance of its function. In the case of digestion the increased quantity of blood sent to the stomach is to supply the material more abundantly for the secretion of gastric juice. In sexual congress the blood is specially determined to the organs concerned in secreting the seminal fluid and conveying it within the sexual organism of the female. In lactation the determination of blood to the mammary glands is for the purpose of supplying the parts with the material from which the milk is formed. And in menstruation the special determination of blood and nerve force, which are always coincident, is to furnish the elements for the evolution of the germ and its nourishment. A certain degree of distension, congestion, plethora or erethism, is necessary to distend the capillary vessels, so that the fimbriated extremity of the Fallopian tube may grasp more completely the matured ovum, and insure its passage to the uterus; and if the ovum in its passage becomes impregnated and fixed to the walls of any part of the reproductive channel, the unusual quantity of blood, or some portion of it, is needed to supply the elements for its nourishment and growth, and for the development of its appendages—the membranes and placenta. In some cases the blood, after imparting the nutrient materials required, is wholly returned to the general circulation, so that no hemorrhage occurs. But, in most cases, more or less of it is effused into the uterine cavity and expelled.

Quantity of Menstrual Blood.—In civilized society, and, to a great extent, in uncivilized, the majority of females lose too much blood at the menstrual period. This results from a relaxed state of the vessels consequent on a weakened and relaxed condition. Indeed, there are few females, except those who suffer from chlorosis or amenorrhæa, who do not have more or less inflammation of the reproductive organs, particularly of the vagina and neck of the uterus, with its necessary concomitants of relaxation and debility, excessive hemorrhage, leucorrhœa, ulceration and displacement. But as this work is not intended to treat more than incidentally of morbid conditions, I must refer the reader who desires full information on the diseases of the sexual organs and their treatment to my work, Uterine Diseases and Displacements, illustrated with colored engravings.

Much observation and an extensive correspondence have enabled me to arrive at a general if not a universal rule with regard to the amount of menstrual blood. It is this: Other circumstances being equal, the less hemorrhage the better. Women who live a more simple life, and are less enervated by the luxuries and stimulants of artificial society, even though they are exposed to excessive toil, and many hardships and privations, have comparatively few of the sexual disorders common to women all over the civilized world, and they lose little blood during menstruation.

The average quantity of menstrual fluid, which is blood largely admixed with mucus, in temperate climates, is reckoned at six to eight ounces. Some women, however, lose twice that quantity, and others still more. I am of opinion that all beyond two to three ounces must be regarded as abnormal in quantity. Professor C. D. Meigs, of Philadelphia, whose experience has been very extensive, states that he has met with many healthy women who never had occasion to employ a napkin; hence the discharge of blood, in their cases, could not have exceeded the above quantity. I have known many similar cases, and some in which hardly an ounce of blood could have been lost; and I have learned the particulars of the cases of a few females, some married and others single, who hardly stain their linen at the menstrual periods. All that is noticeable is a moderate discharge of a sero-mucous fluid for four or five days, with a very slight tinge of color for a day or two. And all of these persons have enjoyed unusually robust health.

I am satisfied, moreover, that, as a general rule, much more blood is lost during parturition than would be the case were women more vigorous and firm in their muscular tissue. I have known several cases in which but a mere trifle of blood was lost—no more, certainly, than is discharged on the average during menstruation—during the delivery of the child and afterbirth, or subsequently. In all of these cases the mothers had an active, vigorous and elastic state of the muscular system, and were more than commonly hygienic in their habits of living. And I have attended one case—an Irish woman of remarkable fineness, firmness, and tone of muscular tissue, who lost no blood at all during nor after parturition, the discharges producing no distinctly sanguineous stain on the sheets or cloths employed; nor did the discharges even stain the hands employed in cutting and tying the umbilical cord or removing the after-birth.

CHAPTER VI.

THE HYGIENE OF MENSTRUATION.

Menstruation is a perfectly natural function, and, understanding this, it is very necessary to know how to conduct the physical life so that it will not cause pain and inconvenience. There should be no suffering when it occurs, more than there is in eating and sleeping in a healthy person. If there is, we may suspect there has been something wrong in the habits of the individual or, perhaps, in those of her ancestors. No woman in perfect health suffers at all during the menstrual period. Unfortunately, however, few women are in perfect health, and too often those who are make, perhaps unintentionally, every possible effort to prevent a long continuance of such a most desirable condition.

If this function does not appear at about the proper age, parents are usually anxious, regarding it as evidence of disease, and physicians, if called in, often prescribe remedies of a stimulating nature in order to force it on. This may be regarded as not only unwise, but positively wrong. If it does not appear at the proper time, it is evidence that the natural forces of the body and nutrition are defective.

The true remedy lies in the adoption of such hygienic measures as will invigorate the constitution, and increase the amount and equalize the circulation of the blood. In many cases, a course of physical training, not excessive in its demands on the strength, considerable out-door life connected with gentle exercise, or play, or amusement, or a summer at the seaside, where, during the warm part of the day, the patient may go barefooted on the beach, now wading in the salt water, now basking in the sunshine on the sand, with an occasional but short dip in the invigorating salt water, will generally prove most salutary. Or those who live in the country may encourage the patient to be much out of doors, to indulge in boyish sports, to help in the garden, to cultivate a love for nature, to gather and arrange and name all wild flowers, collect and classify minerals, ride on horseback, and, in short, do everything in a moderate way that helps to build up a robust constitution. The intellect should not be cultivated at the expense of the health. Occupations requiring long-continued sedentary habits should not be encouraged.

It has been observed that in those persons with what is called the mental temperament the menstrual function usually appears later in life than in those whose temperaments are vital. So it is a matter of observation that the age at which it appears differs according to climate. In the hot regions of the globe, notably India, it is two or more years earlier than in the temperate zone. In the colder regions it is a year or two later. In the same latitude, however, in some persons it develops earlier, and in some later, than the average. Those living in cities, and those who are fed on more stimulating food, develop earlier than those living in the country, or those fed on simple, unstimulating nutriment.

On the appearance of menstruation it is held that the individual is sufficiently developed to become pregnant. Some physiologists have argued that now the person is old enough to become a wife and bear children. The early marriages of India seem to conform this opinion; but, as a matter of fact, the body is not fully developed at puberty, several years still being required to complete its growth. Hygiene requires that marriage should not take place until the body is mature and in full possession of its powers.

Many women suffer during the menstrual period pain, lassitude, and other infirmities. These are most frequent in those whose physical development is least perfect. Peasants and those whose occupation has developed the muscular and bony systems, and the vital organs rarely suffer, most of them being able without inconvenience to continue their labors the same as at other times, and that not only without injury, but with positive benefit.

Many physiologists have held that the monthly appearance of menstruation was a perfect argument that women should not follow any of the professions which require constant attendance, but only such as will allow of rest during the menstrual week. For perfectly healthy women this argument has no force; for the weak and debilitated it may have value. They are exceptions to any rule, and women must order their lives in accordance with their needs or, in other words, adapt their habits and occupations to some extent to their state of health.

On the other hand, the children of diseased parents, who inherit from them a weakened organization, often suffer much, and are compelled to cease almost entirely from all labor during the whole or a part of the time of menstruation may regard rest as important. That those who do muscular work suffer least is an argument for labor rather than for idleness; and among the weakly it is an argument for physical culture for girls, so as to develop in them bodies sufficiently strong to bear any strain that in the ordinary course of nature may fall to their lot.

It has been observed that married women suffer less than the unmarried during the menstrual period, and from this it has been argued by physicians and others that marriage is a cure for the infirmities and defects of this function. While in some cases it has, no doubt, been useful, yet to draw such a sweeping conclusion is most illogical. The chief reason why there is less suffering among married women at this period than among unmarried, is because by the law of sexual selection women who are most healthy and, consequently, least liable to suffer are the ones who marry, while those least healthy and most likely to suffer are the ones either not chosen, or who prefer not to enter wedlock. It is true there are exceptions to every rule, but they are not in sufficient number to abrogate it.

In marriage, where the sexual passion is indulged to excess, diseases of the female sexual organs often develop, and with this comes suffering in menstruation. All this, however, may be avoided by that moderation which should prevail in married life.

Many girls, and even women, sometimes wish to cut short the period of menstruation, and to do so take cold foot-baths. This is most unwise, and has been the cause of much harm. It sometimes happens that an undue exposure to cold and wet, or some unusual strain on the nervous system brings on a premature cessation of the period. The best remedy for this is a hot foot- and leg-bath, or even a hot sitz bath, to which may be added the drinking of hot lemonade, or even hot water if lemons are not at hand. Simple hygienic remedies are far better than severe ones.

The question of food and its relation to menstruation should not be left out of consideration. Plain, simple, wholesome food which contains sufficient of all the material necessary for the perfect nourishing of the body is best. Highly stimulating food, very salt food, and condiments of all sorts should be used most sparingly. Farmers and stockbreeders sometimes give cows large doses of salt to bring on the periods of these animals prematurely. It no doubt acts in the same way on human beings. Only as much of this article as can be made to satisfy the real needs of nature should be used. This is far less than is generally supposed. Alcoholic drinks, tea and coffee should be omitted from the diet, at least in early life, so as not to stimulate the menstrual functions unduly. No doubt the passional nature is augmented by them. Food which is constipating does harm. If the bowels are loaded with accumulated matter so as to press upon all the surrounding parts, it cannot help interfering with the action of those parts. If women would learn to live on more healthful food it would relieve them of many menstrual infirmities.

Insufficiency of food or a diet not balanced to the needs of the body may delay menstruation and result in an imperfectly developed body.

Novel reading by girls before menstruation has begun is believed by some to so arouse the emotional nature as to prematurely bring the function into activity. We have, perhaps, only isolated facts upon which to base this conclusion, but it does not seem unreasonable. This shortens the period of childhood and girlhood, both evils of no slight character. Fiction of a high character, conveying the loftiest thoughts of our noblest thinkers, is most useful in promoting human progress and happiness, but it is more adapted to the mature than the childish mind. It would be far better for the sexual nature of both sexes if all exciting literature could be banished from our homes. The literature of science, simplified for the youthful intellect, acts quite reversely from that of fiction. It cultivates a cooler, calmer state of mind and under its influence sexual passion is modified and made more normal.

Girls are sometimes timid about speaking to their mothers when the menstrual flow first appears. This is apt to be the case when they have not been in as close relations with their children as the highest and best parentage demands. From this timidity has often come serious trouble and suffering which has not been easily overcome. Mothers cannot be too thoughtful of their duties in this respect, and especially of the duty of informing themselves thoroughly on the whole subject under discussion, so as to be able to act wisely. They must not, however, excite in their daughters the idea of fear, for this will do more harm than almost anything they can do, They should simply instruct them in the naturalness of the function, and in the fact that they must espect it and live so as to keep it healthful. If h ey do this faithfully, much suffering will be prevented.

The breasts begin to develop with menstruation, and this requires that the clothing should be changed so as to allow room for their growth; where this is not the case evil results to these important organs may follow. The retardation of the perfect development of the breasts and injury to the bust caused by putting on corsets at this critical period, in order to produce what fashion calls a good form, is a species of barbarism for which there is no excuse.

The question may arise in the minds of some as to whether sexual intercourse is permissible during menstruation. The Jewish law prohibited it, and regarded women as unclean then, and not to be approached. Whether this law was always kept is very doubtful. Human beings are so constituted that they are very likely to violate those prohibitory laws which interfere with their appetites and passions. There is no doubt, however, but that sexual intercourse should be avoided during the menstrual period.

May women bathe during menstruation? Full hot or cold baths should not be taken. A woman may, however, keep the skin active, clean and healthy by friction with a flesh brush, or by rubbing the body with a dampened towel. This is better if done in a warm room. After menstruation, a full bath, with soap and water, should be taken to thoroughly cleanse the body. Those women who accustom themselves to bathe regularly in the intervals between the menstrual periods are healthier, and suffer less, other things being equal, than those who do not.

CHANGE OF LIFE.—As the years roll on they bring changes in the sexual life of women. The greatest of these is one which, in popular language, is known as the "change of life," or the menopause. Sometimes it is called the "climateric period," because it is supposed to be a critical time for women. Strictly speaking, it is that period when the evolution of the ova is coming to an end. When it has passed, menstruation no longer occurs, and no more ova ripen to be thrown off.

In women, the period of reproduction is limited to those years in which they are supposed to be in the fullest vigor of life. It ceases when this vigor begins to wane, when nutrition and repair in the body is less than the waste. It is well that it is so; were it not, they might go on reproducing children when too old and feeble to properly care for them; too old to transmit to them health and vigor of constitution. The result would then be, that a still larger number of weakly ones would be brought into the world to contend in the struggle for existence, only in the end to fail.

After the cessation of menstruation and the development of ova and child-bearing, the forces used in carrying on these functions will be distributed to the system at large, and give to woman that strength in her declining years which she so much needs.

This change of life takes place at slightly different ages with different races and individuals. It may occur at forty years; it may not before fifty. Instances are on record when it has not taken place till at or near sixty. Usually it occurs between the forty-third and forty-sixth or forty-seventh years.

As a rule, women dread this change because it is supposed to bring with it more or less suffering. In a perfectly normal process, when the constitution has been good and the habits correct, it causes little or no trouble. When the constitution is a poor one, or has been subject to nervous strains, or if the habits have been unhygienic, more or less suffering necessarily follows.

One of the most important suggestions for the hygiene of this period is that the mind be kept in a normal state. If the early education has been a wise one, and if the emotional nature has not been cultivated excessively by too much novel reading, or an undue indulgence of the passions, then it is easy; otherwise it may not be. A philosophical state of mind is favorable, and a thorough belief that the change is for the best, and that it will bring with it benefits.

The habits of life should now be systematic, if they have not been so before. Abundant rest should be taken; over-eating should not be indulged in. If the person can adopt a wise vegetarian diet, or some near approach to it, it will, in most cases, be well. An out-of-door life should be cultivated, so far as can be, and wholesome recreation indulged in. Highly spiced and stimulating foods should be avoided. Wines should not be taken. Many women feeling weaker at this time, take to wine as an aid, instead of nutritious food and plenty of recreation and sleep. Overwork should be avoided. The reading should be such as to cultivate faith, hope and love—without these the world is dark at any period, and especially at this.

The skin should be kept healthy by proper bathing—in most cases warm bathing—and the bowels kept open by such a diet as acts on them naturally. Warm sitz baths, and vaginal injections while in the bath, sometimes relieve distressing symptoms.

Women often rebel at the trials to which they are subjected during the years when nature gives them over to reproduction; but a normal motherhood brings with it joys which offset all these trials, and the one cannot be had without the other.

After the change of life is over the system renews itself, or should do so. The function of nutrition increase, and there is a tendency with some, more especially with those of the vital temperament, to take on fat, which is best prevented by moderation at the table, and as much physical labor or exercise as is consistent with the bodily strength.

The moral and intellectual nature, which has not had an opportunity for the same development that man's has in his struggle with the world during the same period, may now be cultivated, and the last part of life, alas, too often a blank, or nearly so, be made full and rich in the highest degree.

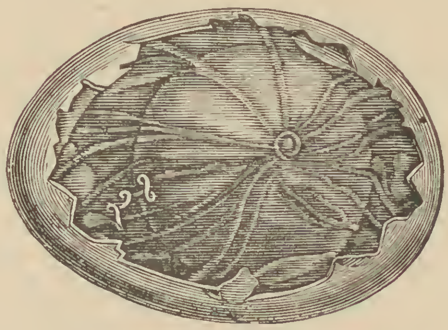
CHAPTER VII.

IMPREGNATION.

The Nature of the Ovum.—The physical characteristics of the spermatozoa have been fully given in a preceding chapter. The nature of the ovum, like that of the sperm, has been the subject of much investigation and microscopic analysis; and as the egg of the fowl contains essentially the same parts as the ova in the mammals and in man, it has afforded the most convenient means for studying the elementary properties and constituents of the vitalized germ. By keeping an egg one, two, three or more days in an incubator, and then removing it from the shell to a microscope, one may observe the changes that have been going on. This study comes under the head of Embryology, and is very fascinating.

In the egg of the fowl, the yelk membrane and its contents are the essential parts of the germ-cell. The albuminous portion, or "white," and the calcareous covering do not exist in the ovum while it is in the ovary, but are formed during its passage through the oviduct. The yelk—vitellus—consists of albuminous granules and oil globules. Toward the center the yelk is of a lighter color, and the granules have more the appearance of cells, within which are minute globules. The central portion is termed *discus vitellinus.* Imbedded in the vitellus is a transparent vesicle of a rounded form termed *germinal vesicle,* measuring, in the human subject, one eight-hundredth to one five-hundredth of an inch in diameter, and upon its surface is a dark spot, or nucleus, termed the *germinative spot.* The

FIG. 46.

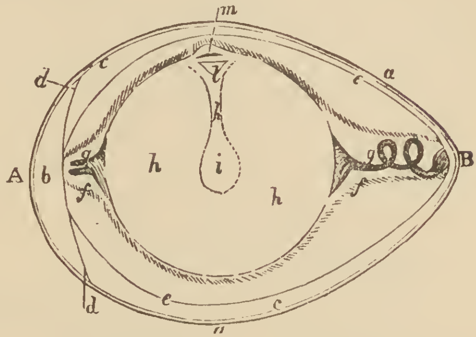


NEW LAID EGG WITH ITS MOLECULE, ETC.

fully-developed ovum in the human ovary, and of mammals, does not often exceed one-fifteenth to one-twentieth of a line in diameter. According to Bischoff, the ripened ova vary from one two-hundred-and-fortieth to one one-hundred-and-twentieth of a inch in diameter.

In Fig. 47 it will be seen that the germ is always uppermost, and that the yelk floats in the upper portion of the white.

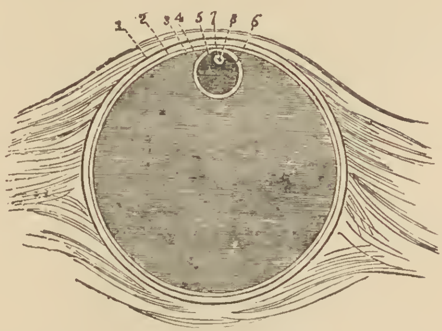
FIG. 47.



IDEAL SECTION OF A HEN'S EGG.

A. Blunt pole or large extremity. *B*. Small end or sharp pole. *a*, *a*. Shell. *b*. Space filled with air to supply oxygen. *c*. Membrane of shell, which at *a*, *d* divides into two layers. *e*, *e*. Limits of the second and thicker albumen. *f*. Limits of the third and thickest albumen, the white being in three layers. *g*, *g*. Chalazæ, or ropes of twisted fibers from the yelk, which hold it in its place. *h*. Yelk. *i*. Central cavity in the yelk, from which a duct, *k*, leads to the *cicatricula*, or head. *l*. Cumulus *proligerus*, or germinal cumulus. *m*. Germ or blastos.

FIG. 48.



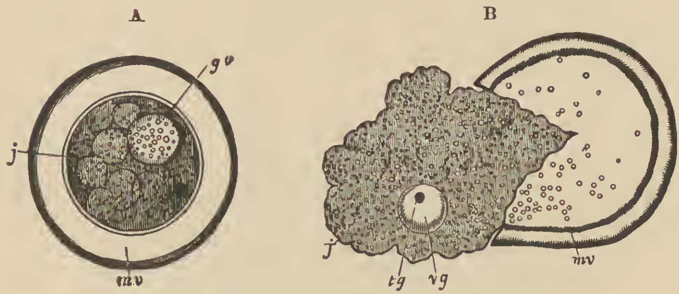
GRAAFIAN VESICLE CONTAINING AN OVUM.

1. Stroma or tissue of the ovary. 2 and 3. External and internal tunics of the Graafian vesicle. 4. Cavity of the vesicle. 5. Thick tunic of the ovum or yelk-sac. 6. Yelk. 7. Germinal vesicle. 8. Germinal spot.

Wagner regards the germinal vesicle as a primary cell, of which the germinal spot forms the nucleus, and suggests the term of *germinal nucleus* be substituted for that of germinal spot. It is homologous with the "germ-cell" or "embryonic vesicle" of the vegetable ovule.

The constitution and arrangements of the different parts of the mammalian ovum are represented in Fig. 49.

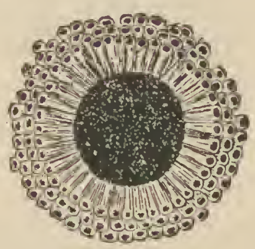
FIG. 49.



CONSTITUENT PARTS OF MAMMALIAN OVUM.

A. Ovum, entire. B. Ovum, ruptured, with the contents escaping. *mv.* Vitelline membrane. *j.* Yelk. *vg.* Germinal vesicle. *tg.* Germinal spot.

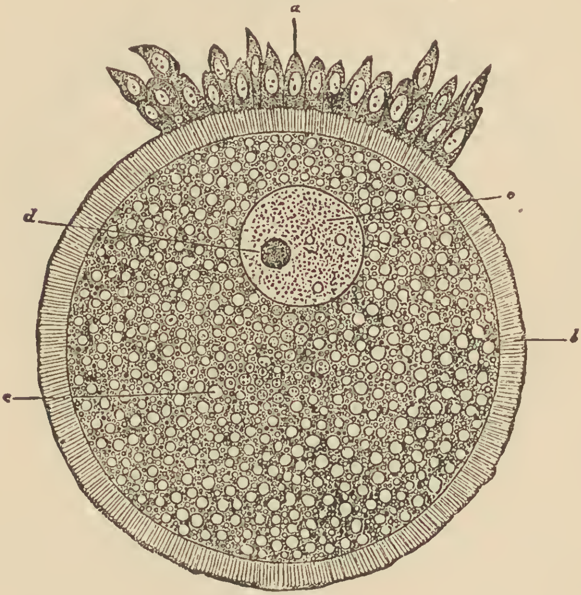
FIG. 50.



MATURE OVUM OF MAMMAL, COVERED WITH RADIATING CONES.

Dunglison remarks ("Human Physiology," vol. 2, page 399), "It was elsewhere remarked that the formation of the ovule by the Graafian follicle must be regarded as a true secretion—the yelk of which it is mainly composed, as well as the membrana

FIG. 51.



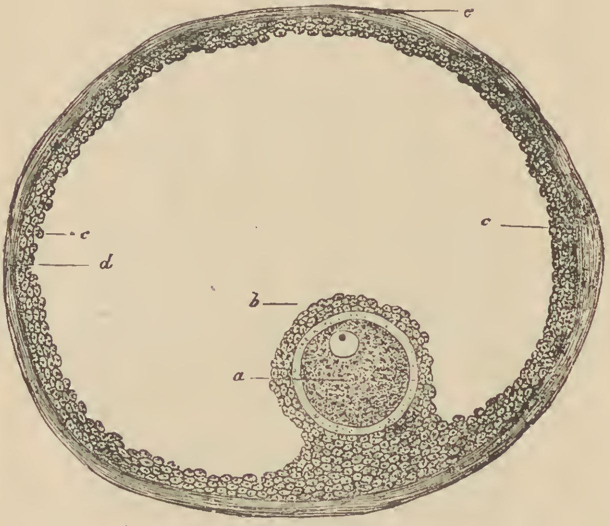
OVUM OF THE RABBIT.

From a Graafian follicle one-fiftieth of an inch in diameter.

a. Epithelium of the ovum. *b*. Zona pellucida, with radiating striations (vitelline membrane). *c*. Germinal vesicle. *d*. Germinal spot. *e*. Vitellus.

granulosa, essentially resembling each other in histological and chemical character. When matured, the ovum, pressed forward probably by fresh depositions of the yellow matter which goes to the formation of the granular membrane and the yelk, is discharged from the ovary, and laid hold of by the Fallopian tube, which acts as an excretory duct, and conveys it into the interior of the uterus."

FIG. 52.



MATURE FOLLICLE.

a. Ovum. *b*. Layer of epithelium enveloping the latter, and lining the cavity of the follicle, *c*. *d*. Fibrous wall. *e*. External surface of the follicle.

FIG. 53.

OVARIUM OF THE RABBIT.

Showing ova in various stages of development and extension at the period of heat.

The different conditions and appearances of the ova, in their various stages of progress toward maturation, can be advantageously studied in the ovary or yelk-bag of the common fowl. The blood-

FIG. 54.

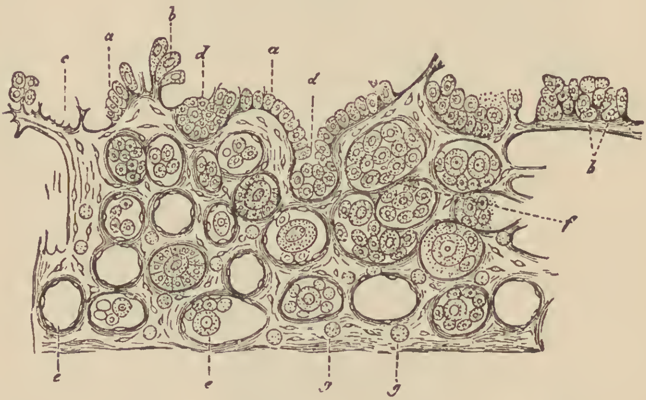
OVARIUM OF A HEN.

The illustration is of life size, and the ova are seen in various stage of evolution.

vessels (arteries and veins) of the ovaries belong to the spermatic. The arteries pass between the layers of the broad ligament to the ovarium, where they have a beautiful convoluted arrangement, similar to the convolutions of the arteries of the testes. They traverse the ovary in parallel lines forming minute branches or twigs, which have an irregular knotty appearance, resulting from their tortuous course. They are mainly distributed to the Graafian vesicles.

The nerves of the ovaries, which are abundant and extremely delicate, are derived from the renal plexuses. Their lymphatics communicate with those of the kidneys.

FIG. 55.



VERTICAL SECTION OF THE OVARY A HUMAN FETUS 32 WEEKS OLD.

a. Germinal epithelium. *b.* Younger egg-cells, the primordial ova contained in this. *c.* In-growing band of fibrous connective tissue. *d.* Epithelial cells in process of being folded in. *e.* Youngest follicles. *f.* Ova and germinal epithelial cells in groups. *g.* Lymphoid cells.

This section illustrates the fact that even in the fetus the ovaries and primitive ova are developed, and that Nature begins in early life preparation for generation and reproduction.

Before the rupture of the ovisac it undergoes material changes. Its walls become more vascular

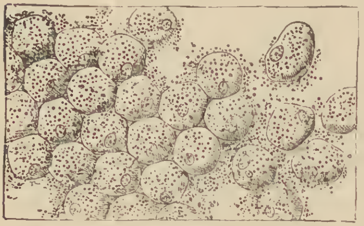
FIG. 56.

HUMAN OVARIUM.

At *p*, is shown the expanded fimbria of the Fallopian tube, near which is seen to project from the surface of the ovary or Graafian vesicle, *v*, the rupture of which has allowed an ovule, *œ*, surrounded by its *discus proligerous*, *c*, to escape. In the center of the upper part of the pit is seen an empty Graafian vesicle, *v*, laid open by the incision, and showing the irregular cavity, *g*. Further up toward the left is shown another Graafian vesicle, with the ovum, *c*, not yet discharged. Other Graafian vesicles, *v v v*, in earlier stages of development, are seen in different parts of the figure.

externally, and are thickened internally by the deposit of a fleshy-looking substance, which consists of an aggregation of cells, as represented in Fig. 57. After the ovum has been matured and discharged, the Graafian vesicle gradually becomes atrophied and obliterated. In one stage of this process of retrogression it is converted into a solid globular body termed the *corpus luteum* (yellow body). Its existence was formerly regarded as an evidence that impregnation had taken place; but it is now known to exist in virgins who have menstruated normally, and to be a consequence of ovulation simply. There is, however, such an altered appearance in this substance, in the cases where pregnancy has occurred, that we have to consider the corpora lutea as they appertain, repectively, to the non-pregnant and to the pregnant states, which have sometimes been contra-distinguished as the *false* and the *true* corpora lutea.

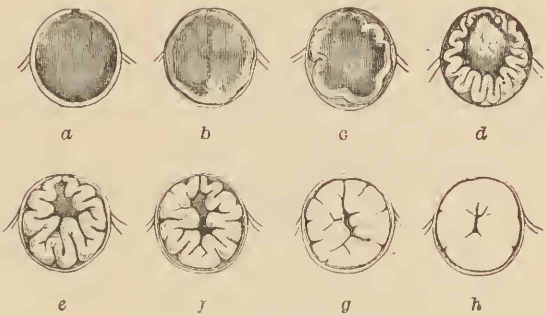
FIG. 57.



CELLS FORMING THE CORPUS LUTEUM.

THE CORPUS LUTEUM OF MENSTRUATION.—When the Graafian vesicle discharges its ovum at the menstrual period. the cavity is filled with blood, which soon coagulates, the coagulum being retained in the interior of the vesicle. This coagulum or clot gradually becomes contracted and hardened from the absorption of its serum, as is the case with blood when extravasated within any part of the living body; the coloring matter undergoes the changes usual in such circumstances, and, with the serum, is partially removed by absorption, at the same time the membrane of the vesicle becomes hypertrophied and convoluted, by which it tends partially to fill the cavity. This process of enlarge-

FIG. 58.



STAGES OF THE CORPUS LUTEUM.

Vertical section of the Graafian follicle of the sow.

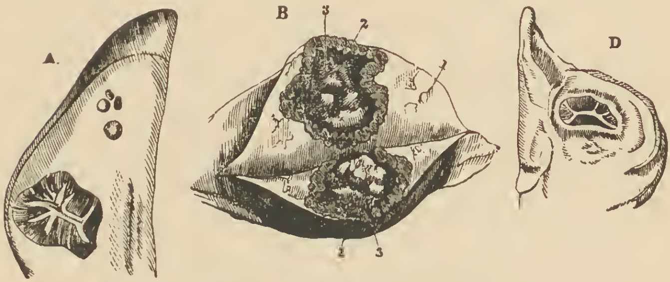
a. State of the follicle immediately after the expulsion of the ovum, its cavity being filled with blood, and no ostensible increase of the epithelial lining having yet taken place; *b*, a thickening of this lining has become apparent: at *c*, it begins to present folds which are deepened at *d*, and the clot of blood is absorbed *pari passu*, and at the same time decolorized; a continuance of the same process as shown at *e*, *f*, *g*, *h*, forms the corpus luteum, with its stellate cicatrix.

ment of the membrane of the vesicle continues for about three weeks, at which time the ruptured vesicle has become so solidified that it receives the name of *corpus luteum*. It may then be felt as a rounded prominence on the surface of the ovary, measuring half an inch in thickness, and about three-quarters of an inch in length. On its surface is a very small scar or cicatrix, occupying the spot of the original rupture.

After the third week the corpus luteum diminishes in size, and at the end of the fourth week it is reduced to three-eighths of an inch in its longest diameter, and at this time the entire body may be extracted from its ovarian bed. As the process of retrogression goes on, its rosy, or dull-yellowish hue, changes to a brighter yellow; its surface becomes confounded with the central coagulum and surrounding tissues, and, at the end of about two months it is reduced to a small yellowish spot or scar, and this disappears entirely in seven or eight months. The ovaries of a healthy female, who has menstruated regularly, but in whom pregnancy has never occurred, will often exhibit several corpora lutea in different stages of development and retrogradation.

THE CORPUS LUTEUM OF PREGNANCY.—When impregnation has taken place, the corpus luteum seldom attains a size greater than that of a small pea, and is generally even smaller; and it begins to diminish about the time for the next menstrual period. The difference between the false and the true corpora lutea is merely one of rapidity of development and decay; that of pregnancy going through the same changes, but more slowly; hence it attains a larger size, a firmer organization, and disappears at a much later period. As pregnancy arrests the process of ovulation, no more ova are matured until after the period of gestation has been completed. Hence, in advanced pregnancy, the corpus luteum is not like that of menstruation, accompanied with unruptured vesicles in active process of development. After parturition it diminishes rapidly, though its characteristic structure may be distinguished for months afterward.

FIG. 59.



CORPORA LUTEA OF PREGNANCY.

B. Corpus luteum of about the sixth week after impregnation, showing its plicated form at that period. 1. Substance of the ovary. 2. Substance of the corpus luteum. 3. A grayish coagulum in its cavity. A. Corpus luteum two days after delivery. D. Corpus luteum in the twelfth week after delivery.

In twin pregnancies, and in the case of triplets, etc., there are corpora lutea corresponding in number to that of the fetuses, all of which are precisely similar to each other; but, in some cases, a single fetus is found in the uterus, while the ovaries contain two corpora lutea of similar appearance, one of which is supposed to belong to an embryo which was blighted in the early stage of pregnancy.

We have seen that in the higher animals impregnation depends on the union of certain elements furnished by male and female organs, each of which are necessary to the production of a human being. It requires but little knowledge of physical conditions and a slight acquaintance with human history to enable us to understand that the future being, with all its bodily, intellectual and moral qualities, is dependent on the good condition of the germ and sperm elements furnished by the male and female parents. It is true that correct training and suitable circumstances may enable a frail and imperfectly organized embryo to become a better adult person than one developed from perfect germs, but subjected to unfavorable conditions. But the principle is clear, and of very great practical importance, that the germ decides forever the general character of the child, the youth and the adult. For this reason great responsibility will always rest upon parents. This subject will be more fully considered in future chapters.

The Action of the Male.—Dr. Flint says on this subject: "Unlike certain of the lower animals, the human subject presents no distinct periodicity in the development of the spermatozoids; but, in reiterated connection, excitement and an orgasm may occur when the ejaculated fluid has no fecundating properties. Such frequently repeated sexual acts are abnormal; but, from a purely physiological point of view, prolonged continence is equally unnatural and may react unfavorably on the nervous system. No absolute or even approximate rule can be laid down with regard to the frequency with which intercourse may take place within physiological limits. We may assume that these conditions are fulfilled, first, when intercourse is confined within the limits of legitimacy, after the unusual excitement of novelty has passed; second, when both the male and female are in perfect health, and no undue degree of lassitude follows coitus, after a proper period of repose; third, when there is no marked diminution of sexual desire, except that which may be accounted for by age; fourth, when pregnancy occurs at proper intervals, progresses normally, and is followed by the normal period of lactation; fifth, when menstruation is regular, and when there is a period, usually after the cessation of the flow, during which there is unusual sexual excitement, responded to by the male, and disappearing after the sexual desires have been satisfied. It may be somewhat rare to find these conditions fulfilled in all respects, as so few men and women in civilized life are absolutely normal during adult age, and as the sources of unnatural sexual excitement are so numerous; but they approximately represent the physiological performance of the generative functions in both sexes. It is true that the female can frequently endure sexual excesses better than the male, because she is more passive, and may often not participate in the venereal excitement; but, if we assume that intercourse is physiologically confined within the limits fixed by social laws, the same rules as regards the frequency of the sexual act should apply to both. It is certain that intercourse is not normal in the female during menstruation or during the greater part of the period of utero-gestation; and, at these times, it is physiological that the male should be continent. Taking our view chiefly from what appear to be the sexual requirements of the female, intercourse most properly takes place at the time following the menstrual flow, when there is usually a certain amount of sexual excitement, and this should not be immediately repeated, though it may be physiological after a few days. As sexual excitement is gratified and diminishes, intercourse, as far as the desires of the female are concerned, is suspended, and it does not take place to any great extent during pregnancy. This seems to correspond with the the normal progress of the generative functions, as we have traced it in the female. It is evident that this is a subject of great delicacy, and one that is with difficulty brought to the requirements of rigid scientific inquiry; still, it can hardly be avoided in a full account of the physiology of generation, and it is a question often presented to the practical physician." *

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* "A Text-book of Human Physiology for Students of Medicine." By Austin Flint, M. D. New York: D. Appleton & Co.

After the seminal fluid has been ejaculated during intercourse, the generative act, so far as the male is concerned, is accomplished. It now remains for us to study the action of the female, and the process by which the spermatozoids are brought in contact with the ovum.

Action of the Female.—Dr. Flint remarks, "If we can credit the statements made to physicians in their professional intercourse, there are some females in whom the generative function is performed, even to the extent of bearing children, who have no actual knowledge of a true venereal orgasm; but there are others who experience an orgasm fully as intense as that which accompanies ejaculation in the male. There is, therefore, the important difference in the sexes, that preliminary excitement and an orgasm are necessary to the performance of the generative act in the male, but are not essential in the female. Still, there can be scarcely a doubt but that venereal excitement in the female facilitates conception, other conditions being favorable.

"In considering the mechanism of the penetration of spermatozoids into the uterus, it is also necessary to take into account the secretions, particularly of the mucous glands at the neck. Most writers of the present day admit that, during the height of the orgasm, there is an ejaculation from the uterus of a small amount of alkaline mucus. That an erection of the cervix, followed by sudden relaxation and opening of the os, may occur, cannot be doubted, and there is no evidence of a muscular action in the uterus sufficient to project this fluid forcibly, as the semen is discharged by the male. Assuming that the views just stated be correct, we can readily understand how the neck may be erected and hardened during the orgasm, extruding an alkaline mucus, that the semen is ejaculated forcibly toward the uterus and becomes mixed with the mucus, and that the sudden relaxation of the cervix and opening of the os may exert a force of aspiration, and thus draw in the fecundating elements. Certain it is that spermatozoids may be found in the mucus of the cervix a very short time after coitus. It is possible, also, that a sexual connection may be occasionally even more intimate, and that a portion of the glans penis may be actually embraced by the dilated cervix, though this must be unusual. This latter idea of the establishment of a "continuous canal" during intercourse is one that was advanced by many of the older writers.

"Quite a strong argument in favor of the view that the spermatozoids are imprisoned, as it were, in the cervical mucus soon after ejaculation, is the fact that vaginal injections immediately after intercourse, which are frequently resorted to to prevent conception, often fail to produce the desired result, even when they are so thorough as to wash out the vagina completely.

"While we must accept as probable the view that the uterus may draw into the neck an alkaline mucus previously ejaculated, and with it a certain amount of seminal fluid, the fact that conception may take place without orgasm on the part of the female, and even without complete penetration of the male organ, shows that the action we have described is not absolutely essential, and that the semen may find its way into the uterus in some other manner, which it is certainly very difficult to explain."

Other writers and experimenters have thought that the alkaline mucus at the mouth of the uterus developed an electrical current which flowed toward the uterine cavity, and that it, together with the power of movement in the spermatozoids, which enables them to move forward quite rapidly, is sufficient to explain their presence, soon after coition, in the uterine cavity and Fallopian tube; but this is not satisfactorily determined.

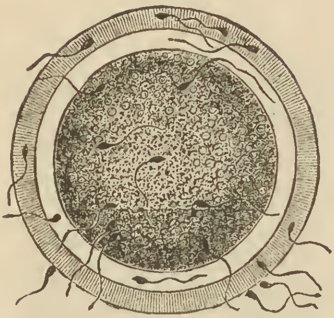
Vitality of the Spermatozoids and Ovum.—The question as to how long the spermatozoids may live after their passage into the uterus is an interesting one, and has an importance, bearing on the time when conception is most likely to follow intercourse. It is doubtful if this question can be answered with absolute certainty. They may have greater vitality in some persons than in others; their long or short life may depend on the healthy or diseased condition of the vaginal and uterine cavities. If there be any disease which would cause an acid condition of the secretions, instead of an alkaline one, the spermatozoids would not long survive, as acids are unfavorable to their life. There is no doubt but in perfect health of the female organs and great vigor in the spermatozoids themselves, they may retain their vitality for at least several days.

There is an idea, based upon rather general and indefinite observation, that conception is most liable to follow an intercourse which occurs soon after a monthly period; but it is certain that it may occur at any time. It is extremely probable that, during the unusual sexual excitement which the female generally experiences after a period, the action of the internal organs attending and following coitus presents the most favorable conditions for the penetration of the fecundating elements, and this may explain the more frequent occurrence of conception as a consequence of intercourse at this particular period.

The length of life of the ovum cannot be determined, but it is not many days. If it does not meet in the generative passages the male elements, it soon dies and is cast off. This is a difficult subject for investigators.

The Mechanism of Fecundation.—The mechanism of fecundation has been carefully studied in the lower animals, and we may be sure it consists in an actual union. The spermatozoids penetrate the vitelline membrane of the ovum, as may be seen by the following figures, which have been drawn from nature.

Fig. 60.



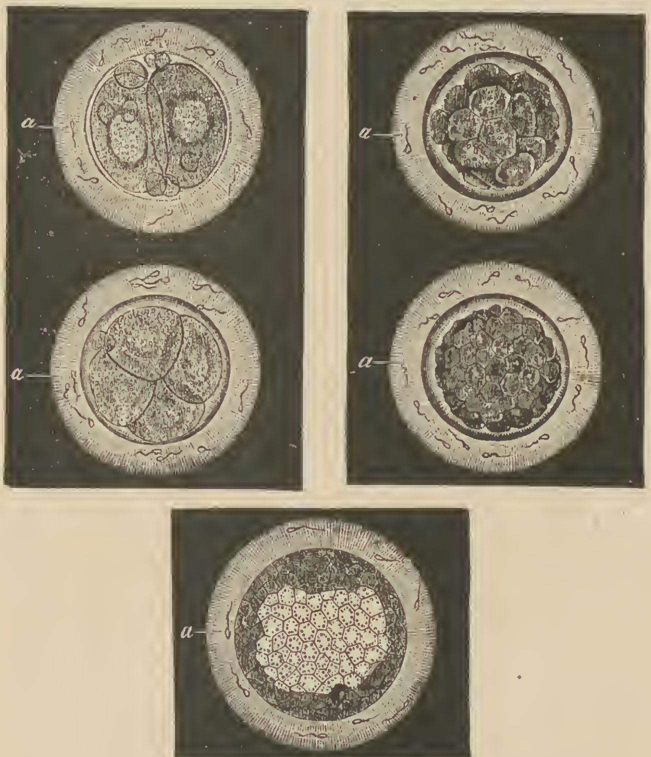
PENETRATION OF THE SPRMATOZOIDS THROUGH THE VITELLINE MEMBRANE OF THE OVUM.

As soon as the spermatozoids have penetrated the ovum, segmentation begins at once, as shown in Fig. 61.

Fig. 62 shows a still more advanced development where every trace of spermatozoa has disappeared and the embryon is fully formed.

Where Impregnation Occurs.—The place of impregnation has been a question which has puzzled physiologists. The general belief has been that it occurs in a Fallopian tube soon after an ovum has made its entrance into one of them. A more probable view is, that it may occur either in this tube or in the cavity of the uterus itself. So far as investigations have been made on rabbits, it has been found that the ovum has died if not impregnated before it reached the uterus; but this animal is one whose constitution is poor, and, consequently, the egg will of necessity be short-lived. In man and in many animals their vitality is much greater, and this would give a longer life to them. In birds, also, impegnation always takes place in the Fallopian tubes.

FIG. 61.

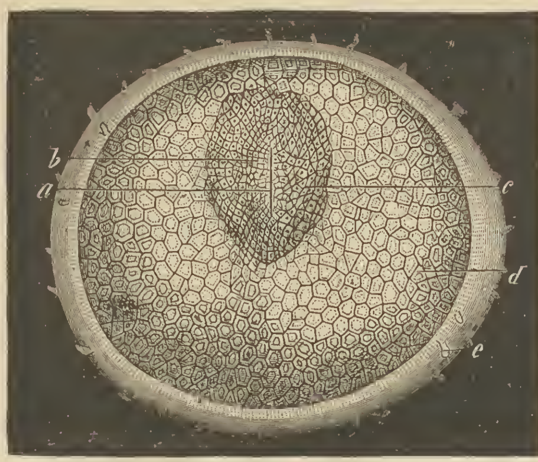


SEGMENTATION OF THE VITELLUS.

a, a, a, a, a. Spermatozoids. The four upper figures represent the progressive segmentation of the vitellus. The lowest figure shows the cells of the blastoderm.

If the ova in the human female are impregnated in the Fallopian tube, then the spermatozoa must make a long journey after being emitted by the male, to reach them. There would be one advantage in this, namely, that only the strongest would ever succeed in doing so, and in this way a more vigorous offspring would be insured. The spermatozoa are not all of equal vigor. Like human beings, there is a great variety of them, and it must

FIG. 62.



PRIMITIVE TRACE OF THE EMBROYON.

a. Primitive trace. *b.* Area pellucida. *c.* Area Obscura. *d.* Blastodermic cells. *e.* Villi beginning to appear on the vitelline membrane.

be an advantage to the ovum and the future child that only the most perfectly developed come together. The same may be said of the ova. They are not all equally vital, but most so during the prime of life, when the constitution is at its best. This perhaps explains why the most talented persons are, in most cases, born of mothers about thirty years old, and fathers four or five years older.

THE NUMBER OF SPERMATOZOA REQUIRED TO IMPREGNATE AN OVUM.—It is not known how few spermatozoa will impregnate an ovum. Some have held that a single one is sufficient; others, that several are required. So far as observations have been made, there have always been a number of them seen in an ova after impregnation. Nature is very lavish in her supply of material. If she were not, conception would be more difficult and uncertain than it is. In a single drop of the spermatic fluid there must exist many thousand spermatozoa; of these only a few are ever required; the remainder die.

CHAPTER VIII.

PREGNANCY.

CONCEPTION.—Impregnation is not conception. The ovum may be fecundated, by intermixing with the elements of the sperm-cell, without pregnancy resulting. We have seen that wherever, in the generative passages of the female, the living spermatozoa come in contact with ripened ova, then impregnation occurs. But the impregnated ovum may be, nevertheless, expelled, as in the ordinary monthly process of ovulation. Many cases of sterility are attributable to the inability of the uterus to retain the ovum after its impregnation, in consequence of weakness, relaxation, leucorrhœa, etc. Violent exertions will also frequently excite uterine contraction sufficiently to occasion this expulsion, hours and even days after impregnation. If, however the impregnated ovum becomes *attached* to the walls of the genital channel, the process of fetal development will then and there commence. This attachment or *fixation is conception.* How soon this fixation occurs after impregnation is a problem not very well settled. Doubtless the time varies much with different females, as do all functional processes concerned in menstruation or pregnancy. I have been collecting data bearing on this point for years, but cannot yet regard them as conclusive; and there is no problem in sexual physiology respecting which the facts are more confused and contradictory. That this attachment or fixation may and does occasionally take place in the Fallopian tube, and even in the ovary, is proved by the cases of extra-uterine pregnancy which are recorded. But that the uterus is the place for normal conception is my full conviction, the reasons for which will be considered hereafter.

Signs of Pregnancy.—The *suppression of menstruation* is ordinarily the first well-marked sign that pregnancy has occurred; but this is not conclusive, as pregnancy may occur with females who have never bled at the menstrual periods, and the monthly hemorrhage may continue during the whole period of pregnancy. Dr. Good relates the case of a woman who "menstruated only during pregnancy," but he mistook hemorrhage for menstruation. The cases, however, in which pregnancy is not attended with a suppression of the monthly period are very rare, so that we need not be surprised that this even has long been regarded as an unerring symptom.

Nausea and *vomiting*, with *capricious or depraved appetite*, are among the usual symptoms of early pregnancy; but they are occasionally entirely absent; and when present, they seem to depend much more on the morbid conditions or erroneous dietetic habits of the patient than on the incident of pregnancy. Dr. Bedford, who sometimes confounds pathology and physiology, regards vomiting "as among the most constant accompaniments of pregnancy, and its relation to this, as a general rule, is based on sound physiology." We have known several cases in which women went through gestation without a moment's disturbance of the stomach; and I am of opinion that if all women would live as hygienically as they did, few or none of them would be troubled with this "sign of pregnancy."

Salivation, or a copious excretion from the salivary glands, affects some women during pregnancy, but as a sign of pregnancy it is to be regarded as an exception rather than the rule.

Enlargement of the Breasts is a more uniform and reliable symptom. The mammæ, very soon after conception, usually become more hard and movable, with a prickling sensation, while the nipple is more prominent and frequently somewhat painful or tender. The veins of the breast enlarge. These changes may occur in two or three weeks, or not until two or three months after conception. The general rule is, the more healthy and vigorous the woman, the sooner will they be manifested. As the breasts enlarge, the areola around the nipple becomes of a darker color, with a development of small prominences or follicles. These are among the most reliable evidences of pregnancy, yet they are not infallible. I have known cases in which they occurred a few weeks after a suppressed menstruation. There are cases, also, in which the breasts evince no change whatever till near the period of parturition.

Milk in the Breasts is one of the common accompaniments of pregnancy; but the secretion of this fluid takes place in many conditions of the system when pregnancy does not exist. The facts are well authenticated that milk has been found in the mammary glands of young virgins, and in their analogues of the male sex. Irritation of the breasts and ovarian diseases have occasioned the secretion of milk in non-pregnant females.

Enlargement of the abdomen is apparent in the third month of pregnancy, but a similar appearance may result from dropsy, or from a tumor. When the uterus begins to increase in bulk, and sinks down a little in the pelvic cavity, it occasions, in most cases, some degree of tenesmus, with frequent urination, causing the abdomen to appear a little flattened in the hypogastric region.

Edema of the lower extremities frequently accompanies pregnancy, and is usually attributed to obstruction in the venous circulation, from pressure of the impregnated uterus; but the essential, though more remote cause, is undoubtedly general plethora or local congestion. It rarely troubles those whose regimen is reasonably hygienic.

Quickening, which occurs about the middle term of pregnancy, but may occur two or three weeks earlier or later, is commonly regarded as conclusive of the fact of pregnancy, but even this may be deceptive. The term is applied to the first consciousness of motion in the uterus on the part of the mother; but spasmodic contractions may produce a similar sensation. In *true quickening,* the motions of the fetus are for the first time recognized. The ancient doctrine was that, at this period, the fetus was endowed with life, and many absurd statutes in relation to willful abortion have been predicated on this erroneous notion. The child has organic life progressively developing in structural arrangements from the moment of conception to that of parturition, although it has no volition, no mental or soul life, until its lungs are expanded and "God breathes into its nostrils the breath of life." Then its organs of external relation come into play, and it begins to ascertain its relation to external objects and to other beings.

Although pregnancy may exist with none of the above-mentioned signs and symptoms, or with all of them, the cases in which the woman mistakes her condition in this respect are comparatively few; and in cases where it is important that all doubt shall be removed, recourse must be had to examination *per vaginam.*

Duration of Pregnancy.—That the period of human utero-gestation is, in a majority of cases, about nine calendar months, all are agreed. But there is much discrepancy of opinion with regard to the limits of the deviations from this period. This difference is owing, to some extent, no doubt, to the difficulty of fixing the exact time of conception. It is certainly impossible to determine how much beyond the ordinary or normal period gestation may extend in a given case. But it is safe to say that it seldom varies many days from thirty-nine or forty weeks. According to the French code, the legitimacy of a child born 300 days after the dissolution of marriage may be contested; but many authors think this period too limited. In the celebrated Gardner Peerage case, referred to in most of the works on Medical Jurisprudence, the London physicians disagreed very greatly, as physicians usually do in medico-legal cases. While five of them maintained that the period of gestation in woman was limited to 280 days, twelve of them were of opinion that it might be protracted to 311 days. The University of Heidelberg allowed the legitimacy of a child born thirteen months after the date of the last intercourse; and the Supreme Court of Friesland decided in favor of the legitimacy of a child born 303 days after the husband's death. These may be examples of judicial philanthropy, but here, as everywhere where there is a doubt, the accused party is entitled to the benefit of it.

In Pennsylvania two cases of gestation—one protracted to 313 and the other to 317 days have been admitted as legitimate. This decision, however, though it determined the legal action in their cases, does not settle the scientific problem.

Viability of the Child.—The earliest period at which it is capable of carrying on an independent existence is involved in the same uncertainty as is the extreme limit of the period of utero-gestation. It is often an important question in medico-legal investigations, yet never admits of positive demonstration. The period generally assigned is the end of the seventh month; and this is quite correct as a general rule, but there are many exceptions. On good authority cases are recorded in which children have lived for weeks and months, and in some instances have been reared to adult age, and distinguished themselves by great physical and intellectual power, who were born at or near the end of the sixth month.

The Decidua.—Soon after conception occurs, a flocculent exudation covers the inner surface of the uterus, constituting, in a few days thereafter, a soft, pulpy membrane termed the *decidua*. Its principal object is the protection of the embryon. Whether this decidua is a changed condition—a special development—of the mucous membrane, or a new formation, has been a point in dispute, but it is now generally regarded as the former.

FIG. 63.

DECIDUA UTERI.

In Fig. 63 the dark shade, over and between the villi, represents the decidua. The uterine vessels are seen extending into the decidua and forming loops there. The cut is a representation of the decidua very soon after conception, when it is in a pulpy state; the villi of the mucous membrane of the uterus which, in the non-pregnant state are very short, are found remarkably elongated, while over them extends an effused substance, not yet organized, but evidently the incipient decidua.

FIG. 64.

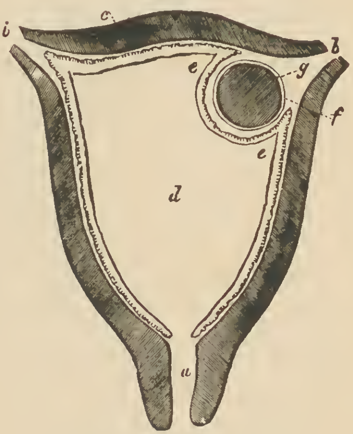
UTERINE CAVITY.

Section of the uterus about eight days after impregnation, its cavity surrounded by the exudation which constitutes the incipient decidua.

a. Cervix or neck of uterus. *b*, *b*. Orifices of the Fallopian tubes. *c*. Decidua vera. *d*. Cavity of the uterus.

The arrangement and structure of the decidua have not yet been fully determined by anatomists. Some of those who entertain the opinion that normally, impregnation takes place in the ovary, believe that the decidua is formed prior to the arrival of the ovum in the uterus, and that the ovum on passing into the uterine cavity becomes involved in the secretion (which covers the surface of the uterus), and absorbs a portion of it for nutrient material, while the remainder is organized into a double membrane—one corresponding to the uterus, the other adhering to the ovum. When, according to this view, the ovum reaches the cornua of the uterus, it pushes the decidua before it, the projecting portion constituting the *tunica decidua reflexa,* which envelopes the whole ovum except the part where the decidua is detached from the uterus, which is the seat of the future placenta. MM. Velpeau, Wagner, Payet, Kirkes and others adopt this view; but other authors of equal reputation, after dilligent investigation, have concluded that it is impossible for so small a body as the ovum to perform so difficult a task.

FIG. 65.

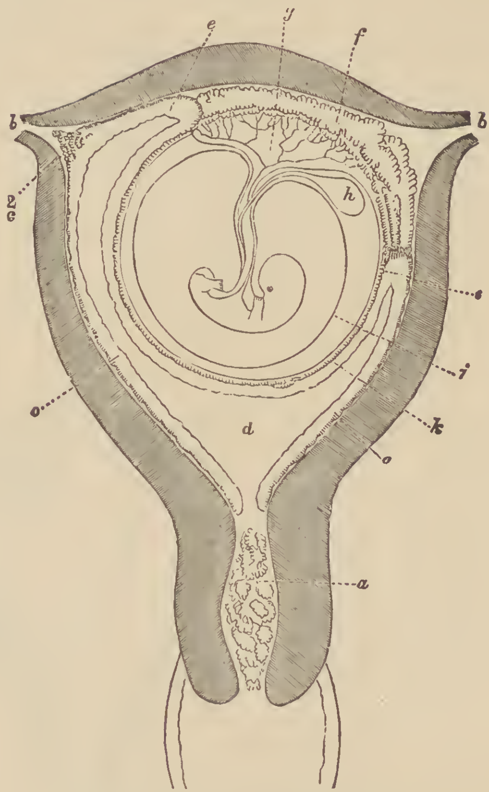


OVUM ENTERING UTERUS.

f. Ovum surrounded by its chorion, *g.* *a.* Cervix. *b, b.* Fallopian tubes. *c.* Decidua vera. *d.* Cavity of the uterus. *e.* Decidua reflexa.

Prof. Sharpey, with Dr. William Hunter, regards the structures of the decidua and the decidua reflexa as different, and the decidua vera as a new production, the development of which is simultaneous with that of the ovum. At the point of supposed reflection there is found a substance precisely similar to the decidua reflexa, which attaches the ovum to the side of the uterus; this has been termed the *decidua serotina.*

FIG. 66.



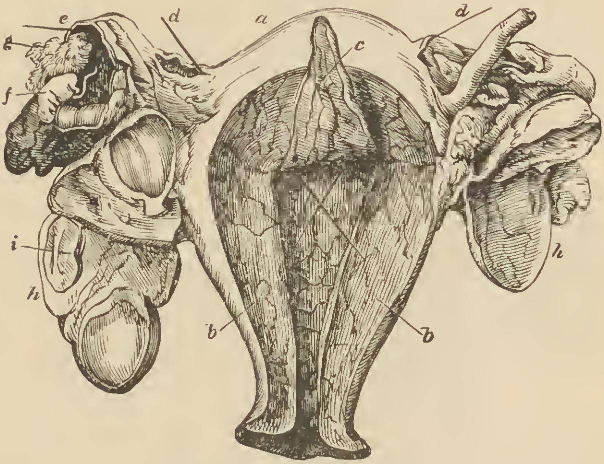
UTERUS NEARLY FILLED WITH THE OVUM.

Section of the uterus with the ovum somewhat advanced, and almost completely occupying the uterine cavity.

a. Muco-gelatinous substance blocking up the os uteri. *b*, *b*. Fallopian tubes. *c*, *c*. Decidua vera prolonged, at *c* 2, into the Fallopian tube. *d*. Cavity of the uterus. *e*, *e*. Angles at which decidua vera is reflected. *f*. Decidua serotina. *g*. Allantois. *h*. Umbilicle vesicle. *i*. Amnion. *k*. Chorion, lined with outer fold of serous tunic.

Professor Dalton regards the *decidua* as the "uterine mucous membrane, developed and hypertrophied," which "becomes exfoliated and thrown off at the same time that the egg itself is finally discharged." Perhaps this opinion is the result of

FIG. 67.



EXTRA-UTERINE PREGNANCY.

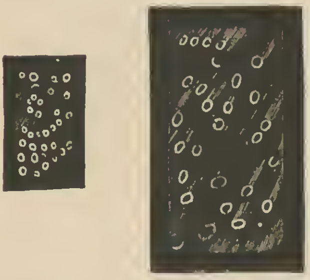
Occurring in the right Fallopian tube.

a. Uterus, its cavities laid open. *b*. Uterine walls thickened, as in normal pregnancy. *c*. Portion of decidua separated from its inner surface, *d*. Bristles to show the direction of the Fallopian tubes. *e*. Right Fallopian tube distended into a sac which has burst, containing the extra-uterine ovum. *f*. Fetus. *g*. Chorion. *h*. Ovaries; in the right one is a well-marked corpus luteum, *i*.

confounding the "flocculent exudation" with the *excretion* which takes place in croup and similar diseases. The "exudation" of the mucous membrane of the impregnated uterus is undoubtedly a *true formation*. It is true that M. Velpeau speaks of the decidua as a "product of excretion;" but it seems to me to be a rule and a law, without any exception, that all *formative* products from the blood are *secretions.*

Whatever the origin of the decidua, whether it is an *excretion* of coagulable lymph, a hypertrophy of the uterine mucous membrane, or a *secretion* from the blood, it is certain that during the formation of the decidua reflexa both the ovum and the body of the uterus become considerably enlarged; but after the third month all of the decidua, except that portion to which the ovum first became attached, gradually becomes thinner and, in appearance, less glandular. The decidua uteri remains quite thick, especially around the placenta, until the end of gestation; but the decidua reflexa is, at this time, extremely thin. Toward the third or fourth month they touch and press upon each other; but, according to M. Velpeau and Bischoff, they are never confounded.

Fig. 68.

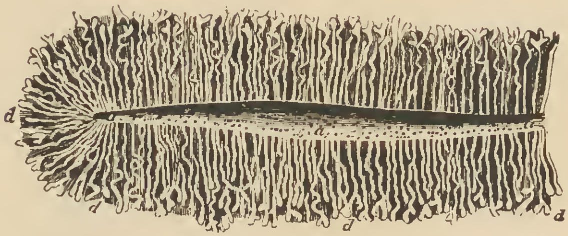


SEGMENTS OF HUMAN DECIDUA, after recent impregnation, viewed on a dark ground. They show the openings on the surface of the membrane.

M. Velpeau considered the use of the decidua to be to retain the impregnated ovum at a given point of the uterine cavity. M. Breschet affirms that it exists in all cases of extra-uterine pregnancy, and hence cannot belong to the ovum. Chaussier found it in cases of tubal gestation; Evrat supposes that one is secreted after each act of sexual intercourse; M. Pouchet thinks it is formed at each menstrual period, while Dr. Robert Lee declares that it is not found in all cases of extra-uterine pregnancy.

Weber and Sharpey do not regard the decidua as a new formation, and M. Coste says: "The only

FIG. 69.



SECTION OF THE MUCOUS MEMBRANE OF THE HUMAN UTERUS AT THE COMMENCEMENT OF PREGNANCY,

showing the arrangement and other peculiarities of the glands, *d d d*, with their orifices, *a a a*, on the internal surface of the organ. Magnified to twice the normal size.

modifications of which the uterus becomes the seat consists in the turgescence or etherism of its tissue, and more especially in a considerable thickening of its mucous membrane—a thickening which results especially from congestion of the blood vessels, and an extreme development of the glands that enter into its composition, and, in certain subjects, plait them into more or less numerous convolutions." He adds: "In the normal state neither the opening of the cervix uteri, nor that of the Fallopian tubes, is closed by membrane. They are always free, permeable, and consequently permit the ovum to pass into the cavity of the uterus; and the folds of the mucous membrane, by coming in contact, are sufficient to arrest it."

Mr. Goodwin states that the interfollicular spaces, in which the network of capallaries is situated, are occupied by a texture consisting wholly of nucleated

FIG. 70.

EXTRA-UTERINE PREGNANCY.
The fetus developing in the ovarian extremity of the Fallopian tube.

particles, "a tissue represented by Baer and Wagner as surrounding what they supposed to be uterine papillæ, and regarded by them as decidua."

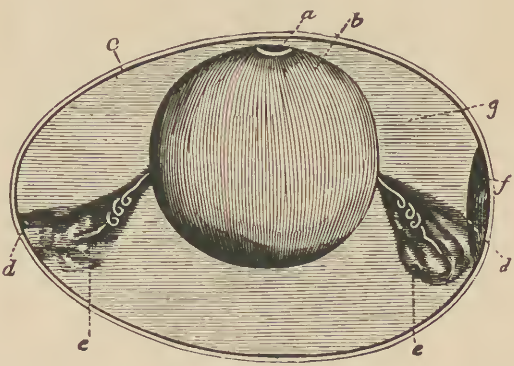
Dalton, as well as other late authors, regard the decidual membrane as intended to supply the fecundated ovum with the requisite materials for its nourishment—a proposition which its structure and manner and time of development seems to render almost self-evident. He remarks: "The uterine mucous membrane is developed during the process of gestation, in such a way as to provide for the nourishment of the fetus in the different stages of its growth. At first the whole of it is uniformly increased in thickness (decidua vera). Next, a portion of it grows upward around the egg and covers its projecting surface (decidua reflexa). Afterward, both the decidua reflexa and the greater part of the decidua vera diminish in the activity of their growth, and lose their importance as a means of nourishment for the egg; while that part which is in contact with the vascular tufts of the chorion continues to grow, becoming exceedingly developed and taking an active part in the formation of the placenta."

CHAPTER IX.

EMBRYOLOGY.

Development of the Germ.—As the process of development between the egg of a fowl and the human ovum is analogous, and as the changes which occur in the fecundated egg are more conveniently

Fig. 71.



SECTION OF A HEN'S EGG.

a. Cicatricula. *b*. Yelk. *c*. Shell membrane. *d*. Attachment of chalazæ. *e*. Chalazæ. *f*. Air chamber. *g*. Albumen.

traced than those which take place in the impregnated ovum, it will be profitable to examine the data which have been furnished by the observations made with respect to both.

When the ovum of the mammalia leaves the ovary it consists of the yelk or vitellus contained in its membrane, the germinal vesicle and the germinal spot. The yelk, as we have seen, serves the same purpose for the animal as the oily and starchy matters in the seeds serve for the plant. It is the nutriment of the embryo. In its passage through the oviduct, the yelk is gradually exhausted, and the albumen, or white, supplies its place. Carpenter says: "Our knowledge of the first stages of the developmental process in the mammalian

Fig. 72.

CLEAVING OF THE YELK AFTER FECUNDATION.

A B C. Ovum of ascaris nigrovenosa. *D* and *E.* Ovum of ascaris acuminata.

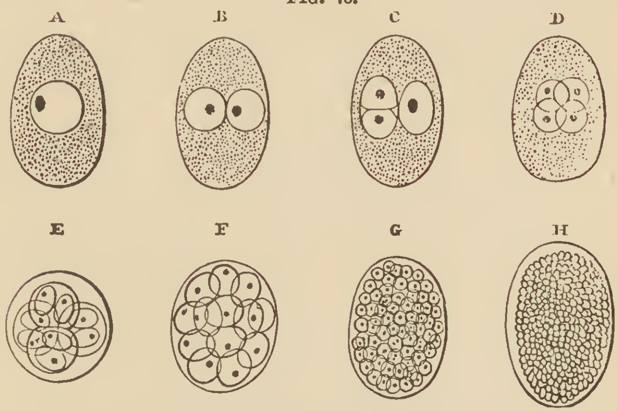
ovum is, in many respects, incomplete; and it is requisite to interpret what has been obscurely seen in the ova of this class, by the clearer views derived from observation of those of the lower animals. As already stated, the germinal vesicle disappears at or about the time of fecundation; but its disappearance is not a result of fecundation, since it also takes place in the unimpregnated egg, in consequence, it may be presumed, of the completion of its term of life, and of those operations which it was developed to perform. Its place is seen to be occupied, at an early period after fecundation, by a new and peculiar cell, the origin of which is obscure, but the destination of which is most important; for it is by the duplicative subdivision of this cell, first into two, then into four, then into eight, and so on, and by the metamorphoses which its progeny undergo, that the whole embryonic fabric is gradually evolved; hence, this cell may be termed the *embryo cell*. At the same time, a peculiar change begins to take place in the yelk, the whole sphere of which is just marked out by a furrow into two hemispheres, and is at last completely divided by the extension of this center; each half is again furrowed and then cleft in the same manner, and thus the entire yelk is broken up into a mass of segments."

Segmentation of the Vitellus.—This process of duplication of cells, which Kolliker and Bagge have depicted as seen in the ova of certain parasitic worms, in which it presents itself in the least complex form, continues, the cells becoming progressively smaller, until a large mass of cells are produced, the whole assuming the form of the embryo.

In some entozoa the embryonic portion is embedded in the interior of the vitellus, and as the cells multiply they appropriate the surrounding nutrient matter, until the whole yelk is exhausted, and the original yelk-membrane is filled with a mulberry-like mass of cells. But more commonly each cell formed by the cleaving of the embryonic vesicle appropriates a certain portion of the yelk.

"These changes," says Carpenter, "take place in the mammalian ovum during its transit along the Fallopian tube to the uterus, so that by the time of its arrival there, the whole cavity of the

FIG. 73.



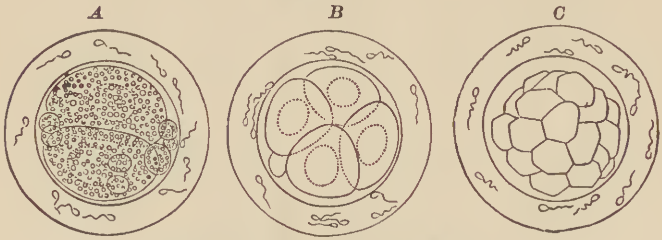
DUPLICATION OF CELLS.

A B C D. Successive stages of the ovum of ascaris dentata, showing the duplication of the cells. *E F G H.* Ovum of cucullanus elegans, showing the advance of the process.

zona pellucida is occupied by minute sphericles of yelk, each containing a transparent vesicle, the aggregation of which gives it a mulberry-like aspect; and by a continuance of the same process of subdivision, the component segments becoming more and more minute, the mass comes to present a fine granular aspect."

THE BLASTODERMIC MEMBRANE.—By the time that the "vitelline spheres" have become subdivided into the "mulberry-shaped mass," they are *supposed* to be transformed into true animal cells, which, adhering by adjacent edges form a continu-

FIG. 74.

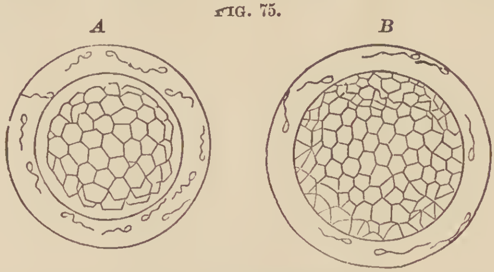


SEGMENTATION OF MAMMALIAN OVUM.

A. First division into two halves. *B*. Subdivision of each half into two. *C*. Further subdivision, producing numerous segments.

ous organized membrane. This is the *Blastodermic Membrane,* also called the *germinal* membrane. This membrane soon divides into two layers termed

FIG. 75.

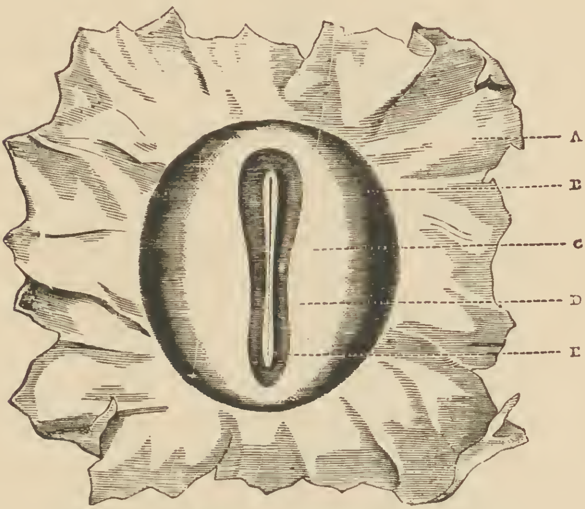


LATER STAGE OF SEGMENTATION.

A. The "mulberry mass," formed by the minute subdivisions of the vitelline spheres. *B*. A further increase has brought its surface into contact with the vitelline membrane, against which the spherules are flattened. Traces of spermatozoa are still present.

the *external* and *internal layers.* Says Dalton: "They are both still composed exclusively of cells; but those of the external layer are usually smaller and more compact, while those of the internal layer are rather larger and looser in texture. The egg then presents the appearance of a globular sac, the walls of which consist of three concentric layers, lying in contact with and inclosing each other, viz.: 1. The structureless vitelline membrane on the out-

FIG. 76.



GERMINAL MEMBRANE OF THE OVUM OF A BITCH.

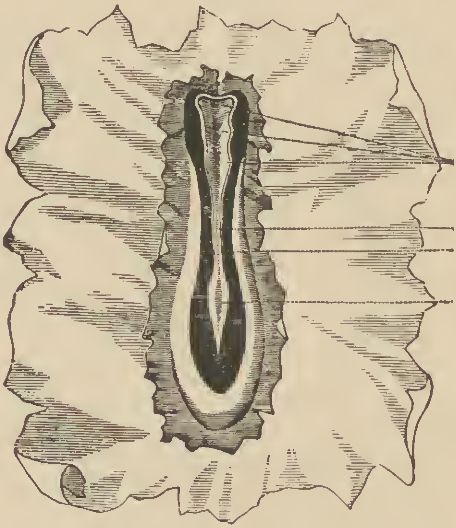
A portion with the area pellucida and rudiments of the embryo magnified ten diameters.

A. Germinal membrane. *B*. Area vasculosa. *C*. Area pellucida. *D*. Laminæ dorsales. *E*. Primitive groove, bounded laterally by the pale pellucid substance of which the central nervous system is composed.

side; 2. The external layer of the blastodermic membrane, composed of cells; 3. The internal layer of the blastodermic membrane, also covered with cells. The cavity of the egg is occupied by a transparent fluid, as above mentioned.

"This entire process of the segmentation of the vitellus and the formation of the blastodermic membrane is one of the most remarkable and important of all changes which take place during the development of the egg. It is by this process that the simple globular mass of the vitellus,

FIG. 77.



EMBRYONIC RUDIMENTS, FROM THE OVUM OF A BITCH.

A. The primitive groove, not yet closed: at its upper or cephalic end it presents three dilatations, *B*, which correspond to the three divisions or vesicle of the brain. At its lower extremity the groove presents a lancet-shaped dilatation (*sinus rhomboidalis*), *C*. The margins of the groove consist of pellucid nerve-substance. Along the bottom of the groove is observed a faint streak, which is probably the chorda dorsalis. *D*. Vertebral plates.

composed of an albuminous matter and oily globules, is converted into an organized structure. The blastodermic membrane, though consisting only of cells nearly uniform in size and shape, is nevertheless a truly organized membrane, made up of fully-formed anatomical elements. It is, moreover, the first sign of distinct organization which makes its appearance in the egg; and as soon as it is completed, the body of the new fetus is formed. The blastodermic membrane is, in fact, the body of the fetus."

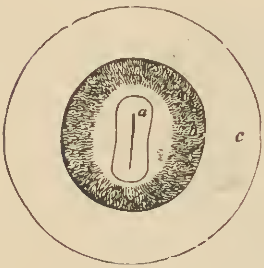
The development of the egg commences in the same way in all classes of animals. All of the organs of the fetus commence their development with the two layers of the blastodermic membrane, the spinal column and all the organs of universal life—the cerebro-spinal system—being developed by the external layer, while the intestinal canal and all the organs of vegetative life—the organic system—are developed by the internal layer. The external layer has also been termed *serous* or *animal*, while the internal has been called *mucous* or *vegetative.*

The *area germinativa* changes from a rounded form to that of an oval, and then becomes pyriform in shape, during which changes a clear space is seen in the center. This is the *area pellucida*, bounded externally by an opaque circle which subsequently becomes the *area vasculosa*, in which blood vessels are first developed. The embryo first appears in the serous, external, or animal layer of the blastodermic or germinal membrane, in the center of the area pellucida, consisting of a trace or streak termed *primitive groove*, with two oval marks (laminæ dorsales) on each side. As these become more raised, the elevated points approach each other, and ultimately convert the groove into a tube, which is the seat of the future great central organs of the nervous system—the brain and spinal cord. At the same time, the rudiments of the vertebral column, termed *chorda dorsalis,* are seen in a row of cells on a line parallel with the primitive groove.

While the dorsal laminæ are closing the primitive goove by an approximation of their raised portions, prolongations of the internal layer of the germinal membrane extend from the lower margin of each. The prolongations are termed visceral or ventral laminæ—*laminæ ventrales seu viscerales.* The ventral laminæ, extending downward and inward toward the cavity of the yelk, unite and form the interior wall of the trunk. At the same time an accumulation of cells between the external and internal layers of the germinal membranes become arranged into a distinct structure or layer termed the *vascular.* In this vascular membrane the first vessels of the embryo are developed.

Incubation.—As the vascular layer develops, the *insulæ sanguinus,* or blood dots, appear at the circumference of the vascular area, and, gradually uniting, form vessels which have a circular shape and retiform appearance, and are filled with blood. These vessels have been termed *venous circle* (*circulus venosus*), and *terminal vein* or *sinus* (*vena seu* *sinus terminalis*). These vessels, constituting the *vascular area*, or *figura venosus*, are generally extended over the whole surface of the membrane that contains the yelk, as seen in Figs. 79, 80 and 81, which are representations of the chick at different stages of incubation.

FIG. 78.



VASCULAR AREA IN THE CHICK THIRTY-SIX HOURS AFTER INCUBATION.

a. Yelk. *b*. Fiddle-shaped pellucid area, in the middle of which is the embryo. In the vascular area, *c c*, the blood islets (*insulæ sanguinus*) begin to appear.

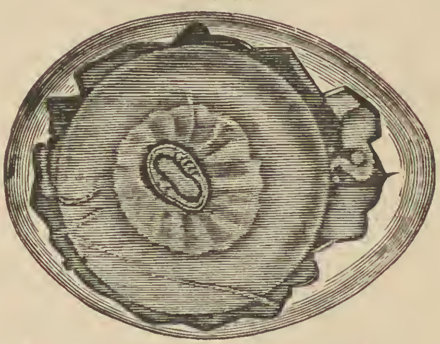
Fig. 88 shows the network of blood vessels in the vascular lamina of the germinal membrane and the trunks of the omphalo-mesenteric veins entering the lower part of the S-shaped heart. The first part of the aorta is also seen.

When the parieties of the abdomen are formed, which takes place at an early period of embryonic life, by a constriction in the fold of the germinal membrane, the yelk-sac becomes the *umbilical vesicle* (*vesicula umbilicalis*). See Fig. 83.

As the umbilical vesicle, whose walls are formed of the several layers of the blastodermic membrane, develops, another vesicle extends from the caudal extremity of the embryo. This is the *allantois*, or *allantoid vesicle*, which is seen in several stages of development, both in the egg of the hen and in the human ovum, in the following figures.

The walls of the allantois, when developed, become very vascular, and contain the ramifications

FIG. 79.



EGG THIRTY-SIX HOURS AFTER INCUBATION.

of the subsequent umbilical arteries and umbilical vein. It is regarded as a temporary organ of respiration, by bringing the vessels of the chick in

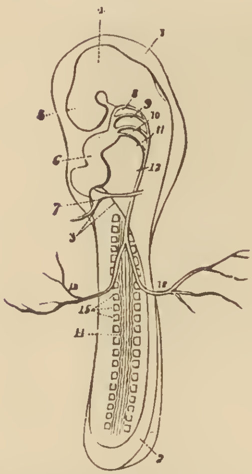
FIG. 80.

EGG THREE DAYS AFTER INCUBATION.

relation with atmospheric air, and, in the mammalia, conveying the embryonic vessels to and from the chorion.

The allantois is divided at the umbilicus by a closing of the visceral laminæ in the abdominal cavity into two partitions, the larger of which proceeds with the umbilical vessels to the chorion, while the smaller is retained in the abdomen and converted into the urinary bladder, the two portions being connected by the *urachus*.

FIG. 81



EMBRYON OF THE CHICK AT THE COMMENCEMENT OF THE THIRD DAY, as seen from the abdominal aspect.

4. Prominence of the corpora quadrigemina, or optic lobes of the brain. 5. Anterior cerebral mass or hemispheres. 6. Heart. 7. Entrance of the great venous trunks in the atrium cordis or auricle. 8, 9, 10 and 11. The four aortic arches. 12. The descending aorta. 13. Arteries of the germinal membrane. 14. The dorsal lamina, rendered slightly wavy by the action of water. 15. Rudiments of the vertebræ.

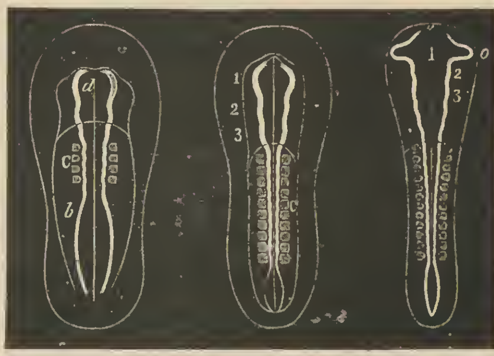
While the changes above mentioned are taking place, the cephalic, caudal and lateral edges of the internal layer of the blastodermic membrane are elevated in the form of two folds, extended over the body of the embryon, and, meeting on its dorsal aspect, inclose it in a double envelope, the inner layer of which forms the sac of the amnion, while the external layer lines the inner surface of the chorion.

The mode of the development of the umbilical vesicle is represented in Figs. 84, 85 and 89.

Figs. 91, 92, 93 and 94 represent the human ovum in various stages of progress till three weeks old;

FIG. 82.

A B C

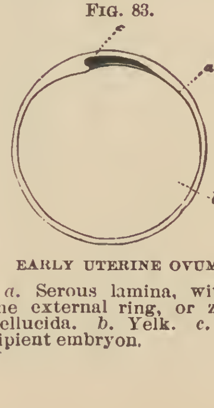


DEVELOPMENT OF THE NERVOUS SYSTEM OF THE CHICK.

A. The two primitive halves of the nervous system, twenty-four hours after incubation; B, the same, thirty-six hours after; C, the same, at a more advanced stage. c, the two primitive halves of the vertebræ; *d*, anterior dilitation of the neural canal; *b*, posterior dilatation (the lumbar enlargement); 1, 2, 3, anterior, middle and inferior cerebral vesicles; *a*, slight flattening of the anterior cerebral vesicle; *o*, formation of the ocular vesicles.

but the data on which our calculations as to time are predicated, manifestly cannot be very exact. Says Dunglison: "From the difficulty of appreciating the exact age of any ovum or its contained embryo, it is impracticable to assign any precise weight or measurement, or, indeed, any special development to the different periods of intra-

FIG. 83.



EARLY UTERINE OVUM.

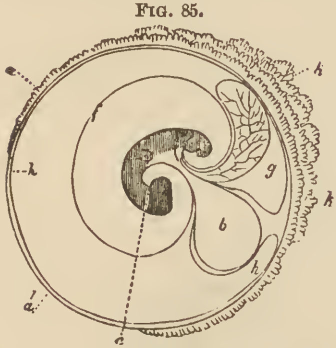
a. Serous lamina, within the external ring, or zona pellucida. *b*. Yelk. *c*. Incipient embryon.

FIG. 84.

FORMATION OF THE AMNION by the arching over of the serous lamina.

a. Chorion. *b*. Yelk-bag, surrounded by serous and vascular lamina. *c*. Embryon. *d e f*. External and internal folds of the serous layer, forming the amnion. *g*. Incipient allantois.

FIG. 85.



HUMAN OVUM IN SECOND MONTH.

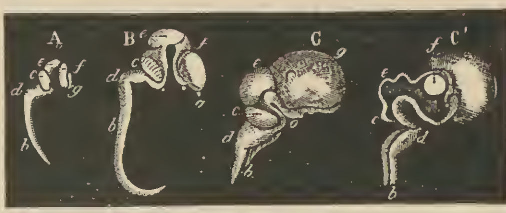
a 1. Smooth portion of chorion. *a* 2. Villous portion of chorion. *k k*. Elongated vill beginning to collect into placenta. *b*. Yelk-sac, or umbilical vesicle. *c*. Embryon. *f*. Amnion (inner layer). *g*. Allantois. *h*. Amnion (outer layer) coalescing with chorion.

uterine existence. The discordance among observers is indeed extreme."

The force of this remark will be still better appreciated when it is considered that it is not yet settled whether impregnation really takes place in the majority of cases, and hence normally, in the uterus or in the Fallopian tubes of the human female.

The weight of the embryon at the end of the second week is, as near as has been ascertained, about one grain, and its length about one-twelfth of an inch. At the end of the third week its size and shape have been compared to a large ant or a grain of barley. On the thirtieth day the situation of the upper and lower extremities become visible; the length has increased to one-third of an inch, and the rudiments of the principal organs are apparent. About the

FIG. 86.



DEVELOPMENT OF THE SPINAL CORD AND BRAIN OF THE HUMAN SUBJECT.

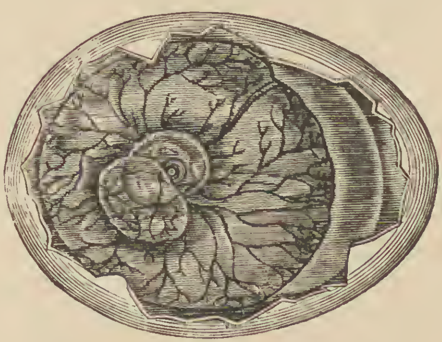
A. Brain and spinal cord of an embryon of seven weeks; lateral view.

B. The same, from an embryon farther advanced in development. *b.* Spinal cord. *d.* Enlargement of spinal cord with its anterior curvature. *c.* Cerebellum. *e.* Tubercula quadrigemina. *f.* Optic thalamus. *g.* Cerebral hemispheres.

C. Brain and spinal cord of an embryon of eleven weeks. *b.* Spinal cord. *d.* Enlargement of the spinal cord, with its anterior curvature. *c.* Cerebellum. *e.* Tubercula quadrigemina. *g.* Cerebral hemispheres. *o.* Optic nerve of the left side.

C'. The same parts in a vertical section in the median line from before backward. *b.* Membrane of the spinal cord turned backward. *d.* Second curvature of the upper portion of the spinal cord, which has become thickened and constitutes the peduncles of the cerebrum. *e.* Tubercula quadrigemina. *f.* Optic thalami covered by the hemispheres.

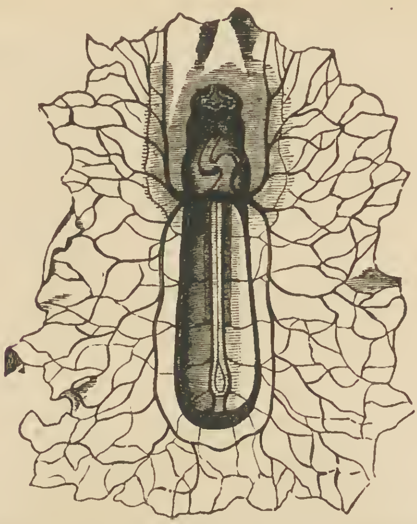
FIG. 87.



EGG FIVE DAYS AFTER INCUBATION.

fortieth day the shape of the child may be recognized, when, in anatomical parlance, it ceases to be the embryon and becomes the *fetus*. Some anatomists, however, do not apply the term fetus to the embryon until after the beginning of the fourth month, when its motions in utero are noticed by the mother. This is called the *period of quickening.*

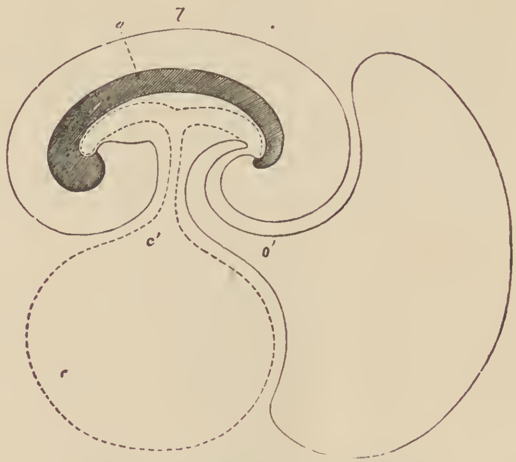
FIG. 88.



EMBRYON FROM A BITCH AT THE TWENTY-FOURTH OR TWENTY-FIFTH DAY.
Magnified ten diameters.

The head is very large in proportion to the body; the trunk is elongated and pointed; the limbs resemble the shoots of vegetables; dark points or lines indicate the existence of the eyes, mouth and nose, and parallel points indicate the situation of the vertebra. The length is nearly one inch or about ten lines.

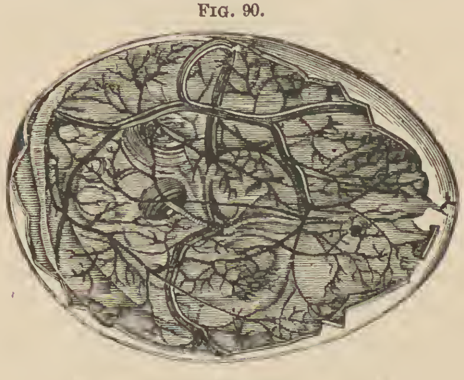
FIG. 89.



UMBILICAL VESICLE AND ALLANTOIS.

a. Dorsal structures of the embryon. *b*. The amnion. *c*. Yelk sac or umbilical vesicle. *c'*. Vitelline duct or pedicle of the umbilical vesicle. *o*. Allantois. *o'*. Urachus.

FIG. 90.



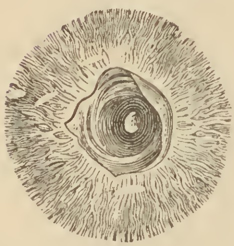
EGG TEN DAYS AFTER INCUBATION.

In the second month nearly all of the parts are apparent. The eyelids are well-defined and extremely transparent; the nose projects, the mouth enlarges and open, the fingers and toes are distinct.

FIG. 91.

OVUM FOURTEEN DAYS OLD.

FIG. 92.



OVUM AND EMBRYON FIFTEEN DAYS OLD.

In the third month the eyelids are more developed and firmly closed; the *meatus auditorius* is indicated by an opening in the pavilion of the ear; the sides of the nose—*a la nasi*—are distinguishable; the lips are distinct, and the mouth shut. During this month the genital organs are rapidly developed. The penis is long; the scrotum fre-

FIG. 93.

OVUM AND EMBRYON THREE WEEKS OLD.

quently contains a little water, but the testes are absent. The vulva is apparent, and the clitoris very prominent. The brain is considerably devel-

FIG. 94.

HUMAN EMBRYON, THIRD WEEK.
Showing villi covering entire chorion.

oped though still pulpy, as is the spinal cord. The lungs are insignificant, but the liver is large. The heart's action is easily detected. The upper and lower limbs are fully developed. The fetus is now three and half inches in length, and weighs two and a half ounces.

FIG. 95.

FETUS AT FORTY-FIVE DAYS.

FIG. 96.

FETUS AT TWO MONTHS.

During the fourth month the head and liver increase less in proportion than the other parts; the muscular system becomes distinct, and slight movements are manifested. At the end of four months and a half the length of the fetus has increased to five or six inches, and the weight to four or five ounces.

FIG. 97.

FETUS AT THREE MONTHS IN ITS MEMBRANES.

During the fifth month the muscular system becomes well marked, and the movements of the fetus active and unequivocal. The head is still disproportionately large, and begins to be covered with small, silvery hairs. The length is seven to nine inches; weight, six to eight ounces.

In the sixth month the derma or true skin begins to be distinguishable from the epidermis or cuticle. The skin is of a purple color, smooth and delicate, and, owing to the absence of adipose matter in the subcutaneous areolar tissue, seems plaited or wrinkled. The scrotum is small and of a deep red color; the vulva prominent, its lips separated, and the clitoris projecting; the nails are formed. The length is ten or twelve inches, and the weight nearly two pounds. Fetuses born at this period usually breathe and cry for a short time, but are rarely viable.

During the seventh month all parts of the body very nearly attain their permanent proportions. The head occupies the lower portion of the uterine cavity, and is directed toward its mouth or orifice—*os uteri*. The finger passed into the vagina readily detects it as a rounded, firm, but movable body. The eyelids begin to separate, and the *membrana pupillaris*, which previously closed the pupil, begins to disappear; the whole form becomes more rotund from the increase of fat; the skin is redder, and its sebaceous follicles excrete a white cheesy substance termed *vernix caseosa*. The length at seven months is about fourteen inches, and its weight nearly three pounds.

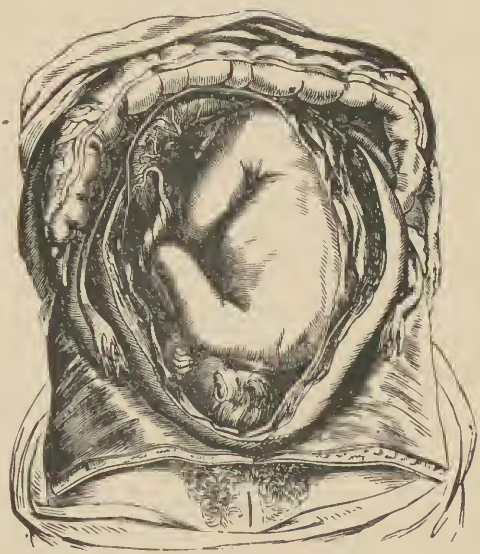
In the eighth month the fetus develops proportionably more in breadth than in length, and the child at this period is regarded as capable of maintaining an independent existence. The testicles, which were formed within the abdominal parieties, descend into the scrotum; the ossification of the bones of the skull, ribs and limbs is nearly completed; the nails are also completely formed. The length is sixteen inches, and the weight upward of four pounds.

At the end of nine months the length of the fetus is ordinarily eighteen or twenty inches, and the average weight six to eight pounds. It is then fully matured—the normal period of pregnancy, or *full term*, being generally reckoned at about 280 days.

Numerous cases are, however, on record in which the measurement and weight greatly exceed the above calculations. In some well authenticated cases the child at birth has measured twenty-four inches in length; and obstetricians of character and experience have published cases of children weighing at birth from ten to fifteen pounds. One or two cases are recorded in which the weight exceeded seventeen pounds. In the case of twins the weight of each is usually somewhat less than in uniparous cases, but their united weight is greater. M. Duges, of Paris, ascertained the average weight of 144 twins to be four pounds, the extreme weights being three and eight pounds. It should be remarked, however, that the tables furnished by authors, on the length and weight of fetuses at different periods of gestation and at birth, are considerably discordant, as all observations must be when the subjects of them are suffering under a great number and variety of abnormal conditions; and this difficulty is further complicated by the ignorance or uncertainty that exists respecting the changes which the embryo undergoes during the early period of its existence.

POSITION OF THE FETUS.—The cause of the position of the fetus in utero, during the various periods

FIG. 98.



FULL PERIOD OF UTERO-GESTATION.

of gestation, has not been very clearly explained. The "law of gravitation" which, it is assumed, *draws* the more weighty head to the lowest part of the uterine cavity, is more the expression of a theory than of a fact. Professor Simpson and others are of opinion that, until about the sixth month, the normal position of the head is uppermost, and that the change of position is then a vital act, dependent on the motions of the fetus. Certain it is, that the position with the head downward—which is the usual and only strictly normal position—is best adapted to the process of delivery. This position is shown in figure 98.

As seen in the cut, the body is bent forward; the chin rests on the breast; the back of the head, *occiput*, toward the brim of the pelvis; one or both arms lying upon the face, and both approximated in front; the thighs flexed upon the abdomen; the knees apart; the legs drawn up and crossed; the feet bent upon the anterior surface of the legs—the whole body forming an oval whose diameter is about ten inches.

FETAL DEPENDENCIES.—These are: 1. The two membranes which constitute the parieties of the ovule, the external of which is called *chorion*, and the internal, which contains a fluid in which the fetus floats, is called *amnion* or *amnios;* 2. The *placenta*, a spongy, vascular body, external to the chorion, covering about one-fourth of the ovule, and connecting it with the uterus; 3. The *umbilical cord* or *navel string*, containing the blood vessels which maintain the circulation between the placenta and the fetus; 4. The *umbilical* and *allantoid* vesicles.

The *Chorion,* according to M. Velpeau, becomes thick, opaque, resisting and flocculent at both surfaces, about the twelfth day after conception; but as the normal *place* for impregnation is yet a disputed problem, the authors do not agree *where* the ovum receives the chorion. Some think it is received as the ovum passes along the Fallopian tube; others maintain that it is formed in the ovary; while others, taking the opposite extreme, contend that it is produced in the uterus. The inner surface of the chorion corresponds to the amnion; and the two membranes, in early fetal life, are separated by an albuminous fluid. At the end of about three months this fluid disappears, when the membranes are in contact. By some anatomists the chorion is regarded as consisting of two layers, the external of which is called *exochorion,* and the internal *endochorion.*

The *Amnion,* which lines the inner surface of the chorion, contains the fetus, and is filled with a serous fluid. In the early period of fetal existence it adheres to the chorion only by a point, which corresponds to the abdomen of the fetus. The other parts of the membranes are separated by the serous fluid above mentioned, which is termed *false liquor amnii.* The membranes subsequently coalesce; but the adhesion, except at the placenta and umbilical cord, is very feeble. As pregnancy advances this membrane becomes thicker, and at full term is much tougher and more tenacious than the chorion. Both the amnion and the chorion cover the fetal surface of the placenta, envelop the umbilical cord, and, extending to the umbilicus of the fetus, there become blended with the skin. The serous fluid—*liquor amnii*—contained within the amnion, is transparent in early fetal life, but at full term the flocculi of an albuminous substance give it a milky appearance. It has a saline taste,

FIG. 99.

MATERNAL SURFACE OF THE PLACENTA.

a spermatic odor and a viscid and gelatinous consistence. According to the analysis of Vauquelin and Buniva its solid consituents—albumen, chloride of sodium, soda, phosphate of lime and lime—amount to only 1.2 parts in 100, the remainder, 98.8, being water. The analysis, however, by no means proves that all of these ingredients are *normal* constituents, nor that they exist *normally* in the above quantities or proportions.

The quantity of fluid contained in the amnion is in inverse ratio to the size of the fetus. The source of this fluid is not yet well ascertained, some physiologists ascribing it to the mother, others to the fetus. Its quantity varies from a few ounces to three or four pints.

The *Placenta*, or *after-birth*, is a soft, flat, spongy, highly vascular body, in most cases of a circular

Fig. 100.

FETAL SURFACE OF THE PLACENTA.

shape, but sometimes assuming the oval form. It is the medium of communication between the mother and child, its office being to supply nutrient material to the fetus. It is usually from six to eight inches in diameter, and from an inch to an inch and a half in thickness at its center, gradually becoming thinner toward its circumference. Its average weight is about one pound. One of its surfaces corresponds to the fetus, the other to the uterus.

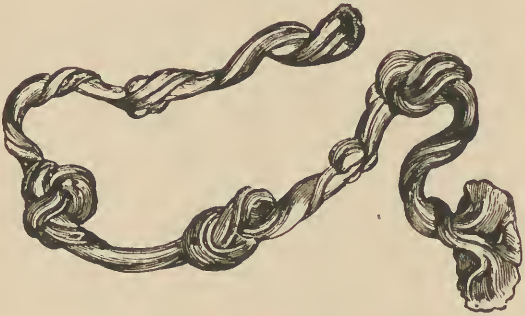
The distribution of the umbilical arteries and veins give to the fetal surface an arborescent appearance resembling the branches of a tree; it has also been called membranous, because both the chorion and amnion pass over it. The fetal surface is smooth and glistening. The maternal or uterine surface is in contact with the uterus, and after its detachment it exhibits an irregular, broken aspect.

There is, probably, no direct vascular connection between the mother and fetus, the blood vessels of the maternal portion of the placenta not being continuous with those of the fetal portion. The contrary opinion has long been held; but it seems now to be well established that physiologically, the pla centa consists of two distinct parts, each having a circulation independent of that of the other. The circulating vessels on the fetal surface are those of the umbilical cord, while utero-placental vessels maintain the circulation on the maternal surface. It is stated, also, as a further evidence that these circulations are distinct, that the size and relative number of the red corpuscles which are found in the blood of the parent differ from those found in the blood of the fetus, and that there is also a difference in the relative amount of fibrin and albumen.

The fact that madder administered to a pregnant female will readily color the bones of the fetus, only proves the permeability of the two sets of vessels in the placenta. The formation of the placenta does not commence until the second month of pregnancy.

The *Umbilical Cord* (*Funis umbilicus*) is the channel of communication between the fetus and the placenta. It is composed of two arteries and one vein, and its length, at all periods of fetal development, is generally about equal to that of the body of the fetus. The arteries convey the *impure* blood of the fetus to the placenta, while

Fig. 101.



KNOTTED UMBILICAL CORD.

the vein carries *arterial* blood from the placenta to the fetus. This may seem like a contradiction of terms; but it must be recollected that, in the language of anatomy, a vein is a blood vessel going toward the heart, while an artery is a blood vessel proceeding from the heart, this organ being regarded as the center of circulation.

At the end of five or six weeks after conception the cord is straight, shut and very large, owing to its containing a portion of the intestinal canal, presenting, also, three or four enlargements or dilatations, which gradually disappear, after which the cord lengthens and becomes smaller. It is frequently knotted and twisted as represented in the cut. After the fifth week the umbilical cord contains, in addition to the duct of the umbilical vesicle, the omphalo-mesenteric vessels and a portion of the allantoid vesicle and intestines.

The *Umbilical Vesicle,* termed also *vesicula alba* and *intestinal vesicle,* was unknown to the ancients, and some of the modern authors are disposed to regard it as an abnormal product. It seems to be situate between the chorion and amnion, and to disappear about the sixth or seventh week.

FETAL PECULIARITIES.—The head is disproportionately large, and the bones of the skull are united by membrane—a circumstance which allows the bones to approach and even to overlap each other in the process of parturition, thus facilitating greatly the delivery of the head. These membranous or unossified portions are important guides to the midwife in determining the position, or "presentation," of the head. In the anterior superior portion of the skull is a soft depression, having four angles, termed the *anterior fontanelle,* and in the posterior superior portion, having three angles termed the *posterior fontanelle.* When the head presents in the best possible position for delivery, the finger of the accoucheur, on being passed into the uterus, readily comes in contact with the *posterior fontanelle,* which is found near the symphysis pubis, while the anterior fontanelle will be toward the sacrum, on the opposite side of the pelvic cavity.

In the upper part of the thorax, situate in the superior mediastinum over the upper portion of the pericardium, is a large glandular structure termed

FIG. 102.

SECTION OF THYMUS GLAND.

Thymus. Its greatest bulk is usually attained near the end of embryonic life, although in some cases it is said to have increased slightly after birth. But in most cases it rapidly diminishes after birth, becoming very small at adult age, and almost or quite undistinguishable in old age. Its average weight at birth is about half an ounce. It has no excretory duct, is well supplied with nerves, and contains a fluid resembling chyle or cream. Its function is unknown; but I have no doubt it is one of the appendages of the organic nervous system, serving as an additional source of nervous power to the nutrient system, especially in developing the pulmonary apparatus. Its structure and location are certainly in harmony with this view, as are the changes it undergoes before and after birth. Dunglison says, "It is one of the most obscure, in its physiology, of any organ of the body."

The *Thyroid Gland* has a similar history and structure and, undoubtedly, a similar function.

The *Lungs* are collapsed and dense, of a dark color, like liver, and do not fill the cavity of the chest, and, having a greater specific gravity than water, readily sink when immersed in that fluid. The mean weight of the lungs compared with the body of a full-grown fetus which has never breathed, has been calculated by M. Ploucquet as 1 to 70.

The digestive organs exhibit nothing remarkable except the presence in the bowels, at full term, of a quantity of dark or greenish feces, termed *meconium*, from its resemblance to the inspissated juice of the poppy. It consists mainly of the excretions of the liver and intestinal canal, and generally passes off without difficulty soon after the child begins to nurse. The common practice of giving purgative or even laxative medicines, whether it be castor oil or sweetened urine, to expel the meconium is exceedingly pernicious.

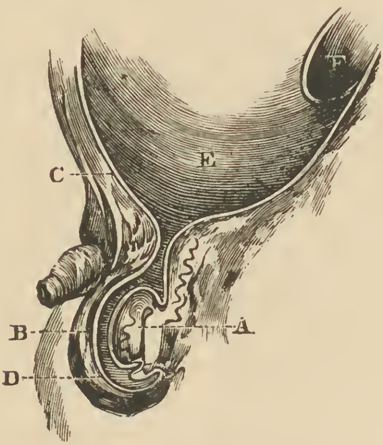
The *Liver* is very large and rapidly diminishes after birth, a part of its decarbonizing function being then transferred to the lungs.

The *Bladder* is large and elongated, and seems to possess more proportionate power than in adult life. From the fundus of the bladder a conical ligament, called the *urachus*, ascends between the umbilical arteries to the umbilicus, forming a kind of suspensory ligament to the bladder.

The development of the genital organs has occasioned many fanciful speculations with regard to the cause of sex. The sexual organs are not perceptible until near the commencement of the sixth week, when a small cleft eminence appears—the rudiment of the scrotum or vulva. Soon after an aperture becomes perceptible, which is common to the genital organs and anus. In front of this aperture is a projecting tubercle which, a week or two later, manifests a glans, and is grooved on its under surface by a channel which extends to the anus. At about the twelfth week the perineum, which separates the anus and genital organs, is formed. The sex becomes distinctly apparent about the fourteenth week; but there remains for some time a groove beneath the penis or clitoris, which is soon formed into a canal in the former case, or closed in the latter.

The *Descent of the Testes* deserves a brief explanation in this place. In the early months of embryonic life, the testicles are situate below the kidneys in the abominal cavity. At about the seventh month they are in a state of progression toward the scrotum. About the middle of the third month a sheath of peritoneum extends from the abdominal ring to the lower part of the testicle; it also contains a ligament which is termed *gubernaculum testis;* surrounding this is a thin layer of muscular fiber. known as the *creamaster*, by whose contraction the

FIG. 103.



DESCENT OF THE TESTICLE.

A. Testicle in the scrotum. B. Prolongation of the peritoneum. C. Peritoneum lining the abdomen. D. Peritoneum forming the tunica vaginalis. E. Cavity of the peritoneum. F. Kidney.

testicle is moved. During the descent the creamaster muscle is gradually everted, and when the transition is completed, it constitutes a covering or envelope external to the peritoneal sheath which immediately surrounds the gland.

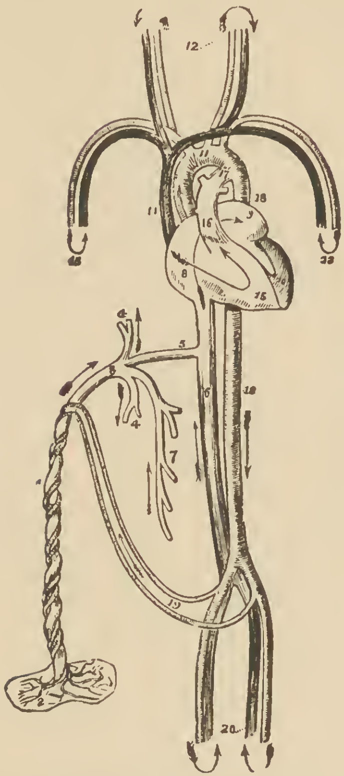
In its descent, the testicle passes successively from one portion of the peritoneum behind another immediately below; and the lowest part of the pouch formed around the testicle becomes the *tunica vaginalis testis*, while that portion of the peritoneum which descended before the testicle eventually becomes the *tunica vaginalis*, or second coat.

When the neck of the pouch does not completely close, after the testicle has reached the lower part of the scrotum, the intestines pass down, constituting congenital hernia.

The descent of the testicles is not always completed at birth: in some instances one or both will remain for weeks or months in the abdomen; and in rare cases one or both remain in the abdominal cavity during life, creating a suspicion of defect or deformity, but not materially interfering with the normal function. I have known several cases in which one testicle remained in the abdomen, and the parties were supposed to have but one testicle.

Circulation of the Fetus.—As the blood cannot circulate through the lungs of the fetus, an opening exists between the right and left auricle, called the *foramen ovale*, through which the circulating current passes from the venous to the arterial system. This foramen has a valve which allows part of the blood of the right auricle to pass through the opening into the left auricle, but prevents its return.

FIG. 104.



CIRCULATION OF THE FETUS.

1. Umbilical cord. 3. Umbilical vein divided into three branches, twc (44) to be distributed to the liver and one (5), ductus venosus, which enters the inferior vena cava (6). 7. Portal vein uniting with the right hepatic br n h. 8. Right auricle; course of blood denoted by the arrow, proceeding from 8 to 9, left auricle. 10. Left ventricle; the blood follows the course of the arrow to the arch of the aorta (11); arrows 12 and 13 indicate the return of the blood from the head and upper extremities through the jugular vein and the subclavian veins to the superior vena cava (14), to the right auricle (8), and following the direction of the arrow through the right ventricle (15), to the pulmonary artery (16). 17. Ductus arteriosus, the offsets at each side are the right and left pulmonary arteries cut off. 18 18. Descending aorta. 19. Umbilical arteries. 20. External iliacs. The arrows at the termination of these vessels mark the return of the venous blood by veins to the inferior cava.

The *Umbilical Arteries* arise from the internal iliacs, and passing by the sides of the bladder, on the outside of the peritoneum, perforate the umbilicus and proceed to the umbilical cord and placenta. The *umbilical vein*, which conveys the blood from the placenta to the fetus, arises from the radicles in the substance of the placenta. It enters the umbilicus, and passing toward the inferior surface of the liver, unites with the left branch of the vena porta hepatica, where is a vessel called the *ductus venosus*, opening into the vena cava inferior. Only a part of the blood of the umbilical vein is emptied into the liver.

The Placenta.—The placenta is the sole means of communication between mother and child; in fact, it represents, physiologically, both the respiratory and digestive organs of the adult. The impure blood is brought from the system of the fetus to the placenta, through the umbilical arteries, as already explained. Although there is supposed to to be no direct communication between the vessels of the two surfaces of the placenta, the umbilical arteries ramify and anastomose with the radicles of the umbilical vein on the fetal surface; indeed, as in all parts of the capillary system, the arteries and veins become so intimately blended as to almost baffle the researches of the anatomist, even when aided by the microscope. But, although the structural arrangement of capillary vessels cannot be very satisfactorily traced, there is no question concerning the changes which the blood undergoes in them. In the lungs of the adult the blood ex-

FIG. 105.

DIAGRAMMATIC FIGURE SHOWING THE PLACENTA AND DECIDUA.

c. Embryon. *i.* Intestine. *p.* Pedicle of the umbilical vesicle. *o.* Umbilical vesicle. *m m m.* Amnion. *a'.* Chorion. *a.* Lower end of the umbilical cord. *q q.* Vascular tufts of the chorion, constituting the fetal portion of the placenta. *n' n.* Maternal portion of the placenta. *n n.* Decidua vera. *s.* Decidua reflexa.

pels its carbonic acid gas, and probably receives more or less oxygen from the atmosphere. The fetal blood imparts its accumulated carbonic acid gas, and receives oxygen or vital air. Bedford regards this interchange of elements as an "endosmotic process." The effete material passes into the vessels of the mother, to be purified from her system through the usual channels, while her own arterial blood supplies the elements necessary for the sustenance and growth of the fetus.

This view of the connection of the circulation of mother and child, and of the dependence of the fetus on the mother for oxygenation and purification, suggests an important practical consideration. If the mother does not breathe sufficiently the child must suffer. Many a mother gives birth to a frail, scrofulous child for no reason except that during the period of gestation she is too sedentary and plethoric. I have known women of vigorous constitutions, who had given birth to several healthy children, become the mothers of children so puny and scrofulous that it was impossible for them to be raised to adult age. In many such cases the child has not vitality enough to survive but a few weeks, days or hours. The reason was that the mother had changed her active habits to passive ones, was breathing too little, and did not inhale oxygen enough to supply the needs of the intra-uterine being. Every woman who changes her habits from those of a very active to a very sedentary life, or who becomes suddenly fat or plethoric, is liable, if she become pregnant, to produce sickly and malformed offspring.

CHAPTER X.

PARTURITION.

RATIONALE OF LABOR.—*Why* the uterus expels its contents at or near the completion of nine calendar months from the date of conception, may be as difficult to explain as would be the problem why the average height of human beings is a little more than five feet, or why the earth revolves on its axes in just twenty-four hours. For all practical purposes it is enough to know that such is the law of reproduction. At that time the fetus is capable of independent existence, and at that time the uterus has acquired the organic devolpment and sensibilities which enable it to perform the momentous work of ushering into this breathing world another immortal being, "made in the image of God," and partaking more or less of the peculiar qualities of its earthly parents, its muscular fibres contract, its cavity is diminished, and its contents are expelled.

So true, so admirable, and so energetic are the manifestations of the vital instincts of the uterus on this occasion, that they seem almost like intelligences. But as the majority of women in civilized life are sadly disordered in the sexual organism, childbirth is usually attended with great pain, and often with excruciating agony.

When the fetus is expelled from its uterine cavity, before the period of viability, the process is termed *abortion* or *miscarriage*—the term abortion being usually limited to the period preceding quickening. When the expulsion occurs during the seventh or eighth month, it is termed *premature labor*.

Says Dunglison: "With respect to the causes that give rise to the extrusion, we are in utter darkness. It is in truth as inexplicable as any of the other instinctive operations of the living machine. Our knowledge appears to be limited to the fact, that when the fetus has undergone a certain degree of development, and the uterus a corresponding distention and organic changes, its contractility is called into action, and the uterine contents are beautifully and systematically expelled."

Dr. Flint says, "The cause of the first contraction of the uterus in normal parturition is undoubtedly referable to some change in the attachment of its contents, which causes the fetus and its membranes to act as a foreign body. When, for any reason, it is advisable to cause the uterus to expel its contents before the full term of pregnancy, the most physiological method of bringing on the contractions of this organ is to cautiously separate a portion of the membranes, as is often done by introducing an elastic catheter between the ovum and the uterine wall. A certain time after this operation, the uterus contracts to expel the ovum, which then acts as a foreign body.

"In the normal state, toward the end of pregnancy, the cells of the decidua vera and of that portion of the placenta which is attached to the uterus undergo fatty degeneration, and, in this way, there is a gradual separation of the outer membrane, so that the contents of the uterus gradually lose their anatomical connection with the mother. When this change has progressed to a certain extent, the uterus begins to contract; each contraction then separates the membranes more and more, the most dependent part pressing upon the os internum; and the subsequent contractions are probably due to reflex action. The first 'pain' is induced by the presence of the fetus and its membranes as a foreign body, a mechanism similar to that which obtains when premature labor has been brought on by separation of the membranes."

The action of the uterus in expelling the fetus is quite analogous to that of the alimentary canal in expelling its contents. In each case the abdominal muscles powerfully co-operate with the peristaltic contractions of the organ. It is true that uterine contractions, when once established, may continue, vigorously,too, with little action of the respiratory muscles of the mother; but ordinarily the force of one of these actions is measured very precisely by that of the other. When ether, which occasions a greatly diminished action of the respiratory system, is administered to diminish pain or produce relaxation of the sphincter muscles, the uterine contractions are generally but little disturbed, and in some instances, considerably intensified. Ergot and many other drugs, as is well known to accoucheurs, if administered at any time after the occurrence of "true labor pains," will generally occasion increased force of uterine contraction, and thus expedite the process of delivery.

RATIONALE OF LABOR PAINS.—By the term, *labor pain*, the obstetrician understands a single contraction of the muscular fibers of the body of the uterus. The pains of labor, other circumstances being equal, in length and severity, correspond to the force and duration of each contractile effort. The muscular fibers of the uterus are so arranged that, while each contraction diminishes the cavity of the organ, it at the same time dilates its mouth. Each contraction or pain continues but a short time, usually only a few seconds, and is followed by an equal or longer period of relaxation or repose. By these repeated contractions the fetus is gradually pressed against the os uteri, which continually enlarges until the dilatation is sufficient to admit of the passage of the fetus into the world.

In *true labor pains* the longitudinal fibers of the muscular coat of the uterus contract from above downward, while the respiratory and abdominal muscles co-operate, inducing a pressure upon the whole abdominal and pelvic viscera, attended with a sense of "bearing down." The patient is often directed to "help the pains," by which is meant that she should hold her breath during the uterine contraction and make a bearing down effort. It is rarely in the power of the woman to suspend or materially abate the "pains" by any effort of will, although narcotic drugs, mental shocks, bleeding, opiates, etc., will frequently suspend them for a time. When the pains are not of the bearing down kind, but irregular and spasmodic, at full term, they are called *false labor pains.* The first contractions of the uterus are generally feeble and the pains slight, when they are termed *preparatory.*

Although the pains attending childbirth are, with the daughters of civilization, usually very great, often terrible, the process is not necessarily attended with any feelings or symptoms to which the term pain will properly apply. In the normal condition the experience is that of *labor* or *travail* rather than pain. And there is certainly no reason, except in abnormal habits and conditions, why parturition should be painful. In the ruder states of society, females suffer little; and I have attended several cases in which the pain was insignificant—the patients refusing to acknowledge that they suffered actual pain at all. These women had lived rationally as to diet and exercise for months before conception occurred.

Many interpret the Scripture expression, "In sorrow shalt thou bring forth," as meaning the arbitrary infliction of pain in childbirth as a penalty for disobedience. But a more rational interpretation, and the only one which harmonizes with the experience of all nations and all ages, is the consciousness of bringing children into a world of wickedness, rendered such by transgression, inheriting dispositions to vice and predispositions to disease from their parents.

There are very few adult females in civilized society not to a greater or less extent the subjects of uterine disease. There are very few married women who do not suffer more or less of congestion and inflammation of the sexual organs, and a large proportion, which is constantly increasing, are affected with ulcerations or displacements. And when to these causes we add the dyspeptic stomachs, constipated bowels, and weak abdominal muscles, we have a sufficient explanation of the dreaded sufferings of gestation, and the dreadful pains and perils of parturition.

Natural Labor.—Fig. 106 shows the position of the fetus in the best position for delivery. In the works on Midwifery all labors are termed *natural* when the head, face, feet or breech presents, because in all of these positions the delivery may be accomplished without assistance; while all other presentations require manual or instrumental aid, and are termed preternatural. But with Nature *normal* and *best* are synonymous terms, and hence the position in which the posterior fontanelle or back part of the crown of the head occupies the anterior portion of the pelvic cavity, is the only one that can be regarded as strictly natural.

Preceding labor for a day or two, there is generally

FIG. 106.

NORMAL POSITION.

a discharge of a mucous fluid from the vagina, often streaked with blood. This is called the *show*, and indicates more or less dilatation of the mouth of the womb—the precursor of labor. At this time the os uteri will be found, on examination, to enlarge more or less with every pain, and its edges to be gradually becoming thinner. At first the pains are apt to be grinding or scattered, and to affect more especially the loins and abdomen. After a longer or shorter period they commence in the loins and *bear down* toward the os uteri. In due time the membranes which inclose the fetus, with their contained fluid, protrude through the os uteri, the pouch thus formed being termed the *bag of waters.* The uterine contractions soon rupture the protruding membranes; the waters are discharged; the uterus then contracts firmly upon the body of the fetus, and labor usually progresses rapidly to completion.

FIG. 107.

CASE OF TWINS.

The pulsations of the umbilical cord can be felt for a few seconds, sometimes for a few minutes after birth, but as soon as the lungs are duly expanded—usually indicated by a lusty cry, which every mother and midwife is so fond of hearing—the circulation of the cord ceases entirely, when it may be severed, and the child wrapped in a soft blanket and put in a safe place to enjoy the thing it most needs after its first crying spell—sleep.

After the birth of the child the mother has an interval of repose—usually from ten to thirty minutes, but in some cases extending to several hours—when slight bearing down pains recur ; the uterine contractions are resumed and continued until the placenta and membranes, termed the *secundines* or *after-birth*, are expelled.

In the cases of twins both fetuses may present by the head, or both by the feet, or one by the head and another by the breech, as represented in Fig. 107

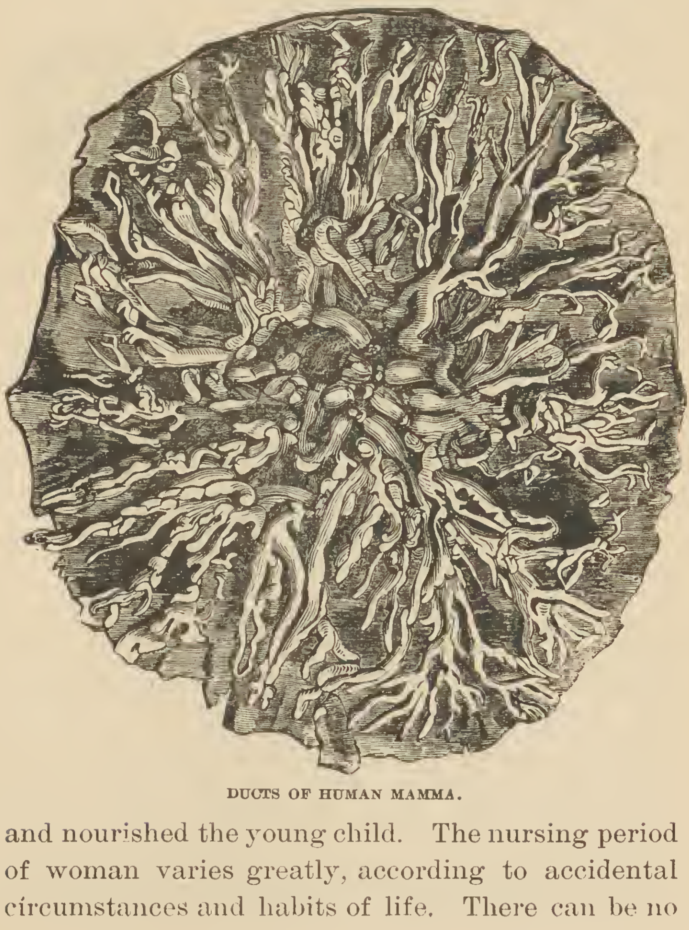
CHAPTER XI.

LACTATION.

SECRETION OF MILK.—The nutriment of the fetus is derived directly from the mother's blood; but after birth the child is intended to subsist on its mother's milk until its masticatory organs are developed. The milk is a *secretion* prepared from the elements of the blood in the mammæ or breasts. Each mammary gland is formed of several lobes united by areolar tissue; each lobe is composed of smaller lobules, and each lobule of still smaller bodies, termed *acini*. These acini are about the size of poppy seeds, and of a rosy-white color; they are lined with cells which secrete the milk. Figure 108 is a representation of the milk ducts as they appear filled with wax. In the virgin the acini are not distinguishable. The excretory ducts (*tubuli lactiferi*) arise from the acini, and enlarging and uniting with each other, terminate in reservoirs or sinuses near the base of the nipple. These sinuses are fifteen to twenty in number, and open on the nipple distinct from each other.

In some instances milk is secreted and flows from the breasts during the later period of pregnancy; and instances are recorded in which young girls, old women, and even men, have had a copious formation of milk, and have successfully nursed

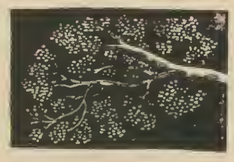
FIG. 108.



DUCTS OF HUMAN MAMMA.

and nourished the young child. The nursing period of woman varies greatly, according to accidental circumstances and habits of life. There can be no doubt that the normal period for nursing the offspring at the breast is as fixed and determinate, in the order of Nature, with the human being as it is with the animals. But the more artificial life of woman has produced more and greater irregularities in this respect. The development of the teeth seems to point to a period of about one year, or a little less, as the proper limit of the function of lactation; yet it is not very uncommon for women to nurse their children for two or three years; and instances have been known in which two or three children, of different births, were nursing at the same breast.

FIG. 109.



ORIGIN OF MILK DUCTS.

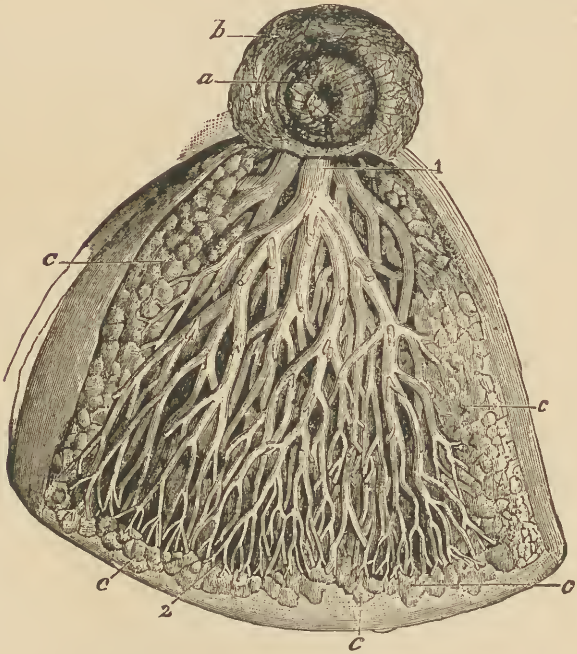
The persistent application of the child to the breast, would, of course, greatly prolong the formation of milk, as the excitement of the mammary gland of the cow, in the process of milking, causes milk to be secreted even up to the moment of giving birth to another offspring; but this is most objectionable, injuring both mother and unborn child. It is a great error to bring children into the world with no interval between the weaning of one and the birth of another. If we wish to

FIG. 110.

ULTIMATE FOLLICLES OF MAMMARY GLANDS.
a a. The secreting cells. *b b*. The nuclei.

improve the race we must take the greatest care of the mother, so she is not deteriorated physically.

Fig. 111.



MAMMARY GLAND OF THE HUMAN FEMALE.

a. Nipple, the central portion of which is retracted. *b*. Areola. *c c c c c*. Lobules of the gland. 1. Sinus, or dilated portion of one of the lactiferous ducts. 2. Extremities of the lactiferous ducts.

The first milk is termed *colustrum*, and is supposed to contain more cream and butter and less casein than that which is produced subsequently.

CONSTITUENTS OF MILK.—The following analysis made from milk obtained on the twelfth day after delivery, shows, as far as chemistry can determine the fact, that the difference in the essential qualities of the milk of woman and of other mammals is inconsiderable :

	COW.	GOAT.	SHEEP.	ASS.	MARE.	WOMAN.
Water . . .	861·0	868·0	856·2	907·0	896·3	905·809
Butter . . .	38·0	33·2	42·0	12·10	*traces*	33·454
Casein . . .	68·0	40·2	45·0	16·74	16·2	29·111
Sugar of Milk and extractive matter . . .	29·0	52·8	50·0	62·31	87·5	43·64
Fixed Salts. .	6·1	5·8	6·8			1·939

Quantity and Quality of Milk.—The amount and character of the mammary secretion are influenced by the quantity and quality of the food, by many conditions of disease, by drugs, medicines, poisons or impurities of any kind taken into the system, and, indeed, by all the habits of life. As the milk is formed from the elements of the blood, and these are derived from the elements of the food, it follows, as a logical sequence, that the welfare of the child is greatly dependent on the dietetic habits of the mother. Every stimulant, narcotic, or condiment—alcohol, opium, tea, coffee, pepper, vinegar, saleratus, etc.—which the mother swallows, irritates her stomach, inflames her blood, and, to some extent, depraves or poisons her milk and injures her child. Mental shocks, anger, melancholy, and all disagreeable or abnormal mental conditions, render all the secretions more or less morbid—the milk as well as the rest—and correspondingly damage the child which partakes of the vitiated aliment. Very few children are so fortunate as to pass through the nursing period without being poisoned by the drug medicines which are administered to the mother; and when we take into account the dietetic abominations which constitute three-fourths of what is termed food and drink, we need not wonder that nearly one-half of the children that are born die in infancy; nor that nearly one-half of the remaining half die in childhood and youth; nor that very few of those who grow up to manhood and womanhood possess sound and vigorous constitutions.

There is one consideration to which, if the attention of mothers and nurses could be properly directed, would, I am sure, have a wholesome influence on their personal habits. During the nursing period the breasts are ready channels through which poisons and impurities are eliminated from the system. Poisons, as opium, alcohol, antimony, calomel, quinine, etc., which do not very seriously affect the mother, or which occasion only what is called their medicinal operation, may be mingled with the milk, or so change its qualities, as to ruin the health and constitution of the child.

Dunglison says: "The milk is apt to be impregnated with heterogeneous matters taken up from the digestive canal. The milk and butter of cows indicate unequivocally the character of their pasturage, especially if they have fed on turnip, wild onion, etc. Medicine given to the mother may in this way act upon the infant. Serious, almost fatal, narcotism was induced in the infant of a professional friend of the author, by a dose of morphia administered to his wife."

Lactation and Pregnancy.—Although the female is much less liable to conceive during lactation, yet a free secretion of milk is not a perfect protection against pregnancy. The recurrence of the menstrual flux is regarded as a sign that the reproductive system is again in a condition for the performance of its function. But, as menstruation may occur during lactation as well as at other times, without hemorrhage, and as hemorrhage may occur without menstruation, this rule is liable to exceptions. Several persons have written me that their wives became pregnant while nursing, and before there had been any appearance of menstruation, which "phenomenon" they desired me to account for. The explanation is self-evident, when we consider that menstruation is simply ovulation. In these cases the menstruation was unattended with the usual hemorrhage.

Whether the child should be weaned when the menstrual flux occurs, is a subject that has been much discussed by medical writers. The question is one of a choice of evils, and must be decided in view of all the existing circumstances.

In the purely normal condition the cessation of the mammary secretion, the resumption of the process of ovulation, and the development of the masticatory organs of the child, so that it can partake of solid food, are co-incident in time. But it happens that abnormal conditions are the rule, and normal the exceptions; hence mothers and infants must do the best they can. The flux may be a mere hemorrhage, or menstruation itself may not very greatly change the quality of the milk, in which cases it would be better to continue the child at the breast. But if at this time the milk undergoes any appreciable change in quality, or is suddenly greatly diminished in quantity, or if the mother's health declines, the child should be weaned.

Analyses of the milk of nursing women when menstruation had returned have been made, but with no very satisfactory results. In 1863 M. Raciborski presented a paper on this subject to the French Academy of Medicine, in which he stated, as the result of chemical investigation, "that the milk of nurses who menstruate during suckling does not sensibly differ in physical, chemical, or microscopic characters, from that of nurses whose catamenia was suspended." He admits, however, that in most cases the milk of menstruating nurses contains less cream during the menstrual period.

In England, women of the working classes are in the habit of nursing their children on the average about fifteen months, and Mr. Robertson has expressed the opinion that in seven-eighths of these cases there will be an interval of fifteen months between parturition and subsequent pregnancy, and that, in most cases when suckling is prolonged to twenty months, pregnancy does not take place till after weaning. Dr. Loudon, in a work on the theory of population, advances the opinion that the laws of Nature require lactation to be prolonged for three years; and he thinks that the "antagonism" between the uterus and breast is so great as usually to prevent conception in nursing mothers. But, on the contrary, Drs. Robertson and Laycock have shown by abundant statistics that in about one-third of the cases, conception occurs during lactation.

That conception should not occur during lactation is very clear. It is certainly not in accordance with physiological law. Nor is it probable that a woman, while nursing one child, will develop, so perfectly, the ovum for another. Whether she ought to be exposed to conception during the nursing period—whether sexual intercourse during the entire period of lactation is not an abuse, and hence abnormal and injurious—I shall consider in a subsequent chapter.

Certain it is that many diseases on the part of the mother, and numerous infirmities and eccentricities, not to say deformities and monstrosities, on the part of the offspring, are attributable to the ordinary habits of free and almost unrestrained sexual indulgence at the very time when all of the surplus vital force of the mother ought to be appropriated wholly to the nourishment and development of the new being. And it is not a little surprising that works professing to teach Physiology and Hygiene, and especially works on the Diseases of Women and Children, of which the medical press is quite prolific, do not give any instruction on this important subject. Perhaps it is ignored on the score of delicacy, as though it could be indelicate or in any sense improper to teach all things which relate to our happiness and welfare.

THE QUANTITY OF MILK SECRETED.—The *quantity* of milk secreted varies greatly in different mothers. Some furnish far more than is required to nourish the child; others not nearly sufficient. The causes of this difference are varied.

Human beings are rarely endowed with the same gifts in the same degree. One has more force of character, more muscular force, greater digestive power, more intellect than another, or less, as the case may be. Health and vital endowments differ. This tendency to differ exists in the ovum and sperm. But there are special causes which diminish the secretion of milk. One of these is the food. In the animal world those creatures which furnish the most milk for their young are the vegetable eaters. The elephant, the camel, the horse and cow are good examples. All of these have been domesticated and used to furnish milk for man; but whoever thought of domesticating a flesh-eating animal for this purpose? No one.

So it is, also, with the different races of the earth. Those which depend largely on the vegetable kingdom for their food, using little or no flesh, nurse their children best. No cows are kept in Japan, yet every mother is able to nurse her children without artificial aid from these animals. When we come to the western world we find multitudes of women unable to suckle their babies. One cause I believe to be the excessive amount of animal food which they consume. The human breast is not adapted to convert it into milk in large quantities. If mothers would increase the flow of this secretion during the time when they are nursing their young, let them not depend on a flesh diet to do it, but on one composed of such products of the vegetable kingdom as are known to produce milk when fed to animals These are mainly the grains, especially wheat, corn, rye, barley and oats, prepared so as to be easily digested and assimilated. Of course the preparation of these articles must be such as to tempt the appetite and be agreeable to the palate. In the older countries of Europe the peasant women, as a rule, have better breasts, which secrete more milk than the women of cities, who eat more flesh food. These peasant women compose their diet mainly from the products of the vegetable kingdom.

There are other reasons why so many women do not furnish enough milk for their offspring. One is because their energies have been used up in other directions—in fashionable follies, in late hours, in tight clothing, in mental work or worry. All these things are antagonistic to the perfect action of the mammary glands. These organs must first be well developed, must be supplied with an abundance of good blood, and have from the nervous centers which control them a sufficient flow of nervous force to keep them in a high state of activity; and there must also exist a calm, equable state of mind. The latter is equally important. We might also learn a useful lesson from the Japanese in this respect. Their women are the most good-natured, gentle women in the world. They do not worry and fret and scold, and find fault and quarrel, and make themselves disagreeable. A principle cause of this condition is believed to be their diet, which does not stimulate them so much and leave behind a reaction which causes irritability of the nervous system.

One other cause only will be mentioned. According to modern views of men of science, natural selection, when it has its perfect play, is an important factor in preserving the most suitable, and discarding the least suitable ones born into the world. During the childhood of the race, and even up to very recent times, this force has been in full activity, and has weeded out children born of mothers not able to nurse them. Most of them have not survived. Now, however, medical and hygienic science saves a considerable percentage of these children by cunningly devised methods of bringing them up by hand. In a very marked degree, however, they inherit the defects of their mothers, and are themselves unable to nurse their own young. If this state of affairs were to go on indefinitely, we might have a race of women without breasts, who could never nurse their own babies. Is this likely to occur? Probably not. It is quite certain that Nature will in some way assert her rights in this respect as she does in many others.

CHAPTER XII.

THE LAW OF SEX.

A study of the law of sex naturally comes within the scope of this work. Most writers have approached it with such a narrow and imperfect knowledge of the subject that their contributions have little value. It is not a question to be mastered in a day, nor one to be thought out in the study with no knowledge of facts. Theorizing and speculation may be very useful, but they must afterwards be submitted to inexorable crucial tests, which alone can decide their value. It is for a lack of scientific thoroughness that most of the literature on this subject is little valued.

It is interesting to note that the constant average proportion of the sexes of all animals and plants is that which seems best adapted to their conditions of life. The law by which this proportion is maintained must be one acting on the parent organism at the time of fertilization; but I am aware that the highest authorities on this subject hold that it may act both before and after this period. Mr. Carl Düring (*) has, perhaps, made the most exhaustive

(*) "On the Laws which Determine the Sex of Embryo in Mankind, in Animals, and in Plants." Carl Düring, "Jenaische Zeitschrift."

study of this subject which has yet been published a brief summary of which has been made by Prof. Brooks, of Johns Hopkins University, for the Popular Science Monthly, as follows:

"He treats, in the first part of his paper, of those conditions which act upon the two parents in opposite ways, and he summarizes his conclusions as follows: 'Each species has acquired, through natural selection, the useful property, in virtue of which any deviation from the average ratio between the sexes is corrected by an increased number of births of the deficient sex, or a decreased number of births of the sex which is in excess.'

"As the result of nearly a million observations of the birth of colts, he shows that, as the number of mares put to a stallion in a year is increased, there is a corresponding and regular increase in the number of male colts as compared with the female colts, and he gives the following summary:

Number of mares to one stallion.	Number of colts.		Number of male to each one hundred female colts.
	Male.	Female.	
20 to 34 . . .	29,023	29,934	96·94
35 to 39 . . .	44,911	46,493	96·60
40 to 44 . . .	66,573	69,045	96·42
45 to 49 . . .	69,774	72,073	96·81
50 to 54 . . .	69,972	71,461	97·92
55 to 59 . . .	75,493	74,912	100·77
60 or more . .	71,407	70,569	101·19
Total . .	1427,53	434,487	98·31

"In three cases where the power of parthenogenetic reproduction has been acquired as a compensation for the absence of males, the parthenogenetic eggs give rise either universally, or in the vast majority of cases, to males.

"For instance, as bees destroy the males after they have been rendered unnecessary by the fertilization of the queen, they are exposed to the danger that when males are needed none may exist, and there can be no doubt that the power of parthenogenetic reproduction has been acquired by bees as a compensating adjustment.

"When the nuptial flight of the queen is delayed by accident, or by the intervention of the breeder, the effect is, of course, equivalent to a scarcity of males, and in such a case more male larva than usual are produced; while early fertilization, which is a sign of the abundance of males, results, according to Huber, in an excess of female births.

"Any influence which is equivalent to a lack of individuals of one sex acts, according to Düring to produce an excess of births of that sex, although there may be an actual deficiency.

"Thus, when the queen-bee is restrained by confinement, or by the lack of wings, from the nuptial flight, or when the seminal receptacle has been removed by accident or by an operation, or when the contained semen has been killed by frost or exhausted, only males are produced.

"Something of the same kind has been observed in man, and the fact that a war, which carries most of the men away from their homes, is followed by an unusually great number of male births, has been recorded by many observers.

"The second part of the paper treats of those influences which act in the same way upon both parents, and the author's conclusion may be summarized as follows :

"'The power to regulate fertility according to the means of subsistence would be of use to the organism, and since the female has gradually acquired, through division of labor, the function of providing the material for the growth of the young, an excess of females is a condition of rapid multiplication. We might therefore expect, what we actually find to be the case, that organisms have gradually acquired, through natural selection, the power to produce an excess of females in time of plenty, and in a season of scarcity of food an excess of males.'

"I think, however, that careful examination of the evidence which Düring has brought together will show that he has stated his generalization in too narrow terms, and I think his facts will prove the following : A favorable environment causes an excess of female births, and an unfavorable environment an excess of male births.

"It is true that abundance or scarcity of food is one of the most important elements of that whole which makes up the environment of an organism, and in most of the cases which Düring quotes it is the controlling factor, but he gives many cases, some of which will be noted further on, where a variation in other conditions of life has produced the same effect, causing an excess of male births when unfavorable, and an excess of female births when favorable.

"In the case of man, the conditions of life are so much under control that it is difficult to state just what constitutes a favorable environment, but I think we may conclude that, as a general rule, an environment which produces a high birth-rate is favorable, and *vice versa*. Now, Düring gives many tables to show that, among mankind, the number of female births, as compared with the number of male births, increases as the birth-rate increases.

"At the Cape of Good Hope the Boers are very prolific—six or seven is a small family, and from twelve to twenty children are not unusual; while the badly nourished and overworked Hottentots seldom have more than three children, and many of the women are barren, and Quetelet says that in 1813–'20 the free whites gave birth to 6,604 boys and 6,789 girls, or 97·2 boys to every 100 girls; while during the same time the Hottentot slaves produced 2,936 boys and 2,826 girls, or 103·9 boys to each 100 girls.

"The birth-rate is higher in towns than in the country, and more boys are born for each hundred girls in the country than in the towns.

"Thus, in Prussia, in 1881, the number of boy-births for each 100 girls was 106·36.

In Berlin it was	105·70
In large towns it was	105·72
In middle towns it was	105·44
In small towns it was.	106·14
In the country it was	106·62

"This table shows that in all the towns the ratio of boys was below the average for the whole of Prussia, and that in Berlin it was very much below the average.

"Ploss was the first to point out that there is an excess of female births in time of prosperity, and he found that in Saxony the ratio of boy-births rose and fell with the price of food, and that the variation was most marked in the country.

"It is well known that the number of conceptions among mankind is greater at some seasons of the year than at others, and from a record of nearly 10,000,000 births Düring has compiled a table (see next page) which shows that the ratio of boy-births is greatest in three months when the birth-rate is smallest.

"From this table it will be seen that in June, the month when the birth-rate was smallest, the ratio of boys to each one hundred girls was highest, and very much above the average for the whole year; while in March, the month when the birth-rate was greatest, the ratio of boys was smallest.

"More than 6,000,000 births took place in the seven months when the ratio of boys was below the average for the year, and only 4,000,000 in the five months when it was above the average; and the table shows clearly that an increase in prosperity,

TABLE SHOWING THE RATIO OF BOY-BIRTHS WHEN THE BIRTH-RATE IS SMALLEST.

Conception. Birth.	April. January.	May. February.	June. March.	July. April.	August. May.	September. June.	October. July.
Boys . .	484,443	451,750	484,786	450,272	446,642	419,541	439,685
Girls . .	455,847	425,091	457,702	424,740	420,867	392,928	411,888
Total. .	940,290	876,841	942,488	875,012	867,509	812,469	851,573
Ratio .	106·27	106·27	105·92	106·01	106·02	106·77	106·75

Conception. Birth.	November. August.	December. September.	January. October.	February. November.	March. December.	Whole year.
Boys . .	458,385	479,023	468,337	452,894	464,024	5,499,782
Girls . .	431,192	452,045	440,447	426,343	435,382	5,174,472
Total. .	889,577	931,068	908,784	879,237	899,404	10,678,254
Ratio .	106·31	105·97	106·33	106·23	106·58	106·287

as measured by the birth-rate, is accompanied by a decrease in the ratio of boy-births, and *vice versa.*

"Among the lower animals, satisfactory statistics are wanting; but Düring states that, while domesticated animals are much more prolific than their wild allies, there is also a much greater preponderance of female births; that when animals are taken from a warm to a cold climate, the ratio of male births increases; and that leather-dealers say that they obtain most female skins from fertile countries where the pastures are rich, and most male skins from more barren regions; and he thinks we may safely conclude that the lower animals, as well as man, give birth to the greatest number of females when placed in a favorable environment, and to most males in an unfavorable environment.

"An extreme instance is furnished by those animals which, during the seasons when food is abundant, lose the power to copulate and multiply parthenogenetically at a marvelous rate of increase. giving birth to generation after generation of parthenogenetic females, so long as the environment remains favorable, but giving birth, as soon as the conditions of life become less favorable, to males and to females which require fertilization.

"The cladocera and aphides furnish the most striking instances of this kind of parthenogenesis, which has apparently been acquired, not to secure fertilization, but to enable the animals to utilize to the utmost the conditions which are most favorable to them, and to expand and contract their numbers in conformity to changes in their environment.

"Among the parthenogenetic cladoceras both males and females are to be found in the fall, and a few males are found in the early spring; but during the warm months of spring and summer only females are found. These multiply very rapidly through the summer by parthenogenesis, generation after generation, and they differ from the females which are fertilized by a male in many features, all of which are of such a character as to render the parthenogenetic females unusually fertile.

"They produce small eggs, which are discharged from the ovary while immature, and are nourished in a vascular broad pouch. They have little or no yolk; they are not protected by a hard shell, and they develop immediately into parthenogenetic females, which mature very rapidly, and in some cases, as in evadne, produce eggs before they themselves are born. All their peculiarities are of such a character as to secure the greatest possible fertility; and thus to enable the animals to avail themselves, to the utmost, of the abundant supply of food.

"Ramdohr found that a single isolated female daphnia produced 190 young in nineteen days, and he computed the number of descendents, at the end of sixty days, to be 1,291,370,075.

"As the supply of food begins to fail in the fall, males are born, and the females produce the so-called winter eggs, which do not develop unless they are fertilized. These are few in numbers, much larger than the summer eggs, and they are incased in protecting shells. Their purpose is not to multiply the race, but to carry a few individuals through the winter, and over to the next season of plenty. They are slowly matured in the ovary, and contain an abundant supply of food-yolk. They are not nourished in a broad chamber, and in many cases they have, in addition to the proper shell, an extra covering or ephipium, formed out of part of the integument of the parent. In daphnella three summer eggs are matured, at one time, in each ovary; but the animal produces only one winter egg, which is seven-tenths as long as the whole body.

"While the abundance or lack of food is a very important factor in determining the absence or presence of males, it is not the only one. Kurg found a few males in midsummer, but only in pools which were nearly dried up; and he was thus induced to attempt the artificial production of males. He was so successful that he obtained the males of forty species, in all of which the males had previously been unknown. He proved that any unfavorable change in the water causes the production of males, which appear as it dries up, as its chemical constitution changes, when it acquires an unfavorable temperature, or in general when there is a decrease in prosperity.

"From these observations and from many others quoted by Düring, I think we may safely conclude that among animals and plants, as well as in mankind, a favorable environment causes an excess of female births, and an unfavorable environment an excess of male births.

"Now, what is the reason for this law? If the welfare of the species can be secured, under a favorable environment, by females alone, why are males needed when the environment becomes unfavorable?

"I have tried to show, in another place, from evidence of another kind, that the female is the conservative factor in reproduction, and that new variations are caused by the influence of the male. While the environment remains favorable no change is needed, but, as the conditions of life become unfavorable, variation becomes necessary to restore the adjustment, and I believe that we have, in Düring's results, an exhibition of one of the most wonderful and far-reaching of all the adaptations of Nature—an adaptation in virtue of which each organism tends to remain stationary as long as no change is needed, and to vary when variation is demanded.

"That this is the true view is shown, I think, by the contrast between domesticated animals and captive animals. The fact that an animal has become domesticated shows that it finds in captivity a favorable environment, and Düring says that domesticated animals are unusually fertile, and that they produce an excess of females. Animals which are kept as captives in menageries and gardens have, as a rule, no fitness for domestication, and their conditions of life are unfavorable. Geoffroy Saint-Hilaire says that individuals born in menageries are usually male, while skins sent to museums are usually female, and that the attempt to domesticate a wild animal increases the number of male births. Düring states that captive birds of prey and carnivorous mammals are very infertile, and that the young are nearly always males.

"The wild races of Oceania and America have been suddenly brought into contact with the civilization which has been, in Europe, the slow growth of thousands of years. Food and climate have not changed, but a new element has been introduced into their environment. The New Zealanders are very infertile, and nearly all the children are boys, and the census of 1872 for the Sandwich Islands gave a ratio of 125 male births to 100 female births."

This is all extremely interesting; but, after all, it does not settle the physiological law of sex. Even admitting that, in a general way, favorable conditions increase the number of female births and unfavorable ones the male births, still there must be a law for each of these which admits of variation, so that conditions may favor the production of one sex at one time, and the other sex at another.

It is this physiological law that we should try to discover. We may be sure it will never be found by only studying the question of the amount of food, the season of the year, whether there is war or peace, or anything which relates to environment. But the facts which have been collected by these studies will be an immense help in testing various theories concerning the law of sex, and these facts will also aid us in forming new theories and estimating their value. Let us now look at this subject still deeper and see what we can make of it.

We find that in the lowest forms of life multiplication takes place *asexually.* That is, the body simply divides itself into two or more parts, each of which grows to the same size and assumes the same form as the parent, and this process goes on indefinitely, or as long as external conditions are favorable In these forms of life we may say there is no such thing as sex. In the higher forms of life this is all changed, and multiplication takes place *sexually,* and instead of it being by division it is by the formation of an egg or ovum which is, after all, but a bud from the female parent. Before it can be developed, however, it must be united with a portion of the male parent, as was fully described in the chapter on Impregnation. In other words, two forces come together and they produce a male or a female. Now, why is sometimes a male and sometimes a female the result? In my opinion it depends on which is the stronger force. If the female germ has the greater vitality, is more richly endowed with protoplasm, has more living matter in a higher degree of activity, then the ovum will develop after the female form, more or less modified, according to the amount of living matter or protoplasm or force in the germ element which has united with the ovum. It is simply a question of force—not the force of the whole parent, but of the minute particles of it, which have been detached from the parent and united to form a new individual. It is the same law that we find all through nature. If two unequal forces come together they modify each other, but the stronger one always produces the greatest effect, and the result is, the new force is more in the line of the stronger than in the line of the weaker one. Now how does this harmonize with the facts that favorable conditions of life cause the production of more females and unfavorable ones of more males? Let us see. Where the conditions of life are most favorable, woman, without doubt, is most favorably affected by it. She is better fed, more tenderly cared for, and maintains a higher degree of physical health. The effect on the ova, produced under such improved conditions, will be a more abundant endowment with living matter, and the chances will be, that more of them will develop as females. On the other hand, if the conditions of life become less favorable, woman suffers most. Among barbarous races, if the food is scarce, the woman gets least of it, partly from the greater selfishness of man, and partly on account of the greater tendency of woman's nature to sacrifice herself for the welfare of others. Of course, there will be a large class of persons who will not be so greatly affected by the slight changes in environment, but the number who will be affected will be sufficient to account for all the difference we have in the ratio of the sexes.

This theory agrees with another class of facts. If the male is older and stronger than the female, the offspring will be more of males than females. If the females are most vigorous the offspring will contain more females.

Dr. Manly Miles, in his most excellent work entitled Stock Breeding, has collected an array of facts bearing on this point, some of which are given below :

"At a meeting of the Agricultural Society of Severac, on the 3d of July, 1826, M. Charles Girou de Buzareingues proposed 'to divide a flock of sheep into two equal parts, so that a greater number of males or females, at the choice of the proprietor, should be produced from each of them. Two of the members of the society offered their flocks to become the subjects of his experiments,' the results of which are given in the following table.

"The principle of division was to place young rams with strong, well-fed ewes, for ewe-lambs, and a matured, vigorous ram with weaker ewes, for ram-lambs.

"The first experiment gave the following results:

Flock for female lambs served by two rams, one fifteen months and the other nearly two years old.

Age of Mothers.	SEX OF LAMBS.	
	Male.	Female.
Two years . .	14	26
Three years .	16	29
Four years . .	5	21
Total . . .	35	76
Five years and over	18	8
Total . . .	53	84

There were three twin-births in this flock.

Flock for male lambs served by two strong rams, one four and the other five years old.

Age of Mothers.	SEX OF LAMBS.	
	Male.	Female.
Two years . . .	7	8
Three years . .	15	14
Four years. . .	33	14
Total	55	31
Five years and over	25	24
Total	80	55

No twin-births in this flock.

"In the second experiment the ewes were divided into three sections.

"The first section included the strongest ewes from four to five years old, which were better fed than the others. It was served by four ram-lambs, about six months old.

"In the second section were the weaker ewes, under four or above five years old. They were served by 'two strong rams,' more than three years old.

"The third section consisted of ewes belonging to the shepherds, 'which are in general stronger and better fed than those of the master, because their owners are not always particular in preventing them from trespassing on the cultivated lands that are not inclosed.' These ewes were served by the same rams as section two.

	Males.	Females.
The first section gave . .	15	25
" second " " . .	26	14
" third " " . .	10	12

"In the first section were two twin-births—four females. In the second and third there were also two—three males and one female.

"These experiments were considered almost conclusive; but it will be observed that the results are not more remarkable for the range of variations presented in the relative numbers of each sex than were obtained in my experience in different years with animals under the same management.

"The number of animals under observation in these experiments is too small to give the results any value as a basis of generalization, and the same objection may be made to the cases collected by Hofacker and Sadler, which we quote from Carpenter.

"'The following table expresses the average results obtained by M. Hofacker in Germany, and by M. Sadler in Britain, between which it will be seen that there is a manifest correspondence, although both were drawn from a too limited series of observations. The numbers indicate the proportion of male births to a hundred females, under the several conditions mentioned in the first column:'

	Hofacker.
Father younger than mother	90·6
" and mother of equal age	90·0
" older by 1 to 6 years	103·4
" " " 6 " 9 "	124.7
" " " 9 " 18 "	143·7
" " " 18 and more	200·0

	Sadler.
Father younger than mother	86·5
" and mother of equal age	94·8
" older by 1 to 6 years	103·7
" " " 6 " 11 "	126·7
" " " 11 " 16 "	147·7
" " " 16 and more	163·2

"'From the statistics recorded in the peerages and baronetages of the United Kingdom, the proportion of male to a hundred female births is stated by Napier to be as below.'

390	parents of equal age	91·8
276	fathers 1 year older than mothers	101·3
312	" 2– 3 years older than mothers	101·8
211	" 4– 6 " " " "	108·0
200	" 6–10 " " " "	130·1
168	" 10–16 " " " "	144·3
120	" 17–25 " " " "	189·7
80	" 26–32 " " " "	125·6
45	" 33–40 " " " "	112·6
18	" 40–50 " " " (mother under 25)	115·4
13	" 40–50 " " " " over 25)	91·6

MOTHERS OLDER THAN FATHERS.

88 mothers	from	1– 3	years	older	94·3
77 "	"	3– 5	"	"	88·8
66 "	"	5–10	"	"	77·1
43 "	"	10–15	"	"	60·6
17 "	"	15–22	"	"	48·3

This theory receives confirmation, also, from the facts which are disclosed by a study of the subject of Inheritance. Fathers transmit more to their sons than to their daughters, and mothers more to their daughters than to their sons. Is the womanly form, with broader hips, narrower shoulders, greater beauty, and all those pecularities which constitute the female, inherited from the father? Is the greater physical strength, the broader shoulders, narrower hips, larger muscles and brain, and all those traits which go to make up the male, inherited from the mother? Mr. Darwin devotes some space to this subject in his work on Animals and Plants under Domestication, from which we extract a few paragraphs :

"Dr. P. Lucas, who has collected many facts on this subject, shows that when a peculiarity, in no manner connected with the reproductive organs, appears in either parent, it is often transmitted exclusively to the offspring of the same sex, or to a much greater number of them than of the opposite sex. Thus, in the family of Lambert, the horn-like projections on the skin were transmitted from the father to his sons and grandsons alone; so it has been with other cases of ichthyosis, with supernumerary digits, with a deficiency of digits and phalanges, and in a lesser degree with various diseases, especially with color-blindness, and a hemorrhagic diathesis, that is, an extreme liability to profuse and uncontrollable bleeding from trifling wounds. On the other hand, mothers have transmitted, during several generations, to their daughters alone, supernumerary and deficient digits, color-blindness, and other peculiarities. So that we see that the very same peculiarity may become attached to either sex, and be long inherited by that sex alone; but the attachment in certain cases is much more frequent to one than the other sex. The same peculiarities, also, may be promiscuously transmitted to either sex. Dr. Lucas gives other cases, showing that the male occasionally transmits his peculiarities to his daughters alone, and the mother to her sons alone; but even in this case we see that inheritance is, to a certain extent, though inversely, regulated by sex. Dr. Lucas, after weighing the whole evidence, comes to the conclusion that every peculiarity, according to the sex in which it first appears, tends to be transmitted in a greater or lesser degree to that sex.

"A few details from the many cases collected by Mr. Sedgwick, may be here given. Color-blindness, from some unknown cause, shows itself much oftener in males than in females; in upwards of two hundred cases collected by Mr. Sedgwick, ninetenths related to men; but it is eminently liable to be transmitted through women. In the case given by Dr. Earle, members of eight related families were affected during five generations: these families consisted of sixty-one individuals, namely, of thirty-two males, of whom nine-sixteenths were incapable of distinguishing color, and of twenty-nine females, of whom only one-fifteenth were thus affected. Although color-blindness thus generally clings to the male sex, nevertheless, in one instance, in which it first appeared in a female, it was transmitted during five generations to thirteen individuals, all of whom were females. A hemorrhagic diathesis, often accompanied by rheumatism, has been known to affect the males alone during five generations, being transmitted, however, through the females. It is said that deficient phalanges in the fingers have been inherited by the females alone during ten generations. In another case, a man thus deficient in both hands and feet, transmitted the peculiarity to his two sons and one daughter; but in the third generation, out of nineteen grandchildren, twelve sons had the family defect, whilst the seven daughters were free. In ordinary cases of sexual limitation, the sons or daughters inherit the peculiarity, whatever it may be, from their father or mother, and transmit it to their children of the same sex; but generally with the hemorrhagic diathesis, and often with color-blindness, and in some other cases, the sons never inherit the peculiarity directly from their fathers, but the daughters, and the daughters alone, transmit the latent tendency, so that the sons of the daughters alone exhibit it. Thus, the father, grandson, and great-great-grandson will exhibit a peculiarity—the grandmother, daughter, and great-granddaughter having transmitted it in a latent state. Hence we have, as Mr. Sedgwick remarks, a double kind of atavism or reversion; each grandson apparently receiving and developing the peculiarity from his grandfather, and each daughter apparently receiving the latent tendency from her grandmother.

"From the various facts recorded by Dr. Prosper Lucas, Mr. Sedgwick and others, there can be no doubt that peculiarities first appearing in either sex, though not in any way necessarily or invariably connected with that sex, strongly tend to be inherited by the offspring of the same sex, but are often transmitted in a latent state through the opposite sex.

"Turning now to domesticated animals, we find that certain characters not proper to the parent-species, are often confined to, and inherited by, one sex alone; but we do not know the history of the first appearance of such characters. In the chapter on Sheep, we have seen that the males of certain races differ greatly from the females in the shape of their horns, these being absent in the ewes of some breeds, in the development of fat in the tail in certain fat-tailed breeds, and in the outline of the forehead. These differences, judging from the character of the allied wild species, cannot be accounted for by supposing that they have been derived from distinct parent-forms. There is, also, a great difference between the horns of the two sexes in one Indian breed of goats. The bull zebu is said to have a larger hump than the cow. In the Scotch deer-hound the two sexes differ in size more than in any other variety of the dog, and, judging from analogy, more than in the aboriginal parent-species. The peculiar color called tortoise-shell is very rarely seen in a male cat; the males of this variety being of a rusty tint. A tendency to baldness in man before the advent of old age is certainly inherited; and, in the European, or at least in the Englishman, is an attribute of the male sex, and may almost be ranked as an incipient secondary sexual character."

INHERITANCE TRANSFERRED TO THE OPPOSITE SEX. —It is not to be denied that fathers transmit many qualities and peculiarities to their daughters, and mothers to their sons. An interesting and unpublished case of this is shown in the decendents of the Wadsworth family, of Mantua, Ohio. The father was born in Connecticut about the year 1800. He was badly deformed, being hare-lipped and both his hands and feet were defective. The three fingers between the thumb and little finger on each hand, including the whole palm of the hand that belonged to these fingers, were wanting. The same defect was found in the feet. The consequence was that the thumb and little finger on the hands, and the large and small toes on the feet, approached each other, but they were not attached by adhesion. This man married a woman not deformed, and had three children—Seth, William and a daughter, which did not live. The boys grew up to manhood. Seth's hands and feet were somewhat different from the father's. He had double fingers on each hand. The feet had a large and small toe spread apart so that it required a shoe six inches broad, but the middle of the foot, including three toes on each foot was absent. This son married, but left no children. William, the younger son, was deformed nearly the same as his father in both hands and feet, and he was also hare-lipped. He married, and had five children. The oldest is a son, and is not deformed. He resembles his mother in feature and complexion. The second child, a daughter, was deformed like the father, only worse, and lived but a few months. The third child, a daughter, is deformed in the hands and feet like the father. The fourth child a daughter, is not deformed. The fifth one, also a daughter, was deformed in its hands and feet, and the mouth was still worse than its father's.

Here we have in the first instance two sons and a daughter inheriting the father's deformities, and in the second case, the children of William, five chil dren—one son and one daughter not deformed, and three daughters inheriting their father's physical defects. Cases of this kind seem to cast doubt on the theory that the father transmits his own sex and the mother hers, and that the question is decided by preponderating force stored up in the germ and sperm elements which go to make the embryo. But we know when two forces meet to form a third, the latter has characteristics from each of the first, and this is necessarily the case in offspring, the result of sexual generation. It may be asked, are the two elements so unlike as to be considered two forces? I answer, Yes. The female element is larger, and its predominent tendency is to develop nutritively. The sperm element is quite different. It is small, formed by the division of certain cells in the male organs, and has a tendency of development unfavorable to nutrition. The female element favors cell-growth; the male element cell-division. From this fact, is it not fair to infer that the female sex is determined by the relative predominance of nutrition or cell-growth, over the conditions of cell-division, and that this must depend on the relative amount of each element comprising the embryo at the stage of impregnation.

Can Sex be Produced at Will.—If the law of sex be known, can it be applied? This is the first question which will naturally be suggested to every one. We must not be too enthusiastic in this matter; if we are, we shall be disappointed. Still, may not something be done? But, in the first place, does not nature manage this matter better than man can. Yet there may be times, however, when it will be desirable to control the sex in animals and in man. If it be true that the matter is decided by the preponderance of the germ or sperm element, then we may be asked can this be done without injury to the offspring. If we make the environment of the female unfavorable and of the male favorable, we may do her and the offspring harm, and *vice versa.* We must not do this. In the present condition of our knowledge, we have but one resource left, and that is as far as we can to control the time of impregnation. While the facts collected from experiments on this point are conflicting, the weight of testimony goes to show that an early impregnation favors the development of females; and a late impregnation the development of males. "Starting from this idea, and supposing that the complete maturity of an ovum might be very favorable to the production of the male sex, and inversely, M. Thury, of Geneva, caused cows to be impregnated, sometimes at the beginning, sometimes at the end of the rutting period. In the first case he obtained female calves; in the second, male calves. The experiment was repeated by a Swiss agriculturist, M. Cornaz, who twenty-nine times in twenty-nine cases, succeeded in producing at will such or such a sex." Experiments on the effect of late fertilization of the eggs of birds had previously been made by Knight, "which," he states, "to have been frequently repeated," and which gave similar results. "When the female was kept without intercourse with the male up to nearly the time for laying, so that the eggs had advanced very far in their development at the time of fertilization, the proportion of males among the offspring was very large, commonly about six out of seven."

THE EXPLANATION.—There are two theories by which to explain the fact that an early impregnation favors the production of females, and a late impregnation the production of males. One is simple and easily understood. It is, that if the impregnation is very soon after the ovum is matured, it is far up in the Fallopian tubes, and consequently a less number of spermotozoa reach it. The result will be that the germ element will be most likely to prevail and the offspring be a female. On the other hand, if the impregnation takes place at a later period, the ovum will be farther down, and consequently more spermotazoa will be capable of reaching it, and the probability will be that the sperm element will preponderate, and a male be the result.

The other explanation is more complex, and has its foundation in microscopical and embryological studies and the changes that go on in the ovum before and after impregnation takes place. It was previously stated that the germ or ovum and the sperm or male element have two very different tendencies. Mature germs result from the extraordinary growth, without division, of certain primitive germinal cells of the ovary, by the aid of the smaller cells by which they are surrounded. In animals, the sperm elements are formed by an entirely opposite process, or the division or breaking up of the male germinal cells. The tendency of the one is to develop in size, and, consequently, the eggs of all animals are larger than the sperm elements of the male. In the germ cells, growth without division predominates; in the sperm cells, division without growth predominates. But the germ element has another property, that of segmentation, which may take place before impregnation. Now, if impregnation occurs very early, and before the segmentation is fairly begun, the ovum has greater power to transform the sperm and develop it after its own kind. There is a relative preponderance of cell growth and a deficiency of cell division. If the impregnation is delayed, exactly the reverse happens; the male pronucleus, so-called, never becomes so large; but its tendency to develop after the manner of the sperm by rapid division, is greater, and so a male is the result.

Recent investigations have shown that the act of impregnation consists in the formation of a male pronucleus, derived from the impregnating sperm-cell, which fuses with the female pronucleus of the germ-cell to constitute the single nucleus of the fertile ovum. And Hertwig points out, "that considerable difference may be observed in the occurrences which succeed impregnation, according to the relative period at which this takes place. When, in Asterias, the impregnation is effected about an hour after the egg is laid, and previously to the formation of the polar-cells, the male pronucleus appears at first to exert but little influence on the protoplasm, but after the formation of the second polar-cell the radial striæ around it become very marked, and the pronucleus rapidly grows in size. When it finally unites with the female pronucleus it is equal to the latter in size. In cases where impregnation is deferred for four hours, the male pronucleus never becomes so large as the female pronucleus.

With reference to the effect of the time at which impregnation takes place, Asterias would seem to serve as a type. Girou found that if the female flowers of diœcious plants be fertilized as soon as they are fit to receive the pollen, the seed resulting produced mainly female plants; and that if the fertilization be deferred to as late period as possible, the seeds resulting produce mainly male plants.

CHAPTER XIII.

EFFECT OF PREVIOUS IMPREGNATION ON THE FEMALE.

One of the most wonderful phenomena of generation is the effect of one impregnation of the female on the offspring by succeeding males. This has been observed in animals and plants, and the law is known to extend to man also. A few facts will make the matter clear.

Mr. George T. Allman, of Tennessee, bred a bay mare, with black points, to Watson, a son of Lexington, who is a golden chestnut, having a large star, and both hind and near front ankles white. After dropping her foal he bred the same mare to his saddle-stallion, Prince Pulaski, a very dark chestnut, with no white save a very small star; this produce was a fac simile of Watson in every particular.

Alexander Morrison, Esq., of Bognie, had a very fine Clydesdale mare which, in 1843, was served by a Spanish ass and produced a mule. She afterward had a colt by a horse, which bore a very marked likeness to a mule; seen at a distance, every one set it down as a mule. The ears were nine and a half inches long, the girth not quite six feet, and he stood above sixteen hands high. The hoofs were so long and narrow that there was difficulty in shoeing them, and the tail was thin and scanty. He was a beast of indomitable energy and durability, and was highly prized by his owner.

A similar case is recorded by Dr. Burgess, of Dedham, Massachusetts, who says, "From a mare which had once been served by a jack, I have seen a colt so long-eared, sharp-backed and rat-tailed that I stopped a second time to see if he were not a mule."

Dr. H. B. Shank, of Lansing, Michigan, informed Dr. Miles that a mare belonging to himself having produced a mule, was afterward bred to a Morgan stallion with remarkably fine ears; the ears of the colt were large and coarse, presenting a close resemblance to those of a mule. A second colt produced by the mare to the same stallion had the head and ears of its sire.

A pure Aberdeenshire heifer was served with a pure Teeswater bull, by which she had a first-cross calf. The following season the same cow was served with a pure Aberdeenshire bull; the produce was a cross-calf, which, when two years old, had very long horns, the parents being both polled.

A small flock of ewes belonging to Dr. W. Wells, in the island of Grenada, were served by a ram procured for the purpose; the ewes were all white and woolly, the ram being quite different, of a chocolate color, and hairy, like a goat. The progeny were, of course, crosses, but bore a strong resemblance to the male parent. The next season Dr. Wells obtained a ram of precisely the same breed as the ewes, but the progeny showed distinct marks of resemblance to the former ram in color and covering.

Mr. Darwin cites the following case from the "Philosophical Transactions," 1821: "Mr. Giles put a sow of Lord Western's black-and-tan Essex breed to a wild boar of a deep chestnut color, and the pigs partook in appearance of both boar and sow, but in some the chestnut color of the boar strongly prevailed. After this boar had long been dead the sow was put to a boar of her own black-and-white breed—a kind which is well known to breed very true, and never to show any chestnut color; yet from this union the sow produced some young pigs which were plainly marked with the same chestnut tint as in the first litter."

Dr. Miles writes: "In July, 1877, in company with my friend Dr. H. B. Shank, of Lansing, Michigan, I visited the farm of Mr. A. N. Gillett, in the town of Delta, Ingham County, where we saw a litter of pigs out of a pure Berkshire sow, and got by a pure Berkshire boar.

"More than one-half of the pigs were apparently Poland-China in the form of the head, and their bodies were spotted with sandy-white. We were informed by Mr. Gillett that the preceding year the dam of these pigs had produced a litter of pigs, by a Poland-China boar, that were marked in the same manner with sandy-white spots. The sow was bred under my direction, at the Michigan Agricultural College, three years ago, and the stock from which she had descended had not shown any variations from the pure Berkshire type."

Mr. Darwin, on the authority of Dr. Bowerbank, gives the following striking case: "A black, hairless, Barbary bitch was first impregnated by a mongrel spaniel, with long brown hair, and she produced five puppies, three of which were hairless and two covered with short brown hair. The next time she was put to a full black, hairless, Barbary dog; but the mischief had been implanted in the mother, and again about half the litter looked like pure Barbarys, and the other half like the short-haired progeny of the first father."

Professor Agassiz states that he had "experimented with a Newfoundland bitch by coupling her with a water-dog, and the progeny were partly water-dog, partly Newfoundland, and the remainder a mixture of both. Future connections of the same bitch with a greyhound produced a similar litter, with hardly a trace of the greyhound. He had bred rabbits with the laws established by this experiment, and at last had so impregnated a white rabbit with the gray rabbit that connection of this white rabbit with a black male invariably produced gray."

A celebrated breeder of short-horns, of my acquaintance, bred the females of a light-colored family to a red bull, and afterward to a bull of their own family; he succeeded, in this manner, in producing the desired shades of color in the offspring of the light-colored females.

The same influence has been observed in the human family. A woman may have, by a second husband, children who resemble a former husband, and this is particularly well marked in certain instances by the color of the hair and eyes.

A white woman who has had children by a negro may subsequently bear children to a white man, these children presenting some of the unmistakable peculiarities of the negro race.

In a lecture, in speaking of the influence of a previous impregnation upon offspring at a later period, Agassiz said: "It therefore shows what I have satisfied myself to be the truth among other animals, by numerous experiments; that the act of fecundation is not an act which is limited in its effect, but that it is an act which affects the whole system, the sexual system especially, and in the sexual system the ovary to be impregnated hereafter is so modified by the first act that later impregnations do not efface that first impression."

Mr. Darwin cites a number of instances in the vegetable kingdom to show the "direct action of the male element on the mother-form," and he comes to the conclusion that "the male element not only affects, in accordance with its proper function, the germ, but the surrounding tissues of the mother-plant."

After citing some of the cases that have already been presented of the influence upon offspring of a previous impregnation of the mother, Mr. Darwin says: "The analogy from the direct action of foreign pollen on the ovarium and seed-coats of the mother-plant strongly supports the belief that the male element acts directly on the reproductive organs of the female, wonderful as is this action, and not through the intervention of the crossed embryo."

It hardly seems necessary to give further illustrations on this subject. In answering the question why this is so, we are met by difficulties which only future study can clear up. The theories advanced by Agassiz and Darwin, which are really the same, may, perhaps, be accepted for the present.

Dr. Manly Miles, in "Principles of Stock-breeding," says: "It was formerly claimed that the peculiar influence of the male was limited to the first impregnation of the female only, but there is good reason to believe that every impregnation may leave its impress upon partly-developed germs, and be thus transmitted with the characters of a subsequent fecundation.

"The intensity of the influence of the male may be impaired by an excessive use of the procreative organs; it has been observed in fowls that when the male is "over-mated" the eggs are sometimes imperfectly impregnated."

Thus do we find that the subject of generation is full of mysteries; and this is partly to be accounted for by the fact that it has been, and still is, to some extent, a subject given over too much to sensuality, and too little to science. As we tread on this almost new world, let us be reverent and thoughtful, and let not unholy thoughts fill our minds to the exclusion of deeper truths.

CHAPTER XIV.

REGULATION OF THE NUMBER OF OFFSPRING.

"WOMAN'S RIGHTS."—No truth is more self-evident, no rule of right more plain, no law of Nature more demonstrable, than the right of a woman to her own person. Nor can this right be alienated by marriage. "Life, liberty, and the pursuit of happiness," and also health—without which life and liberty are of little account, and the pursuit of happiness impossible—are God-given prerogatives, and inhere in the person; and all statutes, ceremonies, creeds, institutions or usages which in any respect contravene the fundamental law of absolute personal freedom, in all the relations of life, are in derogation of the laws of Nature, and in opposition to the best good of the human family. The great want of the age, of humanity—the great need of man as well as of woman—is the recognition of woman's equality. Would it not excite the just indignation of a man to be told by any person, even though that person were his "lawful wedded" wife, that he must beget children when he did not desire them? or that he must submit to the sexual excitement when ill or otherwise employed? Certainly he would never submit to such tyranny, nor should he. And why should woman? It ought to be understood by all men and women that the sexual embrace, when either party is averse to it—when both parties are not inclined to it—is wrong. And whether the consequences are sexual diseases of one or both parties, or personal alienation, or depraved offspring, or all, there is no possible escape from the penalties.

A more pernicious doctrine was never taught than that of absolution from the penalties of our misdeeds. Causes and consequences are as unalterably related in the organic as in the inorganic world. Nature punishes always, and pardons never, when her laws are violated or disregarded. In the vital domain, as in the moral, "no good deed is ever lost," nor any wrong act performed without evil effects. When this great primary truth is recognized in practice; when it is taught in our schools and exemplified in our lives, we shall have the true basis on which to prosecute our physiological redemption. "Cease to do evil" is the first and greatest lesson to be learned. This is emphatically true as applied to the sexual relations, for the reason that the organic laws are more disregarded in these relations than in any other. And this dis obedience, with its train of untold miseries and its wide-spread sensuality and degradation, is, like-other evils, attributable mainly to ignorance; people are ignorant on this subject because they have not studied it at all, or have studied it from the wrong stand-point. Woman's equality in all the relations of life implies her equality in the sexual relation. It is for her to nourish and sustain the new being; it is her health and life that are directly imperiled by bearing children when she is unfitted and unwilling for the sacred office; it is her happiness that is more especially destroyed when forced to bring into the world sickly and deformed children, who can be nothing but a torment to themselves, of no use to the world, and nothing but a shame to their parents.

In the sensuous world around us, habit and feeling rule in the matter of sexual intercourse as much as they do in the matter of eating or drinking or dressing. The why or wherefore is never thought of, and in dietetic habits the masses of people follow no law except that of perverted appetency. They eat and drink to gratify alimentiveness, regardless of all physiological considerations, and without knowing or thinking whether their appetites are normal or morbid, or whether the food is wholesome or not.

And as no propensity is more abused and abnormal, as the world is now constituted, than that of amativeness, and as sexual intercourse has become in married life, with most persons, a habit, to be indulged whenever the man feels the inclination, it follows that woman must be degraded to a mere machine in all that pertains to her highest interest and holiest aspirations.

In the animal kingdom the female does exercise her supremacy in this respect. No male animal offers violence to the female; but when she is in proper condition for his embrace, and desires it, she solicits it, and he invariably responds. So it should be; so it is in the order of Nature with man and woman; and when her supremacy is fully recognized, there will soon be an end of stillbirths, and of frail and malformed offspring who can seldom be reared to adult age, or if they can, are only curses to themselves and to the world.

It may be objected, that to leave this great and important question of having children entirely with woman would endanger the extinction of the race. Such an objection implies little knowledge of woman and less of Nature. The desire for offspring, with all women who are in normal conditions, is the strongest of their natures. It is all-absorbing, all-controlling. It is only in diseased conditions that the pains and perils of childbirth and the cares of maternity are dreaded. It is well understood by physicians that the health of a majority of women in civilized society is seriously impaired and their lives greatly abbreviated by too frequent pregnancies. Thousands are brought to their graves in five, ten or fifteen years after marriage, and rendered miserable while they do live, for this reason. And so general has this conviction become, that women all over the civilized world, and in all classes of society, are more and more resorting to numerous expedients, more or less injurious, to prevent pregnancy or produce abortion. Nor does it avail for the moralist to declaim against the practice as wicked. All laws are equally sacred in the sight of the Lawgiver, and woman's instincts can recognize no higher law (whatever she may assent to intellectually) than that of self-preservation, and no duty greater than that of bringing into the world children of sound and vigorous constitutions, or none at all.

Restore woman to health, and give her what God has ordained as her birthright—the control of her own person—and the trade of the abortionist will soon cease; but until then not only will the abortionist flourish, but the larger race of empirics in every city, who sell useless or injurious specifics for the prevention of pregnancy, will drive a profitable trade.

THE SCIENCE OF PROPAGATION.—Certain modern writers have suggested the idea that, as the propagation of human beings, like that of animals, is governed by laws which can be understood and influenced by conditions within human control, the subject ought to be studied as an "exact science," and its principles applied as a "true art." Why not? This subject has been studied as a science and practiced as an art for centuries—in fact, more or less in all ages—as applied to domestic animals and plants; indeed, as applied to all living things with which man has to deal, with the single exception of his own offspring.

What intelligent breeder would be willing to have his cattle begotten, born and bred under circumstances as unphysiological as are his children? The art of raising domestic animals—horses, cattle, sheep and even swine—has attained a great degree of perfection. The success which has attended this art is due to the recognition of certain principles in physiology which constitute the theory of the science. The laws of life, the conditions of health, and the rules for normal development are precisely the same in all living organisms. Certainly it is of as much more importance that they should be recognized and applied, in relation to the propagation of human beings, as human beings are more important than animals.

But it happens, unfortunately, that while the whole subject is most assiduously investigated in relation to the animal kingdom, and, to a great extent, the vegetable kingdom also, it is too much ignored in its application to human beings. The subject is not alluded to in our text-books on Physiology; it is not taught in medical schools; it has no place in the current medical literature of the world; it is too rarely mentioned in the family circle; the good minister never hints at it, and, with the exception of a few of the more progressive of Sanitarians, nobody tries to disturb the unthinking tranquility of the public mind. Yet it lies at the foundation of all human improvement and all enduring progress, and is intrinsically the most important problem that can occupy the human mind.

Since the publication of the first edition of this work, Dr. M. L. Holbrook has published a most exhaustive work, entitled, "Marriage and Parentage," in which every branch of the subject has received calm, wise and judicious consideration. Every unmarried person and every parent should read it.*

SOUND GERMS AND A SOUND PROGENY.—I cannot help, in connection with this subject, making an extract from a address delivered by the Hon. George F. Talbot:

"Inveterate habits, rooted social, ethical and religious ideas, fenced in by passionate prejudices, time-honored customs, and hardly repealable laws, insure for the caprices and dominant appetites of men such a scope as leaves the result of their operations their hap-hazard chances of good or evil fortune. We imprison the thief and we point the fixed finger of shame at the prostitute; but, when

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* Marriage and Parentage, and the Sanitary and Physiological Laws for the Production of Children of Finer Health and Ability. Price $1.00. New York: M. L. Holbrook & Co.

they come together in the holy bonds of matrimony, the minister of religion pronounces it an ordinance of God, and society stands helpless before the teeming swarms of vicious progeny that are to be the fruit of such a marriage.

"Nearly all the cases of insanity and alcoholism, the outbreak of which inflict such unspeakable suffering upon our domestic life, are due to hereditary taint. Is it too extravagant a hope to cherish that the time may come when increased intelligence and a more sensitive moral feeling will deter from marriage those who have inherited a scrofulous constitution, an uncontrollable appetite for alcohol, insanity, causeless and excessive melancholy, or liability to furious paroxysms of anger? Is it past the ingenuity of man to insure that of such unpromising parentage the children of the future shall not be born?

"But this is not enough. There are no absolutely healthy families. No blood is entirely pure. Go far enough back in the ancestry of the soundest of us, and you will find nearly all the ills, mental and physical, to which flesh is heir. Unless we can induce or compel the apparently sound whom we permit to marry to observe the laws of life in procreation, the weakness that will result will show itself in some reversion to a more or less ancient type of physical or moral disease.

"Nature is willing to help, does help, man in his effort to better himself. That is to say—to state what seems to be one of the vital laws: Healthy parents who do not observe the most favorable conditions for procreation may produce healthy offspring. Unhealthy parents, carefully observing the most favorable conditions for procreation, may produce healthy offspring. In the former case there will be sound children deriving vigor from parents in spite of slight violations of the laws of life. In the latter case there will be sound children, because the parents, though not themselves sound, carried forward their progeny one degree by carefully observing the laws of life. But, if only healthy parents produce the children of a people, and that, too, with a strict compliance with the conditions of procreation, the result will be a steady improvement in the quality of the human race, and the gradual breeding out of physical and moral corruption.

"We keep up the average health, slightly improve it now, though the few healthy parents do not observe the laws of life, and though the parentage is largely itself unhealthy, because half the human race perishes before it attains the age of ten years. That is to say, nature comes along and looks at our puny progeny, and, saying: 'Misbegotten things!' blots them out with diphtheria, scarlatina and cholera infantum.

"In the earlier stages of human life, by ruthlessly destroying all the weaklings nature insured the increasing vigor of the human animal. When man got his large brain, the most intelligent became more than a match for the most strong, and the best intellect had the best chance to survive. Now, at last, that our moral faculties are coming to dominate our intellectual, as these once dominated the physical, our very humanity and sympathy, the tenderness with which we cherish and try to cure and perpetuate not only the feeble-minded, but the vicious-hearted, will tend to arrest the evolution of humanity, unless an intelligent will takes the place of a blind force in insuring the survival of the fittest."

REGULATION OF BIRTHS.—Continuing, the honorable gentleman said:

"If we should give the races of rats access to all our stores of food, destroying our traps and whistling off the cats, and open to every rodent a career of unlimited bread and cheese for himself and his progeny, how long would it be before the rats would be in force to eat us?

"The human animal has not powers of reproduction to vie with the rats; and yet if mankind were relieved of their chronic apprehension of poverty, if an office and a salary awaited every child that was reared—especially if early marriages became a usage, as they inevitably would under such a society—the number of candidates would speedily exhaust all the places, and the great suplus army of men to be detailed to till the ground would soon raise such a surplus of food that it would not pay to harvest it.

"See what checks restrain the prodigality of human reproduction. Few sensible men dare place themselves under obligations to support a family until there is a reasonable prospect of some just and honorable provision for its maintenance. If the consideration does not influence the passions of young men, it does influence the cooler judgment of young women; and it is sure to be considered by parents and friends, whose influence is always potent. So that, as our business grows more complicated, and the chances of fortune more precarious, marriage gets postponed to the wise years when more and more find how much easier and wiser it is to forego it altogether. But, with all these checks, the contribution to population in nearly all civilized States seems to be in excess of the demands of nature, in excess of the means to provide for them by nearly one hundred per cent.; for what are these diseases of infancy that destroy half the human race before they are ten years old but Nature's interference with redundant births? What if we should find out how to isolate or destroy whooping-cough, measles and scarlatina? What safeguard have we against new disorders that would take their place?

"The human race will never attain the condition of health which is best defined in the terse language of Horace: a sound mind in a sound body, till it has learned how to breed healthy children. We have interposed a wise control over the procreation of horses, cattle, swine, sheep. We have neither found how nor dared apply the same intelligence to the procreation of men.

"When the best wisdom of the race, expressing and enforcing itself in a rational way, shall be able to stand at the entrance frontier of human life, and say who shall pass, it will have the key to open for mankind the better era, the good time coming of the popular thought, the Republic of which Plato speculated, the Utopia of Thomas More, the Arcadia of Sir Philip Sidney, the Kingdom of Heaven of Jesus of Nazareth, the New Jerusalem coming down from heaven adorned as a bride for her husband of the Apocalyptic vision. With the abolition of poverty by keeping the numbers of the human race balanced to the supply of the means of subsistence produced in greatest abundance and justly distributed, it will solve at the same time the problem of sickness and of crime by bringing in a progeny in whom the primeval taint of lust and passion, of insanity and sickness, has been reduced to its minimum.

"It is necessary, however, to stipulate that for the accomplishment of his high destiny man needs the hope and patience of God. The world-bettering went on in those early ages, when there was no sympathetic heart of man to long for it, no helping hand of man to aid it. If there be not at the heart of the universe some principle or power of good, how vain are human toils, sacrifices and prayers! It is the faith of democracy that the good purpose we have found in the bosom of nature expresses itself also in the mind of man, the consummate product of Nature.

"The thing to do is to patiently bear the ills of our condition that are irremediable, and to contribute our brief strength to lessen or remove such as are the result of our ignorance or misdoing. Not by dynamite or the dagger, not by revolution or secession, not necessarily by forming a new party or propagating a new faith, but by watching the trend of things toward good, and by aiding with voice and vote the specific reform, that the apparently blind, but really guided impulse of the time has made opportune and feasible, shall we best bring nearer the poet's dream 'of the highest, justest, happiest, and so most perfect, condition of human life on this planet.'"

Children a Necessity to a Perfect Life.—The possession of healthy children is necessary to render life morally complete. I admit that there are many happy marriages which are not crowned by offspring; but they are not of the highest order of happiness. I do not believe that the purpose of marriage is only, as is sometimes coarsely put, to continue the race. Husband and wife can be a great deal to each other, and can be very happy indeed with one another, even apart from the existence of children. The partners of the wedded life should reciprocally supplement the defects of the one by the excellence of the other; should love one another always and wholly, whatever feelings they may have for their children; should lift the duality of sex into a unity of a harmonious life. This is the first purpose of marriage. But it is the peculiar nature of these unities of human life that each opens into a larger unity. Thus, the life of the single man and woman enters into the dual life of matrimony, the life of the pair become one, open into the multiple life of the family, and this again will open and broaden into the vaster life of the community. And though the presence of children is not absolutely necessary, yet those whose marriage is not crowned by offspring do, in so far, lead incomplete lives. Fatherhood and motherhood are not only sacred names, but they imply new and sacred experiences; they impose new responsibilities; they deepen the moral insight in a new direction; they bring into view whole ranges of spiritual facts unknown before.

In Catholic countries one sometimes sees erected along the highways the so-called Stations of the Cross. At each Station the devout believer stops and prays, and tries to recall the peculiar suffering which this Station suggests. Each Station points to the succeeding one; and when he has passed through all, then the believer is made more perfect in faith. So there are stations on the high road to perfection, stations not of suffering merely, but of mingled joy and pain—stations that open larger and ever larger fields of duty. The station of single existence is the first; the station of married life is the second; the station of the family life is the third; the professional, the national, the international life come next; the life in the ideal commonwealth of reason is the last. Through all these stations we must pass; the discipline of each we must receive; to the refining and expanding influences of each we must subject our souls in order to reach the goal to which we are all tending—perfection by the full development of the manliness and womanliness that is in us.

Felix Adler, in one of his matchless discourses, says: "I have read, in my boyhood, of the pious Æneas, who bore his father, Anchises, on his sturdy shoulders out of burning Troy. I never knew then why Virgil persisted in calling him the pious Æneas. I see it now. Because the root of all piety that exists in the world is to be found in the filial relations. I read in my boyhood, in the legendary lore of the Talmud, the story of young Dama, to whom came one day the elders of Israel, to purchase some precious jewels which he alone possessed, for the robe of the high priest. And as they offered him a fabulous price, far exceeding his utmost expectations, he accepted their offer with delight. But when they added the condition that the jewels must be delivered at once, he became grave and silent, and declined to effect the sale. And when they pressed him to give his reason, he said at last, that his aged father was sleeping in the room in which the gems were stored, and not for all the treasures of Israel would he break his slumbers. I read this week of a brave young fireman who was swept from a ladder near the fourth story of a burning building. Thrice he turned in the air, and as he reached the ground he was heard to exclaim, 'Oh, my poor mother!' And I have asked myself, is there any word in human speech by which we can express the depth and tenderness of filial love? Reverence is one word, gratitude is another. Oh, but it is a peculiar gratitude which the child feels for its parent. Gratitude of the ordinary description seeks to return in kind what it has received; but the gratitude which children feel for their parents is marked by the fact that they can never hope to return what they have received; it is a longing which can never be satisfied; it implies the recognition of an endless indebtedness which we can never, never cancel. The conjugal relations on the one hand, the parental and filial relations on the other, stand out well-defined and conspicuous above all other human relations. In them the tie of unity is the closest, and in proportion to the closeness of the unity is the sacredness of the relation. The true spouses recognize in each the entire counterpart of the other; the child recognizes in its parents the founders of its entire existence, both physical and moral.

"Therefore, the names of father and mother are the holiest which human lips can pronounce; therefore, our endless indebtedness to them does not lie like a load upon our souls, but rather like a blessed influence, chastening and exalting us. Therefore, even after years and years have elapsed, and we have long been separated from the home of our childhood, even after we have grown gray and weary in the struggle, our thoughts still go back with ineffable reverence and love to the father who guarded our first timid steps on the thorny pathway of life, to the sweet mother who cared for us as no one ever will care again."

THE NUMBER OF CHILDREN.—The number of children required to fill up the life of a parent in all its completeness, is not a matter requiring much discussion. Many are satisfied with a single one, but it seems to me this is not enough. Happy indeed may be the parents of one noble boy or girl; happier still if there are one of each. And if there are more, strong and healthy, there certainly can be no objection. It is the rearing of feeble, imperfect children that is to be deprecated—children who cannot receive good constitutions and a good start in life.

BEST TIME FOR PARENTAGE.—There are many

married couples who delay parentage till they are more favorably situated. Sometimes there may be wisdom in this; but the most suitable age is when the physical and mental powers are at their best; if parentage is delayed beyond this time the offspring will be less favorably endowed.

CHAPTER XV.

THE LAW OF SEXUAL INTERCOURSE.

THE PRIMARY QUESTION.—In considering the subject to which this chapter will be devoted, the first important question to settle is the object of sexual intercourse—what does Nature intend to accomplish by it? So far as the animal kingdom, or the lower animals, as some prefer to term the brute creation, is concerned, the problem presents no difficulty. To propagate the species is the whole of it. With all animals sexual intercourse is a mere generative act. But is it so with man? This is a question that will be, must be, and should be investigated; for, whatever is the law established in the constitution of human beings, it is for their highest good to understand and obey it.

There are those who, reasoning from the premises that vital laws are essentially the same in all living organism, have arrived at the conclusion that whatever is the law of sexual intercourse in relation to animals must also apply to human beings. So far as the individual functions are concerned, and, indeed, so far as all of the vital functions merely are concerned, this conclusion is incontrovertible; but in applying it to human beings we cannot ignore its moral and religious bearings. Hence, others who have examined the subject with an equally truth-seeking spirit, have come to the opinion that sexual intercourse is, with human beings, intended as a love act as well a generative act. The question has fairly two sides; and the data which apply to its solution are extremely difficult to be found, because of the abnormal habits and perverted instincts of nearly the whole family of mankind.

Whatever views may be entertained with regard to the philosophy of the theory of population, all physiologists will doubtless agree that, in a higher and better condition of society, the number of children born will be diminished, while their quality will be correspondingly improved. It is equally evident, also, that when the physiology of menstruation is perfectly understood, including the knowledge of the times when the woman is or is not liable to impregnation, a single act of coition will suffice to beget a single child; and that, therefore, on the theory that sexual intercourse is intended by Nature merely for the purpose of reproduction, it follows that the acts of intercourse should be limited to the number of offspring. Such is the legitimate result of the theory carried to its ultimatum. That we shall eventually, if not soon, arrive at this knowledge is not only possible but probable. With regard to domestic animals whose sexual instincts are less depraved, our knowledge on this subject is well-nigh perfect—certainly sufficient for all practical purposes. It rarely happens that the breeders of domestic animals do not know when to bring the sexes together for fruitful coition.

But, admitting that we should never make any further advancement in knowledge with regard to the time and conditions for fruitful coition, and that women continue to the end of the world to have as many children as heretofore, on the theory that sexual intercourse has normally no purpose or object except to fecundate the ovum, the exercise of the sexual organs of the male would be, compared with present customs, extremely limited. Pregnancy very frequently results from the first sexual embrace with married couples, and sometimes in the case of those who are not married. Of course there should be, in these cases, no repetition of the sexual act until after the periods of gestation and lactation are completed—nearly two years from the date of conception—and then again a single coitus might result in another pregnancy, and so on. No doubt such a doctrine, or rather such a practice, would be abhorent to the majority of people, who have been educated to regard it more in the light of a lust indulgence than of love.

Whether human beings would be satisfied with, or submit to a life of such continence and utilitarianism, is not here to be discussed. If the principle is true it should be taught, let human beings do what they will.

We cannot refer the decision of this question to the desires of the human instincts or propensities, as we can with regard to animals, for the reason that those instincts are depraved and perverted, while these are normal. I have no doubt that, in a perfectly normal condition, the instincts of human beings, the sexual propensity not excepted, are infallible guides, just as they are with unperverted animals. The greater includes the less. Man has all the instincts of all the creatures below him with other powers superadded. And if he were in all respects possessed of "a sound mind in a sound body," he would never desire sexual intercourse, more than he would food or drink, except when it was best both for himself and the woman to whose desire he would respond. But as we have no such persons to serve as models of what men should be, we must do the best we can with such data as the disordered world affords us.

Animals are not voluntarily progressive. They do improve from generation to generation, not of their own accord, but by a law of nature which promotes the survival of the fittest.

Human beings are progressive. They are ever altering, (sometimes for the worse, perhaps), changing, the object being to improve and perfect; this object obviously implies society, traffic, schools, moral culture, religious influences and provision for the future; all of these necessitate the family relation; the family relation implies one man and one woman as its source and head.

Man, by looking forward to an eternity of existence, provides the means which are to benefit himself or his successors for generations, centuries and ages to come. In a great measure he controls the elements. To a great extent he is superior to circumstances. And while spring time and harvest enable him to lay up stores of food from the well-tilled earth, the winter season affords him the best opportunity for moral and intellectual culture; and, by means of houses rendered comfortable at all seasons, his sexual desires and relations seem to be placed on a very different plane from those of the animal kingdom.

There can be no question that the most perfect organization of the offspring requires the most complete commingling of elements, or magnetism, or whatever else the parents impart or contribute in the sexual embrace, and that there should be the most perfect harmony and enjoyment with each other. They should be as much at-one-ment as possible, so that, at the moment of conferring life upon a new being, each should almost lose, in the intensity of pleasurable sensation, the consciousness of individual or independent existence. I cannot understand how this condition can be so well acquired and maintained as by temperate sexual indulgence, even when offspring are not desirable nor proper. But what is temperate indulgence may not be so easily determined.

The Social Vice.—Between love and lust it may not always be easy to draw the line of demarkation. It would not be difficult to give those who need none a rule for sexual indulgence. They, being in a normal condition, are a law unto themselves. They may safely follow their inclinations in this respect as in all others. But with the great masses of the people the only rule of conduct is appetite, and this is to a great extent morbid. Hence, sexual intercourse, in the homes of the married and respectable, as well as in the dens of prostitution, is indulged in more to appease a morbid craving than to gratify a normal instinct, as gluttony, tobacco and alcoholic liquors are indulged more to stifle for the moment an insatiate and intolerable irritation, than for any pleasure or gratification resulting from them.

The fearful and increasing prevalence of "The Social Vice," especially in all large cities of the world, is one of the problems whose existence our philanthropists deplore, while they see no way to deal with it practically. It has recently been proposed that, as the evil cannot be removed, it should be mitigated and regulated by the license system as it is in Paris; and one of our leading city dailies lately suggested the same plan to apply to the city of Washington. It has too long been the custom of statesmen, when they find it difficult to suppress evils, to make a compromise with conscience, and derive a revenue by "regulating" them. The result has always been a temporary alleviation of some of the evils resulting from the unlicensed vice, while fastening the licensed vice more firmly on society. This has been the case with the liquor traffic and the tobacco trade, and may be with the traffic in character and chastity.

In all of these cases the remedy lies further back. It should be directed to the causes rather than to the effects. If young women were allowed equal opportunities with young men for education and occupation, one-half of the sum total of the causes of prostitution would be removed at once; and if the young of both sexes were educated and trained hygienically—taught to eat, drink, dress and exercise properly—the remaining moiety would be very nearly done away. It is possible to educate people into sensuality or the reverse. Feed men on highly spiced foods, give them wine and beer as drinks, and sensuality will increase. Feed them on natural, plain, rich, nutritious, but unstimulating food, and give all culture and enough to do, and the social vice will gradually disappear. Society has no moral right to regulate or license anything that is intrinsically wrong, nor has it any moral right to punish its debauchees and vagabonds until it removes temptation from them, and provides the means by which they can secure a comfortable livelihood by honest labor. Until this is done, I have no faith whatever in regulations or licenses on the one hand, nor in pains and penalties on the other.

THE SOLITARY VICE.—Terrible as are the bodily diseases and moral ruin which result from the Social Vice, it may be questioned whether the infirmity and degradation of the human race from the Solitary Vice is not the greatest of the two evils.

The manner in which the great majority of children are fed, if it does not ruin their digestive organs and render them dyspeptics or consumptives, is sure to produce permanent congestion, with constant irritation in the pelvic viscera, resulting in a precocious development and morbid intensity of amativeness. Tea, coffee, flesh meats, to say nothing of the abominations of the baker and confectioner, are sufficient to account for the early tendency to sexual dissipation and debauchery manifested by a large portion of the children in primary schools. Many a parent, now confiding in the purity and safety of his own son or daughter, might be appalled if he should investigate this subject.

SHAKERISM.—In view of the prevalence of vice, crime, disease and degradation resulting from perverted amativeness, and the miseries and discontent so rife in married life, one can hardly wonder at the "extreme measures" which have been proposed as a remedy for these evils. The Shakers have certainly gone to the root of the matter, and I fear a little beyond. There is such a thing in jurisprudence as "proving too much;" and while our Shaker friends, who are excellent people, and generally more intelligent with regard to the conditions of health, and certainly more observant than most religious denominations, have adopted a system which will, if universally accepted, assuredly prevent all the evils which have their origin in sexual abuses, it must be at the expense of existence itself. It is like "curing the disease by killing the patient." It is true that the Shakers base their creed on the "Bible argument," as do the Mormons, whose male members appropriate to themselves an unlimited number of females; but in these days of enlightenment it behooves the teachers of all religious systems to square the teachings of the Bible with the Book of Nature and the Laws of the Universe.

Sexual intercourse is condemned by the Shakers because of its sensuality, its degrading and unspiritualizing tendency. It was the means for perpetuating the species under the "old Adamic" dispensation, which Christ, the "new Adam," came to destroy or supersede. Such logic is very like declaring eating and drinking (and who has better victuals and drink than the Shakers?) depraving and demoralizing, because a majority of the human race have made themselves dyspeptics or gluttons by eating and drinking improperly. True physiology teaches that there is nothing low, nothing base, nothing degrading, nothing demoralizing, nothing sensualizing, nothing impure in the normal exercise of any faculty or propensity with which human beings are endowed.

The phrases, "animal passions," "lower propensities," "brutal lusts," etc, have been so frequently applied to the perversions of amativeness, that many persons have acquired the habit of associating the idea of vulgarity with it. Nothing can be more vulgar, indecent and degrading than its abnormal or merely lustful indulgence ; but normally exercised, no act of an intelligent being is more holy, more humanizing, more ennobling. Perverted conscientiousness—conscientiousness misled by an erring intellect—has tortured human beings at the inquisition, burned them at the stake and destroyed them in all the cruel methods that human ingenuity could contrive. Yet no one terms conscientiousness a base or brutal propensity; nor would they apply such an epithet to any mental power if they justly discriminated between its use and abuse.

Mormonism.—The Mormons of Utah profess to derive the principles of their creed from the Bible. Polygamy was practiced in ancient times by good men; the fact is recorded in that book; *ergo*, the Bible teaches polygamy! Such is about the substance of all the logic we have on the subject. But the question that especially concerns us in the discussion is the physiological bearings of polygamy as practiced by the Mormons.

The argument derived from the polygamous practices of the lower animals proves too much. In some instances one male will cohabit with several females, and in other instances one female cohabits with several males. If the Mormons who quote natural history to sustain their peculiar institution would give us all the facts in the case, the argument would be conclusive against them. How would it suit them to permit the women to choose their husbands, one or more, as fancy, interest, caprice, ambition or passion dictated? There is no better test of the righteousness of any principle or system than its working both ways, so far as the sexual relations are concerned. An institution which degrades man or woman, or which places them in society, or before the law, on unequal terms, cannot be right, unless humanity itself is wrong. I only introduce the subject of Mormonism into this chapter for the purpose of indicating the remedy for its polygamous feature, a remedy which our politicians have been seeking for several years in vain. This remedy is the recognition, by the Constitution of the United States, of woman's absolute and unconditional political equality.

Celibacy.—The question has often been discussed whether a married or single life is most conducive to longevity. It is argued on the one side that, as man imparts more or less of his unreplenishable fund of vitality at each sexual embrace, a life of entire abstinence would be most conducive to a long life and a "green old age." I do not regard the question as very important. For all practical purposes the best life is the longest. The object of living in this earthly tenement, and all the object that I can discover, is to develop our own inherent and God-given powers, and assist others to do so. This development implies the use of bodily organs as the instruments of the mind or soul; and it consists in ascertaining the existence of beings and objects external to ourselves, and our relations to them. From the cradle to the grave this process should go on. Even in the decline of life, when the bodily structures are consolidating, and the vital spark expiring, many persons possess the ability to think and feel and reason; they continue to develop almost until the last breath. Others become demented in middle life; while many in youth acquire such morbid conditions that further development in this life is impossible. They have then lived long enough. Who, in the exercise of his reason, would desire to live, even if he had the power to make provision therefor, for one moment beyond the period of usefulness? Who could desire to remain in this earthly tenement for an hour after the capacity to do good or receive good was lost? It is then that Death, the "Angel of Mercy," rather than the "King of Terrors," translates him to another sphere, "to the abodes of more than mortal freedom," where the development of the powers of the soul commenced on the earth, as we hope, go on for ever and ever.

Perhaps the "law of compensation" that pervades the universe is in nothing more beneficently manifested than in the relations and fortunes, the joys and sorrows of married and single persons. Marriage is to a great extent "a lottery," simply because boys and girls are taught the isolated fact that they must "get married," without being instructed in the duties or responsibilities of married life. The result is many unhappy marriages. The same ignorance or miseducation which renders so many marriages miserable, induces or causes many to live unmarried. Each may envy the other; but really there is little to choose. No one will doubt that a true marriage is the happiest condition of an earthly existence. But even this is qualified and modified by the disorderly elements of an artificial state of society all around. The unmarried, while they do not share in the highest joys which human nature is capable of experiencing, are free from many of the cares, trials and afflictions which pertain to married life.

One of the most deplorable signs of the times is the increasing indisposition of the young men of our country, especially in the large cities, to marry. Society must demoralize, both sexes must deteriorate under such circumstances. It is easy to point out the causes of this and to indicate the remedy, but it is not so easy to apply the remedy. It is natural for young men to desire a companion for life as soon as they arrive at maturity. If they do not seek such a companion it is because of powerful counter influences. One glance at the condition of the young women of America tells the whole story. They are generally infirm in health. They are extravagant in dress. And these evils are increasing from generation to generation. The young men whose salaries are small, or whose occupations are uncertain, prefer to "endure the ills they have, rather than fly to others they know not of." Who can say they do not act wisely? It is not in human nature, though it may be in human passion, to marry a woman for the sake of nursing an invalid, hiring Bridgets, employing doctors, feeing apothecaries, listening to constant complainings and dancing attendance on the whims and caprices almost inseparably connected with constitutional infirmity and morbid feelings.

It is true that young men dress vainly and foolishly to some extent, and that they are very generally addicted to degrading and ruinous habits in which very few women indulge, for example, tobacco-using. I blame the young women very much for this filthy and detestable habit on the part of the young men. I am of opinion that a man who uses tobacco is not fit to be husband or father. He has no right to make himself indecent and disgusting in the presence of his wife; and he has no right to curse his offspring with the legacy of a depraved organization.

But, if woman was as she should be, she would have a power to lead man in the way he should go, of which she now little dreams. It is, to a great extent, because he does not find in her the qualities which engage his heart and satisfy his judgment, while they please his eye and charm his fancy, that he seeks other associations and other pleasures. He is apt to take her for what she advertises herself to be—a thing of vanity and show; and to seek her company for mere pastime or lust, instead of for refined conversation, elevating sentiments and substantial happiness.

I have no manner of doubt that if the young women of our country would raise themselves above the sphere of fashionable frivolity, they would soon draw the young men after them and away from the low and degrading vices of liquor-drinking and tobacco-using. There would then be few "old maids" among us; but until they do this there ought to be many.

Frequency of Sexual Intercourse.—On this question there is as much diversity of opinion as on any other that can be named. The only data on which a philosophical answer can be predicated is normal instincts, and these, unfortunately, we do not know where to look for. It is easy to lay down a rule by which all may approximate as nearly as possible to physiological propriety—a life in obedience to the laws of life. The more nearly the parties live in accordance with physiological habits, especially in the matters of food, clothing and exercise, the more nearly normal will be their sexual inclinations, and the less need have they of subjecting their desires to the restraints or control of reason. For those who live riotously; who are constantly goading their sexual passions into abnormal intensity by means of gross food, stimulating viands and obscene associations, no better rule can be given than the less indulgence the better.

The majority of young persons unite in matrimony with no education whatever on this subject; and habits, right or wrong, are soon formed which are apt to be continued through life.

Married men are not always as sensual in character, nor as cruel in disposition, as they seem. With many, sexual intercourse becomes a habit, like eating, working and sleeping; and they indulge in it with nearly the same regularity that they do in their other habits, reckless and thoughtless of its consequences to themselves or to their wives. It is no uncommon thing for the physician to attend an invalid woman for years whose ailments are chiefly attributable to this habit on the part of her husband. Almost every physician of large practice has a circle of patients whom he visits and prescribes for once a week, on the average, for years; who never get much better at home, but usually improve at once when removed to a proper distance from it. I do not charge their physicians with remissness in duty in not instructing both parties how to avoid the necessity of employing him professionally, for, generally, physicians are as ignorant as others upon this subject.

One of the reasons why uterine diseases are treated so much more successfully at Health Institutions, watering places, or at any place except home, is because the husband is not continually thwarting what the doctor or Nature is doing for the patient.

The frequency with which sexual intercourse can be indulged without serious damage to one or both parties depends, of course, on a variety of circumstances—constitutional stamina, temperament, occupation, habits of exercise, etc. Few should exceed the limit of once a week; while many cannot safely indulge oftener than once a month. But as temperance is always the safer rule of conduct, if there must be any deviation from the strictest law of physiology, let the error be on that side.

Pleasure of Sexual Intercourse.—Whatever may be the object of sexual intercourse, whether intended as a love embrace merely, or as a generative act, it is very clear that it should be as pleasurable as possible to both parties. Indeed, when it is otherwise to either party, unless generation is intended, it is a cruelty. Nor can the offspring be as perfect as it should be unless the act is both desired and enjoyed by both parties. This rule or law, for it is a law of Nature, at once suggests the conditions that are necessary to insure this result. There must be mental harmony and congeniality between the parties. Each must be able to respond to the whole nature of the other—bodily, morally and intellectually, to that extent that there shall be no sense of discord, no feeling of repugnance, but, on the other hand, an utter abnegation of selfhood.

But let not sexual love be confounded with sexual lust. The former is always gratified and completely satisfied with legitimate indulgence. The latter is like the appetite of the glutton or the drunkard, each indulgence aggravating but never satisfying.

Those who study this subject in the light of physiology, and who practice conscientiously according to the light that is in them, will have no occasion to envy the libertine and debauchee. They will not fail to be convinced that here, as everywhere, "the ways of wisdom are ways of pleasantness, and all her paths are peace." Those persons whose lives are more simple and pure, who are temperate in all sensuous gratifications, and who indulge the sexual passion moderately, will find the happiness resulting unalloyed, and, in the course of a lifetime, correspondingly more pleasurable and satisfactory. And besides, such persons maintain the integrity of the sexual instincts, with the capacity to enjoy, at a much later period of life, than do those whose indulgences are premature or excessive. Many persons are, sexually, as young at sixty years of age as others are at thirty. Some maintain their virility beyond the age of three score years and ten, while others exhaust it in half the time.

Here it may be proper, because of its intrinsic importance, to repeat the law already alluded to: "Intensive life cannot be extensive." One may so live as to keep all of his "lower propensities"—I mean self-relative—in a state of preternatural excitement, and, mistaking the insatiate cravings of morbid instinct for a "natural necessity," soon exhaust the powers of life by inordinate indulgence. Such has been the history of thousands who have applied to me for professional advice. Had they been properly instructed in early life, their history would have been very different. Had such a book as this been placed in their hands in the days of their youth, it would have been their earthly salvation. How emphatically can the words of the wise man, "Train up a child in the way he should go, and when he is old he will not depart from it," be applied to this subject!

Sexual intercourse should never, under any circumstances, be indulged in when either party is in a condition of great mental excitement or depression, nor when in a condition of great bodily fatigue, nor soon after a full meal, nor when the mind is intensely preoccupied; but always when the whole system is in its best condition, and most free from all disturbing influences.

There is good sense and sound philosophy in the words which Sterne causes his hero, Tristram Shandy, to utter: "I wish my father or my mother, or indeed both of them, as they were in duty both equally bound to, had minded what they were about when they begot me; had they duly considered how much depended upon what they were then doing; that not only the production of a rational being was concerned in it, but that possibly the happy formation and temperature of his body, perhaps his genius and the very cast of his mind, and perhaps the fortunes of his whole house, might take the humors and dispositions then uppermost. Had they duly weighed and considered all this, and proceeded accordingly, I am verily persuaded I should have made a quite different figure in the world from what the reader is likely to see me. Believe me, good folks, this is not so inconsiderable a thing as many of you think it."

CHAPTER XVI.

HEREDITY AND THE TRANSMISSION OF ACQUIRED CHARACTERS.*

A belief in heredity goes back to very ancient times, to the childhood of the race. In all ages and among all people it has been observed that offspring inherit certain characteristics from their parents and transmit them on to their offspring indefinitely. It was a knowledge of this fact that led the half wild Arabs to choose for the progenitors of their horses those which had the best qualities, the most enduring constitutions, the best dispositions and tempers. Experience taught them that by this means they might perfect the breed, and they did perfect it, for it is to the Arab steed that we owe our splendid coursers of to-day. All our best horses trace their origin back to strains of Arab blood. Not a breeder of domestic animals living would or could continue in the business with success if he did not follow in the same lines. We scrupulously keep and publish the pedigrees of our thorough-

*A Paper read by Dr. M. L. Holbrook before several societies for scientific study.

bred animals for this purpose. All buyers of blooded stock require evidence of ancestral merit before buying animals to breed from.

The main facts of heredity are easily seen by observing the different races of men. The negroes never give birth to children with straight hair and Caucasian features. We know a Hebrew at sight, because all of his race have certain physical characteristics belonging to them alone. The same is true of Germans, Italians, Irishmen and Indians.

So persistent is this fact of heredity in every department of life that races do not change materially in thousands of years. There are animals, Agassiz says, in Lake Erie, one of the chain of great lakes, exactly like their progenitors of thousands of years ago, as seen in the fossils now found in the same region. They are adapted to a certain environment, and so long as this environment continues they cannot alter. If the environment suddenly changes by any great catastrophe in nature, they are overwhelmed and lost. Only by slow degrees can environment alter and give them time to adjust themselves to it.

Darwin's Views—Darwin says: "The whole subject of inheritance is wonderful." He adds: "When a new character arises, whatever its nature may be, it generally tends to be inherited, at least in a temporary, and sometimes in a most persistent manner.

What can be more wonderful than that some trifling peculiarity, not primordially attached to the species, should be transmitted through male or female sexual cells, which are so minute as to be invisible to the naked eye, and afterwards through the incessant changes of a long course of development, undergone either in the womb or egg, and ultimately appear in the offspring when mature, or even when quite old, as in the case of certain diseases." Again, the same great author remarks: "What can be more wonderful than the well-known fact that the minute ovule of a good milking cow will produce a male from whom a cell, in union with an ovule, will produce a female, and she, when mature, will have a large mammary gland, yield an abundant supply of milk, and even the same quality of milk as her grandmother."

Are Acquired Characteristics Inherited?—A knowledge of heredity is of great importance. If there is no persistence, no permanency in types, our breeders would not be able to calculate on what they would be able to do to improve their animals, nor could our horticulturists rely on any fixed law in altering the character of a plant. An enormous number of books have been written to illustrate this subject. Until recently, perhaps one of the most thoroughly established beliefs has been *that acquired characters are transmissible to offspring.*

In order to make this matter as plain as possible, it is necessary to state that an acquired character is some trait, some skill, some peculiarity of body or mind taken on by environment, by food, by education, training, accident or disease *during the lifetime of the individual.* This can perhaps be best understood by a few illustrations.

If a horse breeder trains his horse so that it can trot a mile in two minutes and a half, when its natural gait was four minutes, and its ancestors before it had never been able to trot faster than a mile in four minutes, then this extra speed is an acquired character. If an animal receives a wound which, healing up, leaves a scar, this scar is an acquired character. If it receives a fright, and ever afterwards is timid under certain circumstances, this timidity is an acquired character. If by training it learns certain tricks, or if by good usage it becomes much better in its disposition than its ancestors, these tricks and this improvement are acquired characters. If it becomes diseased, when its progenitors were healthy, its diseases are acquired characters.

Is Language and Music Transmitted?—If we take a human being we may illustrate the subject further. Language is an acquired character. No child is born capable of talking. It learns languages by slow and tedious processes. It takes a life-time, often, to acquire a mastery of speech. Nature transmits only vocal organs. Song, or the art of singing, is an acquired character. No child is a singer at birth. It may cry and yell and make noises, but it cannot sing or play the violin. It must learn these arts by slow and careful training. Some are more gifted than others, but even they must learn how to sing, or never be able to do it. In short, all the things we learn at school, at college, by intercourse with our fellowmen, or by the discipline and experience of life, are acquired characters. They are not innate; they were not a part of our outfit at birth.

Now, if any idea of heredity has been thoroughly believed for a long time, it is the possibility of the transmissibility of these acquirements, in part, at least, if not entire. It has become a part of the popular belief of parents that by living in a certain way, by doing certain things, and loving and admiring certain excellencies, the children, even before birth, will acquire them. But not only has this been a popular belief, evidenced by our faith in pre-natal culture, but even scientists believed it. Darwin did most certainly, and it was, in part, at least, because of this belief, that his theory of *pan-genesis* was invented.

PAN-GENESIS.—Pan-genesis simply means generation from every part of the body. The theory is that every cell in the body, brain cells, liver cells, etc., gives off certain granules which, floating in the circulation, are taken up by those organs which form the sperm and germ cells, and give them power to reproduce all parts of the body in the offspring. Every part is reproduced by these granules, in the germ plasma, and if an organ or a part takes on some acquired character the granules from the cells of these organs are altered by it. In this way he was able, to his own satisfaction, to explain why children inherit certain peculiarities from parents. The theory was a wonderfully ingenious one; but it was only a theory which has never been proved, and never can be proved. Indeed, it has been disproved by experiments which need not be given here.

Darwin seemed to think that the general transformation of species demanded that acquired characters be transmitted to offspring. Darwin's grandfather, Erastus Darwin, held a similar view. He believed that animals came to vary from each other chiefly because they were always altering their habits and voluntarily accommodating themselves to new actions and altered conditions of life. Lamarck, that epoch-making man, who fired the world with new thought on natural science, held that modification of species was, in great part, due to use and disuse of parts. To this he seems to attribute all the beautiful adaptations in nature, such as the long neck of the giraffe for browsing on the branches of trees. The effort on their part to reach higher and higher, when food is very scarce, was followed by increased ability in this direction, which was transmitted to offspring.

New Theories.—This whole theory of the transmission of acquired characters has, within a few years, met with a decided repulse. Weismann, an eminent scientist and evolutionist, has set up an entirely new theory of heredity in which acquired characters play no part. Of course it is necessary first to establish his theory by a certain number of facts, some of which will be given.

A wild animal taken from its natural surroundings and domesticated becomes tame, docile, and loses its wildness. This new state is an acquired character; but the young of these animals will inevitably betray the original instinct undiminished in force. The guinea pig is a remarkable illustration. Though domesticated for four hundred years, it is claimed that the young are as wild to-day as their ancestors ever were. We also know something of this in quails, partridges, etc. They do not take to domestication. They do not transmit to their offspring any domesticity they may have acquired by being brought into close proximity to the homes of men. The art of playing the piano, or the ability to sing, no matter how thoroughly understood by parents, is not transmitted to their children.

Weismann draws a very elaborate argument from this musical sense alone, and makes the most astounding statement that it is nearly or quite as strong, on the average, in the African and Polynesian as in the people of Western Europe, and that, under favorable circumstances, one race is as capable of producing individuals possessed of musical abilities of a high order as another. He cites the case of Brindes y Salas, a Cuban negro violin virtuoso, who was endowed not merely with excellence of technique and delicacy of ear, but whose playing, according to the opinions of musical experts, was that of a true artist. He might have cited the case of Blind Tom, the negro idiot, whose ear for music was so acute, and power to execute so great, that often on hearing a piece of music, no matter how elaborate, played once, he could repeat it on the piano with almost absolute accuracy.

The fact that these negro musicians were born of parents who had lived under European influence for a long time counts for nothing, because the length of time of a generation or two is not sufficient for the required growth of brain and nerve as the result of inherited practice, and because music of a high order does not reach the negroes where these persons were born and lived.

The fact that the negroes of the South have a highly developed musical sense is noted, and I have just learned that the native Alaskan children in the schools established there acquire readily the music taught, though there is no native music, but only noise without melody or beauty. The appropriate conditions, that is, good vocal organs and a nervous system capable of appreciating it, existed in the parents, of course, but did not find expression.

Weismann gives case after case of musical celebrities who were born in families in which the musical sense did not exist in any marked degree, and in which it has not been transmitted to descendants.

The question may be asked, Why do not Handels and Mozarts arise in Africa and Polynesia? To this may be replied, even if one having an equal musical sense should be born there, he would not have an opportunity to develop it much beyond the best Polynesian or African musician. In cultivated lands we have opportunities for training musical geniuses when they are produced; there they have not.

The same argument is drawn from the power of uttering intelligible speech. It also is an acquired character. We do not inherit it, though our ancestors from time immemorial have gone on speaking one or more languages. No case was ever known of a child being able to read without being taught, even though the parents had exercised their faculties in this direction all their lives. Children do not even learn to speak untaught, although their parents and countless generations of ancestors have exercised and perfected their ears and vocal organs by learning and speaking many languages. To acquire a language takes great effort, and we only realize this when we undertake to master a new tongue. Our children give years to it, gaining a little every day, and the effort is not felt as so great on this account.

Professor Weismann deems it well established that children of civilized nations, if brought up in a wilderness, and cut off from all communication with man, would make no attempt to talk with each other. This is told in many well-known cases of young and adult persons found living in an utterly wild state in the woods—cases which have occurred from time to time, up to the last century, in Germany, France, England and Russia. Nearly all these are said to have uttered sounds resembling the cries of wild animals with which they had associated, but not one was ever known to speak.

When one considers the constant and unremitting practice in speech which we gain in a life-time, whether by speaking aloud or thinking merely to ourselves, and remembers that, in spite of the effect of this perpetual exercise for centuries upon the human brain and vocal organs, the power of speech has not been fixed or intensified by heredity, Professor Weismann thinks himself justified in doubt-ing whether acquired characters can ever be transmitted in any real sense.

MICE.—If we go from intellectual traits to physical, we get the same results. Weismann made experiments on mice by cutting off their tails for many generations, to test whether the acquired physical character of a tailless mouse would be transmitted, and it was not. Every mouse born had just as long and just as good a tail as if its parents had not been deprived of theirs.

We know how very persistent the tail is in our domestic animals. Farmers nearly always take off the tails of the young of sheep and pigs early in life, before it can give much pain; but notwithstanding that this has been done for a very long time, the offspring have as long and as good tails as if this had not been done. The same is true of the horse.

WOUNDS.—Our author does not forget to take up the subject of inherited wounds, birth marks, etc., but he finds no warrant for believing that there is a single well-attested case. Most of them are rumors and hearsay stories, having no scientific value. Those which seem to have a value are easily explained, he thinks, by coincidences. Few persons but have some wounds on their bodies, made in childhood, but they are not transmitted to offspring.

Continuity of the Germ Plasm.—Let us now turn to the theory by which Weismann explains heredity.

All transmitted characters take place through the *continuity* of the germ plasm or germ cells, that is, the reproductive element of the parents, and there is always some of this germ plasm left over after the production of offspring, and this residue is gathered up in the child and kept for reproductive uses. The amount kept over is, of course, exceedingly minute, but its power of growth is marvelous. It makes a sort of immortality of the germ plasm, which goes back to the origin of life on the globe. These germ plasm elements vary in size, in vigor, in chemical constitution, in molecular activity. A constant fluctuation occurs in them, and the result is, offspring vary also—some are stronger than others, have some added adaptation to environment, are better fitted for the struggle with Nature, and *these* survive; others are weak, have no stamina, and perish. This is going on all the while. An example will perhaps make it clearer.

Suppose it became necessary for our giraffe to have a longer neck. It would take place in a short time. The necks of giraffes already vary in length. If the long neck is useful for the animal in the struggle for existence, the shorter necked ones will not succeed in life so well, will not get so much food, and will be dropped out by the way, will not survive. The longer necked ones, by the advantages they have, will multiply faster and become more numerous, and finally prevail. The conjugation of two long necked giraffes tends to produce a longer necked one in the offspring; if, on the other hand, short necks were more advantageous, the reverse would take place.

TIMIDITY OF ANIMALS.—Or, to illustrate further: The rabbit is a timid animal; but all rabbits are not alike timid. Suppose a greater timidity could be of some profit to rabbits, then the careless ones would lose their lives by their carelessness, and the more timid would survive, and thus a race of careful ones would result.

MAN.—Man is subject to the same law. He wages constant warfare with Nature. *New traits are ready to spring into existence the moment they give him any advantage.* Characteristics that are disadvantages disappear. This is natural selection, and natural selection is quite sufficient to explain any change in man, and the transformation of species. The theory of transmission of acquired characters therefore is not necessary.

SEXUAL SELECTION.—Natural selection is the great force in producing traits most useful to a species. But sexual selection also aids in the same direction.

Sexual selection is called in to explain the origin of music in birds, which is mainly confined to the male. The music of birds is not at all necessary to their success in life. Indeed, there must be some disadvantage in their knowing how to sing; it will betray its presence to an enemy which preys upon it. But in gaining a mate, it is believed the female would prefer one that can sing to one that cannot; and so in the course of generations the birds which do not sing will not find so readily a mate, so those which are good singers will be preferred and leave the most offspring.

Very many characters may be acquired by sexual selection in man. Music may be one. Beauty in women another. Even a beautiful head of hair, it is claimed, is the outcome of ages of sexual selection by the male. Men admire this ornament, and a woman with fine hair is more quickly chosen than one without. For this reason the female sex is rarely bald. Women, on the other hand, rather admire a bald head, and do not refuse offers of marriage from men with them. It gives a venerable appearance, a wise look. It does not interfere with his ability to support her. Hence sexual selection may account for baldheaded men and abundant hair on the heads of women.

Objections.—But not every scientist, nor every evolutionist, has accepted this theory. There has, indeed, been considerable opposition to it by men eminent in their spheres.

Professor Eimer, who has written a valuable work in opposition to Weismann, cites cases in which a variety of dogs has been bred without tails, as a result of removing them through a sufficient number of generations, and gives many individual cases of domestic animals in which physical deformity has been transmitted. So firm is he in his opinion that Weismann is wrong, that he believes the proof of a single case upsets his theory entirely.

I will give a case bearing on this subject, which I have just received from the gentleman who inherited a character acquired by his father. He writes:

"HAMILTON, MO., October 3, 1894.

"*Dear Sir:* My father was deprived of the full use of his left eye by an accident when a boy, and could see but very little with it. A sister five years older than myself could only see dimly with her left eye, and that is also the case with me. I can see with my left eye just enough to walk about, but I cannot tell one letter from another when my right eye is closed. My father and mother reared a family of thirteen children, of which I am the youngest (a man past seventy-two). I never heard my older brothers or sisters say anything about whether their eyes were normal or not. They were old enough to go from home and be in business for themselves before I had learned that my own eyes were not like those of other people.

"Respectfully,

"M. S. Kellogg."

There would be no difficulty in filling a book with similar cases, but it is unnecessary.

Argument from the Nerves of Touch.—It has remained for Herbert Spencer, however, to make the most thorough reply to Weismann. Mr. Spencer regards it as a most important question, and is a thorough believer in the transmission of acquired characters. One of his strongest arguments is drawn from the different degrees of sensitiveness of nerves in different parts of the body. The fact that the tip of the forefinger has thirty times more power of discrimination than that possessed by the middle of the back, and that various intermediate degrees of discriminative power are possessed by the skin in various parts of the body is instanced as a skill that must have been acquired by greater or less use of the nerves of one part over the other. The ends of the fingers are in constant use in testing the hardness, softness and many other qualities of various substances. By this use they acquire wonderful acuteness. Little by little this has been transmitted, so that every one possesses it in nearly an equal degree. The still greater sensitiveness of the tip of the tongue is also mentioned. This is constantly exercised in the touch of food, in endless unconcious exploring of the teeth. There is no special advantage in it so far as survival is concerned, and so it could not have arisen by the process of natural selection. It seems most reasonable to believe it has been acquired by transmission from parent to offspring, and could hardly have been gained in any other way.

ARGUMENT FROM THE HUMAN FOOT.—A very strong argument is also made by Mr. Spencer from the development of the human foot. Assuming, of course, that man is a descendant of some ape-like form, it must have had a foot like other apes. The ape's foot is both a hand and a foot. This was necessary because of its arboreal habits; but when it left off climbing trees it began to travel from place to place. Mr. Spencer says:

"Stability requires that the line of direction—the vertical line let fall from the center of gravity—shall fall within the base, and the walking shall be brought at each step within the area of support, or so near that any tendency to fall may be checked at the next step. A necessary result is that if at each step the chief stress of support is thrown on the outer side of the foot, the body must be swayed so that the line of direction may fall within the outside of the foot or close to it; and when the next step is taken it must be similarly swayed in an opposite direction, so that the outer side of the foot may bear the weight. That is to say, the body must oscillate from side to side, or waddle. The movement of the duck when walking shows what happens when the points of support are far apart. This kind of movement conflicts with efficient locomotion. There is a waste of muscular energy in making these lateral movements, and they are at variance with the forward movement. We may infer, then, that the developing man profited by throwing the stress as much as possible on the inner side of the feet, and was especially led to do this when going fast, which enabled him to abridge the oscillations, as, indeed, we see it now in the drunken man. Then there was thrown a continually increasing stress upon the inner digits as they progressively developed from the efforts of use, until now the inner digits, so large compared with the outer, bear the greater part of the weight, and being relatively near one another render needless any swaying of the body from side to side in walking.

"But what has meanwhile happened to the outer digits? Evidently as fast as the great toes have come more and more into play the small ones have gone more and more out of play and have been dwindling for—how long shall we say?—perhaps 100,000 years."

According to Mr. Spencer, this change in the foot must have been slow, and must have been transmitted from parent to offspring. Natural selection would not have been a sufficient cause. These specimens of Mr. Spencer's manner of meeting this question must suffice.

Viewing the subject from all sides, it seems most probable that some acquired characters are inherited, while it may be true that others are not. It is improbable that the various activities of the individual can go on indefinitely, and not in some degree, at least, affect the germ and sperm elements for good or for evil.

Views of Breeders and Horticulturists.—Looking at this subject from the point of view of our great breeders and horticulturists, who have made such wonderful changes in domestic animals and plants during the past century, we find that they conduct their labors in accordance with the belief that acquired characters are apparently transmitted, in a certain degree, at least. Indeed, with them it is a matter of common observation. If they are wrong in their practice and belief, then the whole art of breeding will be simplified, and much labor now lost will be saved. Their practices are believed to be founded on natural law, and may be arranged as follows:

1—Character acquired by nutrition. Among these may be mentioned size as one of the most evident.

Food influences the size of the frame, its form, length and weight. If none of these characters acquired by food are transmitted, then breeders are laboring under a delusion which is very costly. No breeder now would think of keeping up the size of his animals by *food alone*. They know well enough that the force of heredity, which has continued for a long time, is not easily overcome, even by food, and that breed is more than food, but they believe in both. Small breeds are usually found where food is scarce, and large breeds where it is abundant. The breeders of both horses and cattle in Kentucky rely much on the extra fine and abundant blue grass of that region for raising their almost matchless stock. Offspring from this stock deteriorates when sent to colder and more barren New England, unless surrounded artificially by the conditions they have left, which is not easily done. Smaller breeds increase in size and improve in form when removed to a better climatic region, and one where food is more abundant; and we believe that this increase can be transmitted, at least to a small extent. It was on this principle that the late Leland Stanford acted on his stock farm, apparently with success.

2—Another class of acquired character, and a much more important one, on which breeders rely for improving their animals is the exercise of any function. If we were take any number of young animals, say horses, as nearly alike as possible, and divide them into two classes, and use one of these classes only for hard, heavy work, and the other for light work and fast trotting or racing, is there any doubt that the character of strength acquired by use in the one, and speed acquired by another kind of use in the other, would, in a few generations, bring out different traits in the one from the other? Is not this the way our fast trotters are bred, by choosing those which have acquired speed by exercise and training? The same is true of milch cows for increasing the amount of milk, and especially is it true in the forms of pigeons, of which there are so many curious kinds.

PHYSIOLOGICAL HEREDITY.—There are some things, however, in heredity which are settled :

1—There is an anatomical and physiological heredity. It includes the transmission of the form and features of the face, the stature and strength of the constitution, the tendency to longevity, the complexion of the skin, color of the hair and eyes, the temperament, the moral and intellectual traits of character, and the tendency to think and act in a particular manner. All these things may be modified in many ways and by many conditions, as by food and environment. If the parents are better or worse fed, this will influence their power to transmit their physical constitutions to their offspring. If their lives are lived much in the open air they will transmit better characteristics than if lived largely indoors. So, too, education will have its influence on heredity. Educate, improve and perfect the lives and habits of parents, and at the same time you educate their offspring, though it may be only slightly, for acquired characters, as already seen, *are not transmitted in full* to children, except in rare cases and under laws which, as yet, are quite unknown.

We have excellent illustrations of the force of anatomical and physiological heredity in the different races, as already mentioned. Each of them transmits its own characteristics, and not those of some other race. Witness the negroes, the Chinese, Japanese, Indians and Caucasians. Each can be distinguished at a glance from the other. At the same time no two are quite alike; some little differences appear. This is the result of a tendency of the offspring to differ from their parents. If every child was a perfect image of its father or mother there could be no improvement or progress, except what might take place through education.

This tendency to differ arises, no doubt, in part from the different degrees of admixture of the germ and sperm elements which go to make up the embryo, to the greater or less perfection of nutrition, and to the parental environment. Each germ has a potential force of its own, and united, the result must vary as one or the other force predominates.

2—Pathological Heredity.—Pathological heredity relates to the transmission of diseased tendencies. If the constitution has been injured in any way, if its tone has been lowered, if degeneration of the organs of the body has begun to take place, these characters will be transmitted. There is abundant evidence of this. It is best illustrated in the children of the intemperate, or those who use intoxicants even moderately.

"I have drunk whiskey every day for thirty-five years," remarks a gentleman, rather proudly, in *The Quarterly Journal of Inebriety*, "and I don't see but I have as good a constitution as the average man of my age; I never was drunk in my life." He was telling the truth; but to learn the whole truth you would have to study his children. The oldest, a young lady, had perfect health; the second, a young man, was of a remarkably nervous and excitable temperament, as different from his phlegmatic father as possible; the third, a young lady of seventeen, was epileptic and always had very poor health. Did the father's whiskey-drinking have anything to do with these facts? This instance may be duplicated in almost every community. Think over the families of your acquaintance in which the father has long been a moderate drinker, and observe the condition and the health of his children. It will reveal important facts.

Professor Demme, at the head of a hospital for children in Berne, studied ten families of drinkers and ten families of temperate persons. The direct posterity of the ten families of drinkers included fifty-seven children. Of these twenty-five died in the first weeks and months of their life, six were idiots; in five children a striking backwardness of their longitudinal growth was observed, five were effected with epilepsy, five with inborn diseases. One boy was taken with chorea and became idiotic. Thus of the fifty-seven children of drinkers only ten, or 17.5 per cent. showed a normal constitution and development. The ten sober families had sixty-one children, five only dying in the first weeks, four were effected with curable diseases of the nervous system; two only presented inborn defects. The remaining fifty—81.9 per cent.—were normal in their constitutions and development. From this series of investigations we derive "the sad truth that among the children of drinkers the prevailing mortality is fearful, that the surviving portion represents a pitiful crowd afflicted with unsoundness of mind, idiocy, epilepsy and other disturbances of their nervous system, and that only a very small proportion of the descendants grow up as useful members of society."

The same thing is seen in families with a tendency to consumption, gout, rheumatism, epilepsy. The diseases themselves may not be transmitted, but a condition favorable to their development is.

What these illustrations teach us is that anything which injures the general health of parents renders them less capable of transmitting strength and vigor to their children. These are important facts, which ought to make a deep impression on prospective fathers and mothers.

THE SPECTER OF HEREDITY.—On the other hand, heredity may become a specter. How often do we hear men and women say, "I inherited this or that physical or moral defect from my father or mother, or a remote ancestor, and they can never quite forgive them." We must not, however, forget that we are all indebted to our ancestors for our being born at all; and most of them probably did quite as well for us as we are doing for our descendants. How many to-day look ahead and plan for the bodies and minds of those who may be born five hundred years from now. Not one of us; we can't think so far ahead. Now what I want to say here is that heredity sometimes becomes a specter which prevents us doing anything good or great. If a young man has inherited any defect from his ancestors, as most young men have, it is simply his duty to stop whining about it and go to work to correct it; if his body is weak, as a whole or in any part, because his father was not strong, let him go to work and make it strong. If a daughter has a physical or mental defect inherited from her mother, let her be brave enough to find it out and mend it by an effort of the will, by culture, training, education. I have known a man who inherited a love for liquor, that would have made him a slave had he not conquered it. I have known a woman with a tendency to consumption, inherited from a consumptive parent, by wise physical culture, a life of out of door activity, by moderation in all things, to rise above the disease. If she had lived in mortal fear of it and done nothing she would have died before this; but she has no more fear of it than of the shadow of a passing cloud. Bjornson in one of his novels tells the story of a child in whose veins coursed the wild blood of debauched and depraved ancestors for two hundred years. But he also tells how this child, under the influence of a wise mother, was trained into a splendid manhood. Environment can influence heredity. If we want a higher type of men and women we must not only have healthy parents, but if we have not had such we should perfect the environment, so that the better faculties may be brought into use and the meaner ones suppressed.

CHAPTER XVII.

THE PHILOSOPHY OF LOVE.

In this chapter I wish to speak of the philosophy of love; I wish to do so reverently and from the standpoint of science. What do we understand by the word, Love? It is not easy to define it; it is better understood when felt; yet something can be said which may help us to take a broader and deeper view of the subject.

In the first place, love is a passion, a deep passion of the mind, which takes full possession of and holds it. Love is just the opposite of hatred. Love awakens always in us a feeling of something to be desired, something which we may regard as good. We do not shun contact and association with lovely things, as we do with those which are unlovely. An opposite word is Hate. Hate repels; love attracts. There are many things in nature which attract and repel, and in this respect they resemble love and hate; but the latter are far more complicated phenomena than the former.

Some writers have gone so far as to affirm that love exists between the atoms and between plants.

When oxygen and hydrogen unite to form water, they say that it is because of an affinity, a love between them; but so far as we can know, it is unconscious, and unconscious love is not love as we understand it. So in plant life, certain processes go on which are of the same general nature as the sexual acts in animals, but they are unconscious acts, and, consequently, we cannot speak of love between plants, except as a matter of sentiment. A philosopher may call these phenomena those of love; for our purpose we only mention them.

When it comes to animal life, love proper begins; but its first manifestations are very simple, and with complete unconsciousness of its objects or results. The pleasure of the sexual act is probably the only incentive, and this is entirely instinctive. Love does not extend beyond this short period. That it is often very intense, however, is seen not only in the great excitement manifested, but also in the fact that not infrequently the male dies when, or soon after, his work is done. This is the case with the male bee, and I have observed it in the moth of the silkworm. Those who breed these creatures may easily study them at the period when their love-nature is in full activity. The male moth is very eager for a mate; and as he approaches a female, both move their wings with great rapidity for some time, though not in a manner so as to raise their bodies from the table on which they rest.

This wing movement continues a long time after they are united, and no doubt it acts as a stimulant to the circulation of the blood and secretion of the seminal fluid, and probably adds greatly to their pleasure. When weary of this movement, they cease for a time, only to begin again when they have rested for a longer or shorter period. They remain attached for hours, and I have many times seen the male die before separation from the female. The same male never has sexual relations with more than one female, and I have not been able to observe that there is preference on the part of either in the choice of a mate, as is the case in higher animals when sexual selection comes into play.

The love nature of the spider has been studied carefully by Professor Cook in his great work, "American Spiders," and he devotes one volume to the sexual relations and motherhood of these creatures, which is very curious and interesting. The female usually lives alone in her web. She is, in most species, much larger than the male and lives longer. She does not court a mate, nor seem to care for one, and often when he is seeking to gain her good will she eats him up; sometimes she does this immediately after he has impregnated her. When a male wishes to court a female he has to be exceedingly careful, for she is a savage creature, and will gladly make a meal of a suitor if she is not in a mood for love. So he stations himself on the very edge of her home; sometimes builds a small web there and lives in it. By a slight motion of his feet on the web he is able to vibrate it and thus keep up a sort of telegraphic communication. She is able to distinguish the movements he communicates to her from those of some chance fly alighting on her web. Sometimes he waits for hours, even days, on her moods.

One observer (Termeyer) describes the courtship as follows, and this description is similar to that of other investigators: "The male approaches little by little with great caution, doubtful of the reception he will receive in the web of the female, who occupies the center, intent only on her prey. He begins by touching with one leg a thread of her web. The female approaches him; he flies, allowing himself to hang by a drop-line. Soon he reascends, being assured in some way he will not be illy received. Then he approaches his mate, and with one palp touches her abdomen several times."

Often one male mates with several females. His passions seem to be very strong; were it not so, he would not brave so many dangers and risk his life as he does.

Professor Cook has done well to devote so large a part of his work to the sexual habits of a most common insect. It will help to lift the subject into a higher plane and teach that the scientific study of every part of our nature is pure and elevating.

When we come to the higher animals, love takes a somewhat more complicated form; but the subject has not been studied so fully as it deserves to be. There is a field here for observers which should be cultivated. A knowledge of the evolution of the sexual nature of all living things is so important that it should not be neglected, even in the most obscure creature. It should, however, be studied as a science, rather than for the gratification of a morbid curiosity.

In studying vertebrate animals one thing everywhere has been observed, and that is the tremendous eagerness of the male for the female. There must be some significance in this; what is it? If there were no powerful desire of this kind, animals would not come together sexually, and reproduction would cease. With the love passions strong, all the pains and trials which are likely to result in parturition and in the care of offspring are forgotten. In this way alone is a continuance of the race secured. Weak sexual passions would result in the extermination of any race of animals in which it existed. Nor is there any doubt but the female prefers an eager mate to a tame, indifferent one. Her own eagerness, while it may be considerable, is less than his, and this, too, has its advantages.

If we study domestic animals, we shall find various degrees of love existing between the sexes. In the sheep there is little of it; except in the rutting season, the males do not exhibit much affection, indeed are quite indifferent to the females. Among cattle there is more of it, and among horses still more; true love often exists between a male horse and the mare. Their separation has been known to cause pain and depression similar to that caused by the separation of lovers; and such a pair, when parted and brought together again, manifest joy which is almost boundless. Love between dogs is often very deep and lasting. Even when not influenced by sexual passion they fondle and caress one another in play and sport, and derive an immense amount of pleasure from each others society.

In man we find the love nature wonderful, both in its power and in variety, but it is an instinct the same as in the lower animals, and also spontaneous; we do not need to teach the young to love, only to guide them to its highest manifestations.

Love exists in varying degrees of force in different races of men, and also in different climates. The native Alaskan is not ardent in his love, and the Alaskan maiden has no such deep and tender emotion for the male sex as is seen in the highly developed European. The same is true of the Indian. Both sexes are cold and do not manifest deep passion. The African is a bounteous lover, but coarse and unclean. This is especially true of his decendants in America.

In general, love is less developed in very cold and in very hot regions, and most so in temperate ones. It is also much stronger during certain seasons of the year than at others. It is strongest in Spring, when there is a resurrection of all life and loveliness. It is the weakest in Winter, when nature reposes, from lack of heat from the sun, the fountain from which all life springs.

The love nature is influenced by food and drink. Stimulating, exciting foods increase but render it more coarse and sensual; bland, nutritious but less stimulating foods cause it to be modified and more chaste. Drinks act in a similar way. Alcoholic drinks and many medicines stimulate the sexual passions, and often develop a sensual nature. The men and women who would keep their love natures clean and strong should study the influence of food upon it. Much is yet to be learned on this subject.

Love is more intense at certain ages than at others, and this is the age of fullness and plenitude of reproductive power. Then man is most manly and woman most beautiful. It is at this age that marriage usually occurs and children are born. Before this period the young man is often bashful and the young woman coy. After it, in old age, love takes on, or should take on, a more intellectual and spiritual form.

The culture of the intellect also influences its development in both men and women. The more culture and the higher the degree of education the less vigorous is the sexual passion, the later in life marriage takes place, and the less the number of children likely to be born. In countries where women receive what is called the "higher education," and especially when this education is nearly or quite in the same branches of learning as those which men receive, there are more of them who do not marry and become mothers than in countries where a contrary course prevails. No doubt in the future our educators will see the folly of educating women the same as men are educated. They differ, their lives are to be different, and each should receive a training suited to the nature and needs of the lives they are to live.

Love is often inhibited or held in check. It is not, as many teach, the most irresistible passion; frequently it is the most difficult of all passions to give a free and normal play. The bashfulness of the boy holds him back, often indefinitely, from seeking his mate, and the coyness of the girl acts in the same way. Should these traits prevail, and continue beyond a certain age, the sexual nature is checked in its development, and may never produce its effects on the life.

The influence of the love of the sexes on the life is enormous. Grant Allen, who has worked out this subject more fully than any one else, says: "Look at nature in the bulk and see how this is so. The song of birds, the chirp of insects, the feathers and fur, crests and antlers, the may in the hedge rows, the heather on the hill side, the berries on the holly, the crimson fruit of the yew, the apple tree laden with blushing blossoms in the Spring and with blushing fruit in the Autumn, the great tropical flowering trunks of the forest, and the garrulous birds and bright insects that flit flashing through them—alike owe their beauty to sexual needs and æsthetic preferences. If you go on a country walk, almost every fair object that attracts your attention, from the gorse to the lady-bird, from the stately heron to the daisy on the common attracts you in virtue of some sexual adornment."

How is this so? Let us see. Why has the red clover such a beautiful flower and so much sweet honey therein? In order to attract those bees which feed on honey and are able with their long proboscis to reach it. By crawling over each flower the pollen adheres to their legs and bellies, and is carried to the pistil of some other flower, fertilizing it. Where there are no bees able to do this the red clover never produces seed, but dies out. The beautiful red blossoms are the result of sexual necessity.

Why are butternuts and walnuts encased in such hard shells, and why are the kernels hid in such winding labyrinths within? Because they have so many enemies which feed on the nut, that if they had not this protection few would escape the hungry squirrels that grow fat on such rich food.

Why has the wild cherry, so common over the whole country, a pulpy mass outside the seed? To attract birds to eat the fruit, swallow the stone, and later on deposit it unharmed where it can grow and thus survive. Both the pulpy mass and the hard stone are necessities to their success, in increasing in numbers rather than becoming extinct.

Why has woman such beautiful hair, such brilliant eyes, such a fine form at the age when love most abundantly fills her heart. Because she is thus more attractive to man, and more likely to find a mate. All these attractions impel him unconsciously to choose one; and the fact that he has an eye to beauty and perfection induces him to choose one which pleases him, and thus the finest qualities of body and mind are multiplied. If men become more particular in this respect, as they will be in the future, there will be a larger number of superior women than we now have.

Why are young men brave, strong, generous? Because for ages women have been choosing such that they may be better cared for during the years of maternity, when they are unfitted, if mothers, to earn their support; and if women become more careful still in this respect, rejecting still more than they do of the incompetent, man will so improve that all will equal the best.

Thus we can see how love influences for good the world and makes progress possible.

Maternal Love.—While the sexual instinct is stronger in man than woman, the instinct of parental love is stronger in woman. "The moment a wife becomes a mother her whole being is changed," says Schneider, "until then she had thought only of her own well-being, of the satisfaction of her vanity. The whole world appeared made only for her; everything that went on about her was noticed only so far as it had personal reference to herself; she asked of every one that he should appear interested in her, pay her the requisite attention, and, as far as possible, fulfil her wishes. Now, however, the center of the world is no longer herself, but her child. She does not think of her own hunger, she must first be sure that the child is fed. It is nothing to her that she herself is tired, and needs rest, so long as she sees that the child's sleep is undisturbed; the moment it stirs she awakes, though far stronger noises fail to arouse her. She who formerly could not bear the least carelessness of dress, and touched everything with gloves, allows herself to be soiled by the infant, and does not shrink from seizing its clouts with her naked hands. Now, she has the greatest patience with the ugly, piping cry-baby (Schreihals), whereas until now every discordant sound, every slightly unpleasant noise made her nervous. Every limb of the still hideous little being appears to her beautiful, every movement fills her with delight. She has, in one word, transferred her entire egoism to the child, and lives only in it. Thus, at least, it is in all unspoiled, naturally-bred mothers, who, alas! seem to be growing rarer; and thus it is with all higher animal-mothers. The maternal joys of a cat, for example, are not to be disguised. With an expression of infinite comfort she stretches out her fore-legs to offer her teats to her children, and moves her tail with delight when the hungry little mouths tug and suck. . . . . But not only the contact, the bare look of the offspring affords endless delight, not only because the mother thinks that the child will some day grow great and handsome, and bring her many joys, but because she has received from Nature an instinctive love for her children. She does not know why she is so happy, and why the look of the child and the care of it are so agreeable, any more than the young man can give an account of why he loves a maiden, and is so happy when she is near. Few mothers, in caring for their child, think of the proper purpose of maternal love for the preservation of the species. Such a thought may arise in the father's mind; seldom in that of the mother. The latter feels only . . . that it is an everlasting delight to hold the being which she has brought forth protectingly in her arms, to dress it, to wash it, to rock it to sleep, or to still its hunger."

Of course this picture is that of a mother's love in a high degree of activity. It may exist in many degrees in different persons.

LOVE IN OTHER ASPECTS.—Love has so many forms that a whole book would be required to describe them.

Love is influenced by the moral state. The more full, rounded and upright the character, and the more lofty the ideals of life, the more normal this passion. The immoral love that considers only its own gratification is the cause of many serious evils.

The emotional love of lovers is often associated with pain, pain of the most severe kind. Where heart is not attuned to heart this is sure to come.

Love to be perfect must rise above emotion and become something more than feeling. It must also become moral, intellectual, spiritual. These latter forms constitute, in part, Platonic love.

Love is promoted by health. One cannot have a true love with a nervous system unstrung. For this reason the culture and care of the health becomes an important, we may say a moral, duty.

To make love perfect and enduring, cultivate it, attune it, lift it, if possible, out of the realm of mere passion into the realm of a high and noble manhood and womanhood. This will include all forms and give the highest satisfaction.

CHAPTER XVIII.

EVOLUTION OF THE MARRIAGE RELATION.

Out of love comes marriage. If there were no attraction of one sex for the other this relation would not exist. It is proposed in this chapter to consider the subject from the standpoint of evolution.

Whatever value we may place upon this theory as a means of explaining Nature's method of unfolding the universe, no one can fail to admit that, like a fertilizing rain upon parched and withered plants, it has entered into the domain of science and awakened to new life many departments of knowledge. It may not, and, indeed, it has not, explained to us the why of things, but it has shed much luster upon the how.

Reasons for Two Sexes.—At the very threshold of our subject: *The Evolution of the Marriage Relation,* we are met by the question of the reason for a contrast in the sexes. Lötze, in his "Practical Philosophy," article, "Marriage and the Family," says: "It is not possible to tell exactly why this contrast between them must exist, a contrast which extends into the kingdom of plants; and all attempted explanations on this matter issue in trifling." With due respect for this author, I believe he has not given this subject the attention which it deserves. There are good reasons for two sexes. In the lowest forms of life we have non-sexual animals and plants, but they do not have much tendency to progress. Indeed, the tendency to improvement and more rapid evolution in living things towards higher forms arises mainly from variations in the offspring from its parents. Even a slight variation for the better, continuing from generation to generation, gives a mighty lever for improvement. In non-sexual plants or animals there is no influence from other individuals, brought to bear upon them in the process of generation, to aid in producing variations. It is practically continuous disassociated growth—the plant or animal multiplying by simple division, and no one can tell after it has been divided which part is the parent. They are alike in every respect. Where there are two sexes to produce offspring, the chances of variation are very greatly increased, and in the higher forms of plants or animals this must be of some importance. The two forces brought together from the male and female elements result in a third force, which differs from either of them. Crosses may now occur, and there is no need for continuous disassociated growth to continue the species.

But there are other reasons for duality of the sexes, and one of these is the division of labor. In the primitive races the male attacks, defends and provides; the female builds the home, protects the young, cares for and prepares the food and does the lighter work; and in a highly-developed society, where there are more complicated conditions, the same law generally prevails. How unfortunate would it be for the female, and especially for her offspring, if, while bearing and rearing them, she were called upon to make long journeys, to fight enemies, and to hunt for a supply of daily food! When, as is sometimes the case, this order is reversed, the disadvantage extends to both sexes: the men lose their highest manhood, their courage, their bravery, their noble, manly bearing, and become effeminate; the women lose their beauty, their grace, their tenderness, their power to love, and become coarse and unattractive.

Relation of the Sexes in Apes.—Having now, as I believe, established reasons for the contrast of the sexes, I will proceed to trace briefly the evolution of the marriage relation, and, accepting the theory of man's descent, or, as some prefer to call it, man's ascent, from some lower form of animal life, it becomes important and necessary to give some thought to the marital habits of the lower animals, because these must have been the basis for those of primitive man. The primitive ape of course we are not able to study, for his remains have been destroyed or lie hidden deep down in geological strata, and tell no tales; but the ape of to-day can hardly differ much from his early progenitors. Of him Darwin says: "As far as their habits are known, the males of some species are monogamous, but live only a part of the year with the females. Of that the orang seems to furnish an instance. Several kinds, for example, some of the Indian and American monkeys, are strictly monogamous, and associate all the year with their wives. Others are polygamous, as, for instance, the gorilla, and several American species, and each family lives separately. Again, other species are polygamous; but several males, each with his own wives, live associated in a body, as with several species of baboons. We may, indeed, conclude from what we know of the jealousy of all male quadrupeds, armed as many of them are with special weapons for battling with their rivals, that promiscuous intercourse in a state of nature is extremely improbable. The pairing may not last for life, but for each birth."

Here we have, probably, the genesis of man's marital relations as he first stood upright, began to use language, and became human. The earliest men brought with them the same relations of the sexes as those of the apes from which they had descended.

PRIMITIVE MARRIAGES.—But such relations would not have been of long continuance. The lowest man is quite another creature from the highest ape. He has a far more extended habitat, and adapts himself to a far wider range of climate and variety of food. He makes tools to aid him in his labors, and builds a fire to warm himself and to make his food more palatable and digestible. With man's larger life came, of course, greater dangers, and more competition, and a need for more permanent marriage relations. There are writers who claim that primitive marriage in man was a promiscuous relation of the sexes. In some cases, and among some non-progressive or degenerate tribes, it may have been so; but among the most progressive and intellectual, where the competition was very intense, this could not have been the case. Out of a sexual relation founded upon passion would have come promiscuity only; but from the necessities of the case primitive marriage must have been one of mutual helpfulness. In no other way could there have been the progress which we see among the foremost races of the world. Proofs that primitive marriage was a relation of mutual helpfulness abound on every hand. Read Genesis ii, 18: "It is not good that man should be alone; I will make a *help meet* for him." So we find in the Talmud what the division of labor was among the Jews: "These are the offices which a woman must perform: She grinds, bakes, washes, cooks, suckles her child, prepares his couch, works in wool. If she has brought a slave as her dowry, she is excused from the first three offices; if two slaves, she is exempt from the next two; if three, she does nothing at all; if four, she may lounge in her arm chair. To this Rabbi Eleazer adds: '*If she has brought one hundred slaves she must work in wool*, for idleness leads to infidelity,' and Rabon Shimon ben Gamliel says: 'Even if the husband has vowed that his wife shall do no work, he must divorce her, for idleness leads to insanity.'"

The same idea prevails among the most primitive races to-day. Starkcs, in his recent work, "The Primitive Family," says: "We are by no means without a clue to man's motives for obtaining a wife as his absolute property. He requires her to work for him and to keep his house. The marriage ceremony often indicates this, as when it consists, in part, at least, in the bride preparing a meal for her future husband. We have still a survival of this ancient practice in the wedding cake."

J. C. Eyre, who made a journey in 1845 into Central Australia, asked the native men why they were so anxious to obtain wives, and their usual reply was, "That they may get wood, water and food for us, and carry whatever property we possess."

The same is true of the woman. She does not marry to gratify a passion, except in rare cases, but that she may have some one to provide for her, some one to furnish the means with which to build and maintain a home.

In primitive marriage women were practically slaves Their husbands rarely listened to their counsel or heeded their advice. Affection and love between husband and wife was rare. The betrothal of children, so common among primitive races, indicates this. If more evidence were wanting, it is found in the fact that among savage races food is first served to the men and the women take what is left. In times of scarcity women and children have often suffered from hunger on this account.

Polygamy.—Out of such domestic relations polygamy would result naturally. The more wives a man could secure to help him and maintain him the higher would his rank be, and the more he would be respected. Polygamy would also have been of considerable advantage to primitive women. Some of them would be more favored, and relieved from excessive servitude. In most cases the first wife would take precedence. Their labors would be divided ana consequently less, their social life better. Some of them would have ceased to be slaves and have become free. Only the most capable men would have been able to possess several wives, and they would usually have secured the strongest and most beautiful ones, have provided them with more food and better homes, and have begotten the most children, and this again would have been a positive advantage to the race, if not to the individual. We often speak disparagingly of King David and his son Solomon on account of their many wives and concubines; but the Jews were no doubt improved by their polygamy in many ways, nor could woman's lot have been so hard. Life was on a different plane from what it is to-day, and it would be necessary for us to put ourselves in the places of primitive woman to understand and judge her condition and the amount of her joy or misery. No doubt monogamy is a higher form of marriage than polygamy; but in the evolution of the marriage relation the latter has been one of its phases, and in its day has had some influence on human progress.

Divorce among Primitive Races.—Among primitive races separations were frequent. No laws or restraints bound a couple together if they chose to part. A chief could at any time put away a wife who displeased him, and a husband not a chief could, on slight provocation, kill his wife. The husband, like the chief, could also put his wife away, but if he did not wish to part with her, though she desired to be separated from him, it was more difficult. Among some races the marriages were on trial, and were dissolved if no children were born after a year; but if there were children the marriage became confirmed. We find in the

Talmud a saying: "If a man has lived ten years with a woman and had no children, let him divorce her and give her back her marriage portion." But we do not need to go to earlier times to find examples of such temporary marriages. They are frequent in Persia at the present time. They may be contracted from a few weeks up to thirty years; when the time has expired they may be renewed, but not for life. They are considered respectable and legal. If children are born, the father must provide for them. It is an ancient custom, and regarded among those people as a supplement to the institution of marriage.

Temporary marriages are also quite common among the negroes of the South. My informant, who has seen much of negro life, tells me if a married pair tire of each other, one of them goes away. Even a legal marriage and the birth of children does not always hold them together. If, however, there is property, it makes the bond more fixed and lasting. A wife will not leave a husband who is well off, because she then loses an interest in his wealth.

Such temporary marriages are very disadvantageous, because they do not allow of the establishment of households, and this will tend to render them less and less common as society advances.

We can hardly realize the benefit which fixed marriage relations have bestowed upon the race, even if these marriages have not always been happy ones. They have permitted permanence in the family rather than constant change, which has allowed children to be better nurtured.

Group Marriages.—Another phase of primitive sexual relations is group marriages. In primeval times men lived together in small groups for social reasons, as well as for protection and defense. The group may have been large or small, and stood for the individual. Members of a group could not marry one of the same group; but each member was the husband or the wife of all the members of some other group, excepting such as were their own brothers and sisters. Group marriage is a slight advance on temporary marriage. The males at birth became the husbands of all the females in the particular group into which they could marry, and the females became the wives of all the men in the same group; but as consanguineous marriages were forbidden, their own brothers and fathers were excepted. They were, however, in fact, husbands and wives of all the members of the group theoretically more than practically, and one man might really have had one woman, or several women, as his own, by mutual consent. It was a low form of marriage, and is still practised among certain aborigines of Australia and among a few other people.

Endogenous and Exogenous Marriages. — It will be observed that group marriage is exogenous, that is to say, every man must seek his wife in some other tribe or group than his own. This is a rule exactly the opposite of endogony, which forbids marriage outside of the tribe.

Mr. W. Duncan, who has lived many years in Alaska, has communicated to me a most interesting account of the exogenous marriages of the natives of that country, with whom he has been associated for a quarter of a century. There, every leading family has its crest, or totem, and these crests mark the offspring of the original founders of families. It is the ambition of all leading members of each clan in the several tribes to represent by carvings or paintings their heraldic symbols on all their belongings, not omitting even their household utensils, as spoons and dishes. On the death of the head of a family, a totem pole is erected in front of his house by his successor, on which is carved or painted, more or less elaborately, the symbolic creatures of his clan as they appear in some mythological tale or legend.

The crests define the bounds of consanguinity, and persons having the same crest are forbidden to marry; that is, one with the frog as a crest may not marry another with the same crest, nor a whale a whale; but a frog may marry a wolf, and a whale may marry an eagle.

"Among some Alaskan tribes," says Mr. Duncan, "marriage restrictions are carried still further, and persons of different crests may not intermarry if the creatures of their respective crests have the same instincts; thus, a person with a raven for a crest may not marry one with an eagle, because each seeks and devours the same kind of food; or a grizzly bear may not marry a wolf, for both are carnivorous." This is a purely metaphysical distinction, and on that account is very interesting.

All the children take the mother's crest, and are incorporated as members of her family; nor do they regard their father's family as their relations. A man's heir and successor, therefore, is not his own son, but his sister's son. In case a woman marries into a distant tribe, and goes away from her relations, the offspring of such union, when they are grown up, leave their parents and return to their respective places in their mother's family. On account of this law, natives take quite as much interest in their nephews and nieces as in their own children.

As already remarked, the endogenous marriage compels one to marry within his tribe. It probably had its origin in race pride, and a disdain of forming an alliance with a foreigner or inferior. Endogeny has been exceedingly common the world over. In New Zealand, great opposition is made to any one who wishes to take a wife from another tribe, unless it be by a chief for political reasons. The Arabs were endogenous and permitted very close intermarriages. The best illustration of endogeny is seen in the Jews. They were forbidden to take foreign wives, although the prohibition, like others, did not always work. One reason for this was to prevent the introduction into the tribes of persons with other religions, thus avoiding trouble. (See Leviticus xxxiv., 15, 16.) These restrictions were often violated, and Ezra the priest complains of it when he says: "Ye have transgressed, and have taken strange wives to increase the trespass of Israel." (Ezra x., 12.) In times of scarcity of women, however, the Jews did not confine themselves to endogeny. A most remarkable instance of it is recorded in Judges xxi. The men of Israel had sworn in Mizpah that they would give none of their daughters to the tribe of Benjamin for wives, on account of their rebelliousness. Indeed, the tribe of Benjamin in open battle with the men of Israel were nearly annihilated. Afterward, the men of Israel regretted all this, and gave them wives of such as had been saved alive in battle of the women of Jabesh-gilead. But these were not enough, and the elders said: "How shall we do for wives for them that remain; we cannot give them of our daughters, for we have so sworn." Then they said: "Behold there is a feast of the Lord in Shiloh yearly, in a place on the north side of Bethel," and so they "commanded the children of Benjamin to lie in wait in the vineyards, and when the daughters of Shiloh come out to dance, then come ye out of the vineyards and catch you every man his wife of the daughters of Shiloh to go to the land of Benjamin." "And the children of Benjamin did so, and took them wives according to their number, of them that danced, whom they caught."

This illustrates very forcibly another feature of exogenous marriage by capture, which has existed between warlike tribes, and when there was a scarcity of women. The habit of marriage by capture, once begun, has often been continued in a friendly way long after the necessity for it has passed away. In early times it was quite prevalent, and still is among many savage and primitive races. A run-away match may be considered as a survival of this old practice.

INFLUENCE OF CHRISTIANITY ON MARRIAGE.—With the introduction and spread of Christianity, the relations of the sexes and the marriage relation took a new turn. St. Paul, by his famous saying against marriage came near wrecking the institution. Had it not been for the strength of human nature no one can tell how great an injury he would have inflicted on mankind. As it was, he did much harm, for his advice was, during the first few centuries of the Christian era, extensively followed. Many of the early Christians were deeply tinctured by asceticism, never marrying. "We are," says Octavius, "*chaste* in our speech and *chaste* in our bodies, and very many of us, though we do not boast of it, do inviolably preserve a *perpetual* virginity." Justin Martyr tells the Emperor that "amongst the Christians there were a great many of either sex who had from their childhood been educated in the Christian discipline, who for sixty or seventy years had kept themselves single and uncorrupt, and he wished the like could be shown of all other sorts of men." Another apologist says: "It is very easy to find amongst us both men and women who remain unmarried, even to old age, binding themselves to perpetual virginity, conceiving that in this state they shall have fitter opportunities to draw near to God." And when they did marry, they generally professed that they only did it to comply with the great end of the institution, the propagation of the race. It is almost pathetic to read the early history of the Christians and their relations to chastity, and particularly to the sexual relation. Out of it, no doubt, largely grew the practices of the Church as to celibacy of the priests and nuns. Well may we believe with Buckle and Galton that the withdrawal of so many of the noblest of the race into the vortex of celibacy has had a very depressing influence. The lower and more animal part of the people have had more than their share in procreating human beings, and left far too many offspring.

It is not to be denied, however, that Christianity has in other directions elevated and ennobled the marriage relation, and done much to make the lot of women far more tolerable.

SANITARY MARRIAGES.—But the race never ceases to progress, and with it human institutions are improved. The evolution of marriage has not by any means reached its highest state. It needs to be improved in many ways, but most of all it needs to be made more sanitary.

In primitive times it was not necessary to consider health as a factor in mating men and women, because the number of sickly persons was comparatively small. The weakly rarely survived to maturity as now by the aid of medical and sanitary science. Natural selection had far more influence, and the survival of the fittest, or those adapted to their environment, was the rule, the survival of the unfit the exception. But in civilized communities the diseased in both sexes abound; and the almost universal panmyxia gives the feeble almost as good a chance to leave offspring as the sounder ones. There can be no true *homoculture* so long as this state of things exists. Is not the human race as worthy of improvement by care and wisdom by the application of the laws of science to mating as are bees, horses and sheep, not to say dogs, pigs, and even oysters? We know that man is wiser in some respects now than in earlier times, but is he really better physically? It is to be hoped that he is, but he is not so much better as he might be. Surely if we would only apply the knowledge we have gained by the study of animals and plants we might greatly improve ourselves. In speaking of the sanitary marriage, I use the word in no narrow sense. The sanitary marriage means the perfect marriage, physical, intellectual and moral. The Spartans had many foolish views on this subject, but they had also some most excellent ones. The Spartan husband was forbidden to be jealous. Those who were physically the finest were brought together without regard to their likes and dislikes. By this means a very superior race was produced. We know something of the vigor and splendor of the Greek men. The beauty of the Lacedemonean women was notorious throughout Greece. Xenophon pointed with pride to the tall and vigorous race of citizens produced by Lycurgic institutions. It had, no doubt, too much rigor in it, and too little thought for the human feelings and tender passions; but when those human feelings and tender passions at last gained sway progress ceased.

It may be that we are not yet prepared to institute the true sanitary marriage, but we may begin to agitate it and do our best to realize it. When once we have started on the right road progress will be rapid, knowledge little expected will be revealed, and, above all, happiness in the marriage relation will be many times, perhaps a thousand times, augmented.

CHAPTER XIX.

CONTESTS BY THE MALES FOR FEMALES.

The strength of the passion of the male for the female among animals is so great that their chief desire is to possess one or more for themselves. In order to do this they do not in the least respect the rights of others, but think only of their own desires. We call this sexual selection, and it has no doubt had an important influence on the evolution of higher forms of life. Sexual selection takes place in two ways—through the preferences of the male or female for the more perfect individual of the opposite sex, and through conflict. In this way the strongest or most beautiful animals, or those best suited to their environment, are brought together, and these generate more perfect offspring than would otherwise be the case. Darwin has developed this subject most thoroughly, and it is to him that much of the material of this chapter should be credited. He says: "Sexual selection makes other characteristics essential. The male who seeks the female, who protects her, maintains her, must have a different structure from the female; for instance, the male possesses certain organs of sense and locomotion which are absent in the female, or less highly developed, in order that he may find her or reach her; or the male has certain organs for holding her securely. These organs are of diversified kinds. Instances may be seen in the complex appendages on the apex of the abdomen of some male insects. The female, too, often differs from the male in having organs for the nourishing of her young, as the mammary gland, or the sac in which marsupials carry their young until they are old enough to be permitted to run about. There are instances in which the male and not the female has receptacles for receiving the ova, as in certain tribes of fishes in which the male hatches them in his mouth. In bees the female worker only has apparatus for collecting honey and gathering pollen; her ovipositor, which, in the queen is used for depositing eggs, in the worker becomes a sting for self-defense. In some animals, the males are more powerful, more pugnacious and courageous; in others there are gaudy, showy coats to attract the female, and in birds curious ornaments and power of song.

Among insects there are many kinds in which the males, who live but a day, have no organs for procuring food, but their organs of locomotion are perfect, these being necessary to the finding and fertilizing of the female. As a rule the male is modified more than the female. Why this is we may not be able to decide; but it is probably owing to his stronger passions. It is the rule in all nature, to which there are few exceptions, that the male pursues the female. This great eagerness on his part develop in him characters which in her are wanting. The females, on the other hand, being obliged to nourish the embryo, guard her offspring, cannot afford to expend so much energy in contests, in song or gaining possession of a mate; and it is this contest which the males have with their own sex for the female which is, after all, the most remarkable and interesting feature of the reproductive nature, for there can be little doubt but among the males of most animals there is a constantly recurring struggle for the possession of the females. This contest is not always one of brute strength; indeed, it is often one of skill and cunning, a higher gift of song, a greater beauty, a love of display. In spiders, for instance, there is evinced much intelligence, and the females manifest great affection for their eggs. They guard them with tender care, will carry them on their persons in a silken web to secure them against injury. I have watched with interest, and observed that a female field spider will run for its eggs on there being any appearance of danger. The males have no such instinct; but they search eagerly and fight for the females. The male will mate with any female, but the female has often been observed to reject several males, threaten them with open mandibles before finding one she was willing to join.

Among flies, of which, as all know, there are many varieties, some have been observed to fight with each other for the possession of the female. There are other species that apparently try to win her by their music. H. Müller once observed two males courting a female. They hovered around her, flew from side to side and made a humming noise as if trying to charm her. Mosquitoes seem to attract each other by that music which is so disagreeable to man. The nervous system of flies is quite highly developed, more so than that of most insects.

In bugs, which are mainly unsocial in their habits, living by themselves, the vocal organs are supposed to be for the purpose of calling their mates to them.

The male locust, which fills the air with a harsh sound that may be heard for a mile or more, evidently does it to call the female. She has no means of making a similar sound, being mute. This is believed to be a love song. Dr. Hartman, in speaking of the 17 year locusts which visited a part of the United States in 1851, says, "Standing in a thicket of chestnut sprouts as high as my head, where hundreds were around me, I observed the females approaching the drumming males. Several times, also, on a dwarf pear tree I noticed the females alight near a male while he was sounding his clanging notes." Fritz Müller has seen what was evidently a musical contest between three males for a female. As soon as one had finished his song another immediately began, and after him another. This rivalry would have no meaning if the female was not excited and allured by what to her was the most musical and attractive voice.

Crickets and grasshoppers are both remarkable for their musical genius. The music of the former is really quite agreeable to human ears. The katydid belongs to this order of insects. Mr. Bates has seen a male cricket place himself at eventide at his hole and sing a love song until a female approached, when he sang in a more subdued, tender toned voice, and caressed her with his antennæ until he won her affections.

Among bees and wasps, fights are frequent between the males for the possession of a particular female. She sits by apparently unconcerned and when the victory is won she flies away with the victor. Among some of the solitary bees there is a high appreciation of color, and the males search eagerly for the females, and fight with each other for their possesssion. The mandibles of the males in certain species are much larger than in the females, to fit them for these contests. The females, on the other hand, sometimes appear to select the most beautiful male, in other cases the males select the most beautiful females.

Male beetles fight for the female. Mr. Wallace observed two male beetles contesting for a female which stood close by busy at her boring. They pushed at each other, clawed and thumped, appearing to be in a great rage. The smaller one was vanquished and ran away. Mr. A. H. Davis placed two males and one female in a box and watched the conflict. The stronger pinched the weaker one so hard that he gave up any pretended right he had to the female.

The male butterflies which adorn the field and garden in warm weather, contend vigorously for the female. Several males may be seen pursuing one female at the same time. Male butterflies are quite pugnacious and often break their wings in combat with each other. The wings of the male are generally the most beautiful, and the female has wit enough to admire them, and there is no doubt but much of the display of the male is made to attract her attention. Moths are, as a rule, less brilliantly colored, and as they fly in the night, brilliancy of wings would be of no value in gaining a mate.

"The males of fish," according to Darwin, "fight for the possession of the females. Thus the male stickleback has been described as 'mad with delight,' when the female comes out of her hiding place and surveys the nest which he has made for her. He darts round her in every direction, then to his accumulated materials for the nest, then back again in an instant; and if she does not advance he endeavors to push her with his snout, and then tries to pull her by the tail and side-spine to the nest." The males are said to be polygamists; they are extraordinarily bold and pugnacious, whilst the "females are quite pacific." Their battles are at times desperate; "for these puny combatants fasten tight on each other and fight until their strength appears completely exhausted." With the rough-tailed stickleback, the males whilst fighting swim round and round each other, biting and endeavoring to pierce each other with their raised lateral spines. The same writer adds, "the bite of these little furies is very severe. They also use their lateral spines with such fatal effect, that I have seen one during a battle absolutely rip his opponent quite open, so that he sank to the bottom and died." When a fish is conquered, "his gallant bearing forsakes him; his gay colors fade away, and he hides his disgrace among his peaceable companions, but is for some time the constant object of his conqueror's persecution."

The male salmon is as pugnacious as the little stickleback; and so is the male trout. Mr. Shaw saw a violent contest between two male salmon which lasted the whole day; and Mr. R. Buist, Superintendent of Fisheries, informs me that he has often watched from the bridge at Perth the males driving away their rivals, whilst the females were spawning. The males "are constantly fighting and tearing each other on the spawning beds, and many so injure each other as to cause the death of numbers, many being seen swimming near the banks of the river in a state of exhaustion, and apparently in a dying state." Mr. Buist says, that in June, 1868, the keeper of the Stormontfield breeding-ponds visited the northern Tyne and found about 300 dead salmon, all of which, with one exception, were males; and he was convinced that they had lost their lives by fighting.

The most curious point about the male salmon is, that during the breeding-season, besides a slight change in color, "the lower jaw elongates, and a cartilaginous projection turns upwards from the point, which, when the jaws are closed, occupies a deep cavity between the intermaxillary bones of the upper jaw." In our salmon this change lasts only during the breeding-season; but in the *salmo lycaodon* of North west America the change, as Mr. J. K. Lord believes, is permanent, and best marked in the older males which have previously ascended the rivers. In those old males the jaw becomes developed into an immense hook-like projection, and the teeth grow into regular fangs, often more than half an inch in length. With the European salmon, according to Mr. Lloyd, the temporary hook-like structure serves to strengthen and protect the jaws, when one male charges another with wonderful violence; but the greatly developed teeth of the male American salmon may be compared with the tusks of many male mammals, and they indicate an offensive rather than a protective purpose.

In regard to size, M. Carbonnier maintains that the female of almost all fishes is larger than the male; and Dr. Gunther does not know of a single instance in which the male is actually larger than the female. With some *Cyprinodonts* the male is not even half as large. As in many kinds of fishes the males habitually fight together, it is surprising that they have not generally become larger and stronger than the females through the efforts of sexual selection. The males suffer from their small size, for, according to M. Carbonnier, they are liable to be devoured by the females of their own species, when carniverous, and, no doubt, by other species. Increased size must be in some manner of more importance to the females than strength and size are to the males for fighting with other males, and this is, perhaps, to allow of the production of a vast number of ova.

Mr. W. S. Kent says, that the male of the *Labrus mixtus*, which, as we have seen, differs in color from the female, "makes a deep hollow in the sand of the tank, and then endeavors, in the most persuasive manner, to induce a female of the same species to share it with him, swimming backwards and forwards between her and the completed nest, and plainly exhibiting the greatest anxiety for her to follow." The males of the *Cantharus lineatus* become, during the breeding season, of a deep, leaden black; then they retire from the shoal and excavate a hollow for a nest. "Each male mounts vigilant guard over his respective hollow, and vigorously attacks and drives away any other fish of the same sex; towards his companions of the opposite sex his conduct is far different. Many of the latter are now distended with spawn, and these he endeavors, by all the means in his power, to lure singly to his prepared hollow, there to deposit the myriad ova with which they are laden, which he then protects and guards with the greatest care."

A more striking case of courtship, as well as of display, by the males of a Chinese *marcropus* has been given by M. Carbonnier, who carefully observed these fishes under confinement. The males are most beautifully colored, more so than the females. During the breeding season they contend for the possession of the females, and in the act of courtship expand their fins, which are spotted and ornamented with brightly-colored rays, in the same manner, according to M. Carbonnier, as the peacock. They then also bound about the females with much vivacity, "and appear by the flash of their brilliant colors to attract the attention of the females, which do not seem indifferent to this domestic arrangement; they swim with a soft, floating movement towards the males, and seem to take pleasure in being near them or having them near by." After the male has won his bride, he makes a little disc of froth by blowing air and mucus out of his mouth. He then collects the fertilized ova, dropped by the female, in his mouth; and this gave M. Carbonnier much alarm, as he thought they were going to be devoured. But the male soon deposits them in the disc of froth, afterwards guarding them, repairing the froth, and taking care of the young when hatched. I mention these particulars because, as we shall presently see, there are species of fish the males of which hatch their eggs in their mouths.

To return to our immediate subject. The case stands thus: "Female fishes, as far as I can learn, never willingly spawn except in the presence of the males, and the males never fertilize the ova except in the presence of the females. The males fight for the possession of the females. In many species, the males, while young, resemble the females in color, but when adult become much more brilliant, and retain their colors throughout life. In other species the males become brighter than the females, and otherwise more highly ornamented only during the season of love. The males sedulously court the females, and, in one case, as we have seen, take pains in displaying their beauty before them. Can it be believed that they would thus act to no purpose during their courtship? And this would be the case unless the females exert some choice, and select those males which please or excite them most. If the female exerts such choice, all the above facts on the ornamentation of the males become at once intelligible."

Among crocodiles, the sexes apparently do not differ in color; nor is it known that the males fight together, though this is probable, for some kinds make a prodigious display before the females. Batram describes the male alligator as striving to win the female by splashing and roaring in the midst of a lagoon, "swollen to an extent ready to burst, with his head and tail lifted up he spins or twirls round on the surface of the water, like an Indian chief rehearsing his feats of war." During the season of love a musky odor is emitted by the submaxillary gland of the crocodile which pervades their haunts.

With respect to the rattling of the rattlesnake, we have at least some definite information, for Professor Aughet states that on two occasions, being himself unseen, he watched from a little distance a rattlesnake coiled up with head erect, which continued to rattle at short intervals for half an hour, and at last he saw another snake approach, and when they met they paired. Hence, he is satisfied that one of the uses of the rattles is to bring the sexes together.

The males of some, probably of many, kinds of lizards fight together from rivalry. Thus, the arboreal *Anolis Cristatellus* of South America is extremely pugnacious. "During the spring and early part of the summer two adult males rarely meet without a contest. On first seeing one another, they nod their heads up and down three or four times, and, at the same time, expand the frill or pouch beneath the throat; their eyes glisten with rage, and after waving their tails from side to side for a few seconds, as if to gather energy, they dart at each other furiously, rolling over and over, and holding firmly with their teeth. The conflict generally ends by one of the combatants losing his tail, which is often devoured by the victor." The male of this species is considerably larger than the female, and this, as far as Dr. Gunther has been able to ascertain, is the general rule with lizards of all kinds.

Male birds sometimes, though rarely, possess special weapons for fighting with each other. They charm the female with vocal or instrumental music of the most varied kinds. They are ornamented by all sorts of combs, wattles, protuberances, horns, air-distended sacs, top-knots, naked shafts, plumes and lengthened feathers gracefully springing from all parts of the body. The beak and naked skin about the head and the feathers are often gorgeously colored. The males sometimes pay their court by dancing, or by fantastic antics performed either on the ground or in the air. In one instance, at least, the male emits a musky odor, which we may suppose serves to charm or excite the female, for that excellent observer, Mr. Ramsay, says of the

Australian musk-duck, that "the smell which the male emits during the summer months is confined to that sex, and in some individuals is retained throughout the year. I have never, even in the breeding season, shot a female which had any smell of musk." So powerful is this odor during the pairing season that it can be detected long before the bird can be seen. On the whole, birds appear to be the most esthetic of all animals, except, of course, man, and they have nearly the same taste for the beautiful.

Almost all male birds are extremely pugnacious, using their beaks, wings and legs for fighting purposes. We see this every spring with our robins and sparrows. The smallest of all birds, the humming-bird, is one of the most quarrelsome. Mr. Gosse describes a battle in which a pair seized hold of each other's beak, and whirled round and round till they almost fell to the ground; and M. Montes de Oca, in speaking of another genus of humming-bird, says that two males rarely meet without a fierce aerial encounter; when kept in cages "their fighting has mostly ended in the splitting of the tongue of one of the two, which then surely dies from being unable to feed." With waders, the males of the common water-heron "when pairing fight violently for the females. They stand nearly upright in the water and strike with their feet." Two were seen to be thus engaged for half an hour, until one got hold of the head of the other, which would have been killed had not the observer interfered. The female was all the time looking on as a quiet spectator. Mr. Blyth informs me that the males of an allied bird are a third larger than the females, and are so pugnacious during the breeding season that they are kept by the natives of Eastern Bengal for the sake of fighting.

The polygamous ruff is notorious for his extreme pugnacity. In the spring the males, which are considerably larger than the females, congregate day after day at a particular spot, where the females propose to lay their eggs. The fowlers discover these haunts by the turf being trampled somewhat bare. Here they fight very much like gamecocks, seizing each other with their beaks and striking with their wings. The great ruff of feathers around the neck is then erected, and, according to Colonel Montague, "sweeps the ground as a shield to defend the more tender parts." The ruff of feathers, however, from its varied and rich colors, probably serves in chief part as an ornament to attract a female. Like most pugnacious birds, they seem always ready to fight, and when closely confined often kill each other; but Montague observed that their pugnacity becomes greater during the spring, when the long feathers on their necks are fully developed, and at this period the least movement by any one bird provokes a general battle.

In Guiana "bloody fights occur during the breeding season between the males of the wild musk-duck, and when these fights have occurred the river is covered for some distance with feathers." Birds which seem ill-adapted for fighing engage in fierce conflicts; thus the stronger males of the pelican drive away the weaker ones, snapping their huge beaks and giving heavy blows with their wings. Male snipe fight together, "tugging and pushing each other with their bills in the most curious manner imaginable." Some few birds are believed never to fight; this is the case, according to Audubon, with one of the woodpeckers of the United States, although "the hens are followed by even half a dozen of their gay suitors."

The males of many gallinaceous birds, especially of the polygamous kinds, are furnished with special weapons for fighting with their rivals, namely, spurs, which can be used with fearful effect. It has been recorded by a trustworthy writer, that in Derbyshire, England, a kite struck at a game hen accompanied by her chickens, when the cock rushed to the rescue and drove his spur right through the eye and skull of the aggressor. The spur was with difficulty drawn from the skull, and as the kite, though dead, retained his grasp, the two birds were firmly locked together; but the cock when disentangled was found to be very little injured. The invincible courage of the gamecock is notorious. A gentleman who long ago witnessed the brutal scene, told me that a bird had both its legs broken by some accident in the cockpit, and the owner laid a wager that if the legs could be spliced, so that the bird could stand upright, he would continue fighting. This was effected on the spot, and the bird fought with undaunted courage until he received his death-stroke. In Ceylon, a closely-allied wild species, the *Gallus Stanleyi*, is known to fight desperately "in defence of his seraglio," so that one of the combatants is frequently found dead. An Indian partridge, the male of which is furnished with strong and sharp spurs, is so quarrelsome, "that the scars of former fights disfigure the breast of almost every bird you kill."

The males of almost all gallinaceous birds, even those which are not furnished with spurs, engage during the breeding season in fierce conflicts. The capercailzie and blackcock, which are both polygamists, have regular appointed places where, during many weeks, they congregate in numbers to fight together and to display their charms before the females. Dr. W. Kovalevsky informs me that in Russia he has seen the snow all bloody on the arena where the capercailzie have fought; and the blackcocks "make the feathers fly in every direction" when several "engage in royal battle." The elder Brehm gives a curious account of the "balz," as the love dances and love songs of the blackcock are called in Germany. "The bird utters almost continuously the strangest noises; he holds his tail up and spreads it out like a fan; he lifts up his head and neck with all the feathers erect, and stretches his wings from the body. Then he takes a few jumps in different directions, sometimes in a circle, and presses the underpart of his beak so hard against the ground that the chin feathers are rubbed off. During these movements he beats his wings and turns round and round. The more ardent he grows the more lively he becomes, until at last the bird appears like a frantic creature." At such times the blackcocks are so absorbed that they become almost blind and deaf, but less so than the capercailzie, hence bird after bird may be shot on the same spot, or even caught by the hand. After performing these antics the males begin to fight; and the same blackcock, in order to prove his strength over several antagonists, will visit in the course of one morning several balz-places, which remain the same during successive years.

The peacock with his long train appears more like a dandy than a warrior, but he sometimes engages in fierce conflicts. The Rev. W. Darwin Fox informs me that at some little distance from Chester two peacocks became so excited whilst fighting, that they flew over the whole city, still engaged, until they alighted on the top of St. John's tower.

The season of love is that of battle; but the males of some birds, as of the game fowl and ruff, and even the young males of the wild turkey and grouse, are ready to fight whenever they meet. The presence of the female is the continual cause of war. The Bengali baboos make the pretty little males of the amadavat fight together by placing three small cages in a row, with a female in the middle; after a little time the males are turned loose, and a desperate battle immediately ensues. When many males congregate at the same appointed spot and fight together, as in the case of grouse and various other birds, they are generally attended by the females, which afterwards pair with the victorious combatants. But in some cases the pairing precedes instead of succeeds the combat. Thus, according to Audubon, several males of the Virginia goat-sucker "court, in a highly interesting manner, the female, and no sooner has she made her choice than her approved gives chase to all intruders, and drives them beyond his dominions." Generally the males try to drive away or kill their rivals before they pair. It does not, however, appear that the females invariably prefer the victorious males. I have been assured by Dr. W. Kovalevsky that the female capercailzie sometimes steals away with a young male who has not dared to enter the arena with the older cocks, in the same manner as occasionally happens with the doe of the red-deer in Scotland. When two males contend in presence of a single female, the victor, no doubt, commonly gains his desires; but some of these battles are caused by wandering males trying to distract the peace of an already mated pair.

Even with the most pugnacious species it is probable that the pairing does not depend exclusively on the mere strength and courage of the male; for such males are decorated with various ornaments, which often become more brilliant during the breeding season, and which are sedulously displayed before the females. The males also endeavor to charm or excite their mates by love-notes, songs or antics; and the courtship is, in many instances, a prolonged affair. Hence it is not likely that the females are indifferent to the charms of the opposite sex, or that they are invariably compelled to yield to the victorious males. It is more probable that the females are excited, either before or after the conflict, by certain males, and thus unconsciously prefer them. In the case of the *Tetrao umbellus*, a good observer goes so far as to believe that the battles of the males "are all a sham, performed to show themselves to the greatest advantage before the admiring females who assemble around; for I have never been able to find a maimed hero, and seldom more than a broken feather." I shall have to recur to this subject, but I may here add that with the *Tetrao cupido*, about a score of males assemble at a particular spot, and strutting about make the whole air resound with their extraordinary noises. At the first answer from the female, the males begin to fight furiously, and the weaker give way; then, according to Audubon, both the victors and the vanquished search for the female, so that the females must either then make a choice, or the battle must be renewed. So, again, with one of the field-starlings, the males engage in fierce conflicts, "but at the sight of a female they all fly after her, as if mad."

Naturalists are much divided in opinion respecting the object of the singing of birds. Few more careful observers ever lived than Montague, and he maintained that the "males of song birds and of many others do not, in general, search for the female, but, on the contrary, their business in the spring is to perch on some conspicuous spot, breathing out their full and amorous notes, which, by instinct, the female knows, and repairs to the spot to choose her mate." Mr. Jenner Weir informs me that this is certainly the case with the nightingale. Bechstein, who kept birds during his whole life, asserts that "the female canary always chooses the best singer, and that in a state of nature the female finch selects the male out of a hundred whose notes please her most." There can be no doubt that birds closely attend to each other's songs. Mr. Weir told me of the case of a bullfinch which had been taught to pipe a German waltz, and which was so good a performer that he cost ten guineas. When this bird was first introduced into a room where other birds were kept, and he began to sing, all the others, consisting of about twenty linnets and canaries, ranged themselves on the nearest side of their cages, and listened with the greatest interest to the new performer. Many naturalists believe that the singing of birds is almost exclusively "the effect of rivalry and emulation," and not for the sake of charming their mates. This was the opinion of Daines Barrington and White, of Selborne, who both especially attended to the subject. Barrington admits, however, that "superiority in song gives to birds an amazing ascendency over others, as is well known to bird-catchers."

The curious love-gestures of some birds have already been incidentally noticed, so that little need here be added. In our own country, large numbers of grouse meet during the breeding season on a selected level spot, and here they run round and round in a circle of about fifteen or twenty feet in diameter, so that the ground is worn quite bare, like a fairy-ring. In these partridge-dances, as they are called by the hunters, the birds assume the strangest attitudes, and run round, some to the left and some to the right. Audubon describes the males of the heron as walking about on their long legs with great dignity before the females, bidding defiance to their rivals. Of one of the disgusting carrion-vultures the same writer says, "the gesticulations and parade of the males at the beginning of the love-season are extremely ludicrous." Certain birds perform their love-antics on the wing, as we have seen with the black African weaver, instead of on the ground. During the spring, our little white-throat often rises a few feet in the air above some bush, and "flutters with a fitful and fantastic motion, singing all the while, and then drops to its perch." The great English bustard throws himself into indescribably odd attitudes whilst courting the female, as has been figured by Wolf. An allied Indian bustard at such times "rises perpendicularly into the air with a hurried flapping of his wings, raising his crest and puffing out the feathers of his neck and breast, and then drops to the ground." He repeats this maneuver several times, at the same time humming in a peculiar tone. Such females as happen to be near "obey this saltatory summons," and when they approach he trails his wings and spreads his tail like a turkey-cock.

But the most curious case is afforded by three allied genera of Australian birds, the famous bower-birds—no doubt the descendants of the same ancient species which first acquired the strange instinct of of constructing bowers for performing their love-antics. The bowers which, as we shall hereafter see, are decorated with feathers, shells, bones and leaves, are built on the ground for the sole purpose of courtship, for their nests are formed in trees. Both sexes assist in the erection of the bowers, but the male is the principal workman, So strong is this instinct that it is practiced under confinement, and Mr. Strange has described the habits of some Satan bower-birds which he kept in an aviary in New South Wales. "At times the male will chase the female all over the aviary, then go to the bower, pick up a gay feather or a large leaf, utter a curious kind of note, set all his feathers erect, run round the bower and become so excited that his eyes appear ready to start from his head; he continues opening first one wing and then the other, uttering a low, whistling note, and, like the domestic cock, seems to be picking up something from the ground, until, at last, the female goes gently towards him." Captain Stokes has described the habits and "play-houses" of another species, the Great Bower-bird, one of which was "amusing itself by flying backwards, taking a shell alternately from each side, and carrying it through the archway in its mouth." These curious structures, formed solely as halls of assemblage, where both sexes amuse themselves and pay their court, must cost the birds much labor. The bower, for instance, of the fawn-breasted species, is nearly four feet in length, eighteen inches in height, and is raised on a thick platform of sticks.

Dr. Jerdon thinks that the beautiful plumage of the male serves to "fascinate and attract the female." Mr. Bartlett, of the Zoological Gardens, London, expressed himself to me in the strongest terms to the same effect.

It must be a grand sight in the forests of India, "to come suddenly upon twenty or thirty pea-fowl, the males displaying their gorgeous trains and strutting about in all their pomp of pride before the gratified females."

The male *Rupicola crocea* is one of the most beautiful birds in the world, being of a splendid orange, with some of the feathers like curiously truncated plumes. The female is of a brownish-green, shaded with red, and has a much smaller crest. Sir R. Schomburgh has described their courtship; he found one of their meeting-places, where ten males and two females were present. The space was from four to five feet in diameter, and appeared to have been cleared of every blade of grass, and smoothed as if by human hands. A male "was capering, to the apparent delight of several others. Now spreading its wings, throwing up its head, or opening its tail like a fan; now strutting about with a hopping gait until tired, when it gabbled some kind of a note and was relieved by another. Thus three of them successively took the field, and then with self-approbation withdrew to rest."

With birds of paradise, a dozen or more full-plumaged males congregate in a tree to hold a dancing-party, as it is called by the natives, and here they fly about, raise their wings, elevate their exquisite plumes and make them vibrate, and the whole tree seems, as Mr. Wallace remarks, to be filled with waving plumes.

The courtship of the wild turkey is fully described by Wilson, the ornithologist. According to him, these birds pair early in March. For a short time previous the females separate from and shun their mates, though the latter pertinaciously follow them, uttering their gobbling note. The sexes roost apart, but at no great distance, so that when the female utters a call, every male within hearing responds, rolling note after note in rapid succession; not as when speading the tail and strutting near the hen, but in a voice resembling that of the tame turkey when he hears any unusual or frequently repeated noise. When the turkeys are numerous, the woods from one end to the other, sometimes for hundreds of miles, resound with this remarkable voice of their wooing, uttered responsively from their roosting places. This is continued for hour after hour, and, on the rising of the sun, the males begin to strut for the purpose of winning the admiration of the females.

If the call be given from the ground the males in the vicinity fly towards the individual, and, whether they perceive her or not, erect and spread their tails, throw the head backward, distend the the comb and wattles, strut pompously and rustle their wings and body feathers, at the same time ejecting a puff of air from their lungs. While thus occupied, they occasionally halt to look out for the female, and then resume their strutting and puffing, moving with as much rapidity as the nature of their gait will admit. During this ceremonious approach the males often encounter each other, and desperate battles ensue, and the conflict is only terminated by the flight or death of the vanquished.

This pugnacious disposition is not to be regarded as accidental, but as resulting from a wise and excellent law of Nature, which always studies the good of the species without regard to individuals. Did not females prefer the most perfect of their species, and were not the favors of beauty most willingly dispensed to the victorious, feebleness and degeneracy would soon mark the animal creation; but, in consequence of this general rule, the various races of animals are propagated by those individuals who are not only most to be admired for external appearance, but most to be valued for intrinsic spirit and energy.

When the object of the turkey's pursuit is discovered, if she be more than one year old, she also struts and even gobbles; she turns proudly round the strutting male, and suddenly opening her wings she throws herself towards him, as if to terminate his procrastination, and, laying herself on the earth, receives his dilatory caresses. But should he meet a young hen, his strut becomes different, and his movements are violently rapid; sometimes rising in the air, he takes a short circular flight, and on alighting drags his wings for a distance of eight or ten paces, running at full speed, occasionally approaching the timorous hen, and pressing her, until she yields to his solicitations.

Thus they mate for the season, though the male does not confine himself exclusively to one female, nor does he hesitate to bestow his attentions and endearments on several whenever the opportunity offers. One or more females, thus associated, follow their favorite, and roost in his immediate neighborhood, if not on the same tree, until they begin to lay, when they change their mode of life in order to save their eggs, which the male uniformly breaks if in his power, that the female may not be taken away from the gratification of his desires. At this time the females shun the males during the greater part of the day; the latter become clumsy and careless, meet each other peacefully, and so entirely cease to gobble that the hens are obliged to court their advances, calling loudly and almost continually for them. The female may then be observed caressing the male, imitating his peculiar gestures in order to excite his amorousness.

The cocks, even when on the roost, sometimes strut and gobble, but more generally merely elevate the tail and utter the puff, on which the tail and other feathers suddenly subside. On light or moonshiny nights, near the termination of the breeding season, they repeat this action, at intervals of a few minutes, for several hours together, without rising from their perches.

The sexes then separate; the males, becoming emaciated, cease entirely to gobble, retire and conceal themselves by prostrate trees, in secluded parts of the forest, or in the almost impenetrable privacy of a cane-brake. Rather than leave their hiding-places, they suffer themselves to be approached within a short distance, when they seek safety in speed of foot; at this season, however, they are of no value to the hunter, being meager and covered with ticks. By thus retiring, using very little exercise and feeding on peculiar grasses, they recover their flesh and strength, and when this object is attained, again congregate and recommence their rambles.

About the middle of April, when the weather is dry, the female selects a proper place in which to deposit her eggs, secured from the encroachment of water, and, as far as possible, concealed from the watchful eye of the crow. This crafty bird espies the hen going to her nest, and having discovered the precious deposit, waits for the absence of the parent and removes every one of the eggs from the spot, that he may devour them at his leisure. The nest is placed on the ground, either on a dry ridge, in the fallen top of a dead tree, under a thicket of sumach or briars, or by the side of a log. It is a very simple structure, being composed of a few dried leaves. In this receptacle the eggs are deposited, sometimes to the number of twenty, but more usually from nine to fifteen; they are whitish, spotted with reddish brown, like those of the domestic bird. Their manner of building, number of eggs, period of incubation, etc., appear to correspond throughout the Union, as I have received exactly similar accounts from the northern limits of the turkey range to the most southern region of Florida, Louisiana and the western wilds of Missouri.

The female always approaches her nest with great caution, varying her course so as rarely to reach it twice by the same route, and on leaving her charge she is very careful to cover the whole with dry leaves, with which she conceals it so artfully as to make it extremely difficult, even for one who has watched her movements, to indicate the exact spot; hence few nests are found, and these are discovered by fortuitously starting the females from them, or by the appearance of broken shells, scattered around by some cunning lynx, fox or crow. When laying or sitting the turkey hen is not readily driven from her post by the approach of apparent danger; but if an enemy appears, she crouches as low as possible and suffers it to pass. A circumstance related by Audubon will show how much intelligence they display on such occasions. Having discovered a sitting hen, he noticed that by assuming a careless air, whistling or talking to himself, he was permitted to pass within five or six feet of her; but, if he advanced cautiously, she would not suffer him to come within twenty paces, but ran off twenty or thirty yards with her tail expanded, when, assuming a stately gait, she paused on every step, occasionally uttering a cluck. They seldom abandon their nests on account of being discovered by man; but should a snake, or any other animal, suck one of the eggs, the parent leaves them altogether. If the eggs be removed, she again seeks the male and recommences laying;

otherwise she lays but one nest of eggs during the season. Several turkey hens sometimes associate, perhaps for mutual safety, deposit their eggs in the same nest, and rear their broods together. Audubon once found three females sitting on forty-two eggs. In such cases the nest is constantly guarded by one of the parents, so that no crow, raven, or even polecat, dares approach it.

The mother will not forsake her eggs when near hatching, while life remains; she will suffer an enclosure to be made around her and imprison her rather than abandon her charge. Audubon witnessed the hatching of a brood while thus endeavoring to secure the young and mother. "I have laid flat," says he, "within a very few feet, and seen her gently rise from the eggs, look anxiously towards them, cluck with a sound peculiar to the mother on such an occasion, remove carefully each half-empty shell, and with her bill caress and dry the younglings, that already stand tottering and attempting to force their way out of the shell."

When the process of incubation is ended, and the mother is about to retire from the nest with her young, she shakes herself violently, picks and adjusts the feathers about the belly, and assumes a different aspect. Her eyes are alternately inclined obliquely upwards and sidewise; she stretches forth her neck in every direction, to discover birds of prey, or other enemies; her wings are partially spread, and she softly clucks to keep her tender offspring close to her side. They proceed slowly, and, as the hatching generally occurs in the afternoon, they sometimes return to pass the first night in the nest. While very young, the mother leads them to elevated, dry places, as if aware that humidity, during the first few days of their life, would be very dangerous to them, they then having no other protection than a delicate, soft, hairy down. In very rainy seasons wild turkeys are scarce, because when completely wetted the young rarely survive.

With mammals the males appear to win the females much more through the law of battle than through the display of their charms. The most timid animals, not provided with any special weapons for fighting, engage in desperate conflicts during the season of love. Two male hares have been seen to fight together until one was killed; male moles often fight, sometimes with fatal results; male squirrels engage in frequent contests, "and often wound each other severely," as do male beavers, so that "hardly a skin is without scars." I observed the same facts with the hides of the guanacoes in Patagonia; and on one occasion several were so absorbed in fighting that they fearlessly rushed close by me. Livingstone speaks of the males of many animals in Southern Africa as almost invariably showing the scars received in former contests.

The law of battle prevails with aquatic as with terrestrial mammals. It is notorious how desperately male seals fight, both with their teeth and claws, during the breeding season, and their hides, also, are often covered with scars. Male sperm whales are very jealous at this season, and in their battles "they often lock their jaws together, and turn on their sides and twist about, so that their lower jaws often become distorted.

The courage and the desperate conflicts of stags have often been described; their skeletons have been found in various parts of the world, with the horns inextricably locked together, showing how miserably the victor and vanquished had perished.

Lord Tankerville has given a graphic description of the battles between wild bulls in Chillingham Park, the descendants degenerated in size but not in courage, of the gigantic *Bos primi genus.* In 1861 several contended for the mastery, and it was observed that two of the younger bulls attacked in concert the old leader of the herd, overthrew and disabled him, so that he was believed by the keepers to be lying mortally wounded in a neighboring wood; but a few days afterwards one of the young bulls approached the wood alone, and then the "monarch of the chase," who had been lashing himself up for vengeance, came out, and in a short time killed his antagonist. He then quietly joined the herd, and long held undisputed sway.

Phineas S. Royce has sent me an interesting account of some contests between the bulls for the possession of the cows, which he has witnessed on the plains of Colorado. He says: "The laws of the State require every person having cows running at large, to turn with them one bull for every twenty-five cows. These bulls fight, whenever strange ones meet, with great ferocity; and the occurrence is so common that, if I am in haste, I take no notice of them; but if not hurried, I stay and see the battle to the end, which sometimes lasts several hours. The most severe fights are, of course, those between bulls nearly equally matched. They are more likely to meet when a cow or cows are in heat; in that case the fight commences without any preliminaries, and with a vengeance; and while two full-sized bulls are engaged in a desperate struggle, some yearling or scrub secures the females. When the bulls are not equally matched, the weaker one often cries, seemingly from grief and rage, ready all the time to pitch in for another trial of strength, while the stronger one will often merely stand his ground, not daring to be off his guard for a moment, and in such a case he will pay no attention the cow, or cows. The lighter one will frequently approach the females, relying upon his agility for safety. The conflict will be renewed from time to time if they are not too unequally matched. Bulls frequently form a strong attachment for each other, and will often run together without any cows. I could never see that they wished to form a herd, but they go from band to band without any regard for one set of cows more than another."

"With horses," the same writer continues, "the case is different. A stallion will drive all other stallions and geldings out of his band, and, sometimes, strange mares, especially if his band is large, and he is well acquainted with them. If he desires to increase his band, he will steal any mare he can find. He herds them as closely as though a man were on his back all the time, guiding him in the work. He either leads or drives them to and from water, and, as they are strung out, he will pass back and forth with his head near the ground; if one is missing he will leave the band and search dilligently and effectually, and bring her in, using teeth or heels for a whip. It is both difficult and dangerous to lead a mare from a band having a regular herder, as the stallion is called.

"I have never seen a hard-fought battle between two stallions. 'Old Clyde,' a stallion I have long owned, once broke away from me and got into a band of mares, with a young stallion as herder. Having no aid, I separated them by strategy, and when he found himself parted, his "angry passions" arose to such a pitch that his eyes stood far out of their sockets, the white of them turned red, and his notrils were extended beyond anything that I had ever imagined. I caught him and led him home, a distance of three-quarters of a mile; but if I had not been highly excited I would not have attempted to do so, not even for all the stallions in America."

Admiral Sir J. B. Sullivan informs me that when he lived in the Falkland Islands, he imported a young English stallion, which frequented the hills near Port William with eight mares. On these hills were two wild stallions, each with a small band of mares, "and it is quite certain that these stallions would never have approached each other without fighting. Both had tried singly to fight the English horse and drive away his mares, but failed. One day they came in together and attacked him. This was seen by the captain who had charge of the horses, and who, on riding to the spot, found one of the two stallions engaged with the English horse, while the other was driving away the mares. The captain settled the matter by driving the whole party into the corral, for the wild stallions would not leave the mares."

With savages, the women are the constant cause of war, both between members of the same tribe and between distant tribes. So, no doubt, it was in ancient times, "For before the time of Helen women were the constant cause of war." With some of the North American Indians, the contest is reduced to a system. That excellent observer, Hearne, says: "It has ever been the custom among those people for the men to wrestle for any woman to whom they are attached, and, of course, the strongest party always carries off the prize. A weak man, unless he be a good hunter, and well-beloved, is seldom permitted to keep a wife that a stronger man thinks worth his notice. This custom prevails throughout all tribes, and causes a spirit of emulation among their youth, who are upon all occasions, from their childhood up, trying their strength and skill in wrestling." Of the Guanas of South America, Azara says that the men rarely marry till twenty years old or more, as before that age they cannot conquer their rivals.

Darwin says that in civilized life man is largely, but by no means exclusively, influenced in the choice of his wife by external appearances; but we are chiefly concerned with primeval times, and our only means of forming a judgment on this subject is to study the habits of existing semi-civilized and savage nations. If it can be shown that the men of different races prefer women having various characteristics, or conversely with the women, we have then to inquire whether such choice, continued for many generations, would produce any sensible effect on the race, either on one sex or both, according to the form of inheritance which has prevailed.

CHAPTER XX.

SEXUAL HYGIENE.

Injurious Habits.—The healthy guidance of the sexual organism is of so much importance that we give a few thoughts on the subject in this chapter. They have been taken mainly from Dr. Elizabeth Blackwell's essay on the Human Element of Sex.

"The intense physical pleasure which attends the caresses of love is a rich endowment of humanity, granted by a beneficent Creative Power. There is nothing necessarily evil in physical pleasure. It is a legitimate part of our nature, though inferior in rank to mental pleasure. The satisfaction which all our senses derive from lovely objects adapted to the special sense is a gift of beneficence to our present earthly life. The sexual act itself, rightly understood, so far from being necessarily evil, is really a divinely created and altogether righteous fulfillment of the conditions of life. But this act, like all others, is subjected to the inexorable rule of moral law. Righteous use brings renewed and increasing satisfaction to the two made one in harmonious union. Unrighteous use produces satiety, coldness, repulsion and misery to the two remaining apart, through the abuse of a divine gift.

"The dangerous habit of voluntarily produced excitement, to which alone the term masturbation is due, may be formed by both the male and the female, and also by the child as well as the adult.

"In the child, however—it being immature in body—it is the dependencies of the brain, the nervous system, which come more exclusively into play in this evil habit. The production of ova or sperm, which mark the adult age has not taken place; in the child there are none of those occasional congestions of the organs which mark the growth or effects of reproductive substance in the adult. In the little ignorant child this habit springs from a nervous sensation, yielded to because, as it says, 'it feels nice.' The portion of the brain which takes cognizance of these sensations has been excited, and the child, in innocent absence of impure thought, yields to the mental suggestion supplied from the physical organs. This mental suggestion may be produced by the irritation of worms, by some local eruption, by the wickedness of the nurse, occasionally, though rarely, by malformation or unnatural development of the parts themselves. There is also grave reason for believing that transmitted sensuality may blight the innocent offspring.

"A careful mother who had observed this habit at two years old, as occurring in one only of a large group of children, attributed it to the practice of lulling the child to sleep by laying it face downward over the lap, and thus with continued movement of hand and knee producing unconsciously a long-continued pressure upon the genital organs.

"It is a fact, also, which deserves serious consideration, that many ignorant women resort to vicious sexual manipulation to soothe their fractious infants. The superintendent of a large prison for women informed me that this was a common practice, and one most difficult, even impossible entirely to break up.

"That this habit of self-abuse in early childhood, or, indeed, at any age, is a dangerous one, capable of undermining the health from its tendency to increase, is a very serious fact. A little girl of six years old was lately brought to me, whose physical and mental strength were both failing, from the nervous exhaustion of a habit so inveterate that she fell into convulsions if physically restrained from its exercise. Indeed, cases of injury to childhood from self-abuse are so common in the physician's experience that no farther illustration is necessary.

"Now, it is quite true that this habit when observed in children may often, and I believe generally, be broken up. It is the mother who must do this by sympathy and wise oversight. When a child is known in any way to be producing pressure or excitement in these parts, the watchful observation of the mother must be at once aroused. If no physical cause of irritation such as worms appears to be present, the dangerous habit may be broken up entirely; but no punishment must ever be resorted to. The little innocent child, to whom the sentiment of sex is an unknown thing, will confide in its mother if encouraged to do so. If kindly but seriously told that it will make little children ill to do this thing, and the reply being given, as in cases I have known, that 'the little feeling comes of itself,' the child should be encouraged to come to its mother, and she 'will help him to drive the feeling away.'

"The tact of a mother will never suggest evil to her child; but her quick perception of danger will enable her to detect its signs and avert it.

"The very frequent practice of self-abuse occurring in little children from the age of two years old, clearly illustrates the fallacy of endeavoring to separate mind and body in educational arrangements or systems of medical treatment. In the very young child those essential elements of reproduction, sperm and ova, which give such mighty stimulus to passion in the adult, are entirely latent. Yet we observe a distinct mental impression produced, leading to unnatural excitement of the genital organs. This mental impression growing with the growth of the child, produces an undue sensitiveness to all surrounding circumstances which tend to excite this mental impression. Touch, sight and hearing become avenues to the brain, prematurely opened to this kind of stimulus. The acts of the lower animals, indecent pictures and talk which glide over the surface of the mind of a naturally healthy child, excite self-conscious attention when habits of self-abuse have grown up unchecked. The mind is thus rendered impure, and the growing lad or girl develops into a precocious sexual consciousness.

"At school a new danger arises to children from corrupt communication of companions, or in the boy from an intense desire to become a man, with a false idea what manliness means. The brain, precociously stimulated in one direction, receives fresh impulse from evil companionship and literature, and even hitherto innocent children of ten and twelve are often drawn into the temptation.

"From the age when the organs of reproduction are beginning slowly to unfold themselves for their future work, the temptation to yield to physical sensation or mental impression increases.

"The inseparable relation of our moral and physical structure is seen in full force at the age of twelve or fourteen. Confirmed habits of mental impurity may at any age destroy the body from the physical results of such habits."

Chastity.—Happily in all civilized countries there is a natural reserve in relation to sexual matters which indicates the reverence with which this high social power of our human nature should be regarded. It is a sign of something wrong in education or in the social state when matters which concern the subject of sex are discussed with the same freedom and boldness as other matters. This subject should neither be a topic of idle gossip, unreserved publicity or cynical display. This natural instinct of reserve, springing from unconscious reverence, renders it difficult for one sex to measure and judge the vital power of the other. The independent thought and large observation of each sex is needed in order to arrive at truth.

UNCHASTITY.—In conclusion it may be said that unchastity, and the enormous and unnatural development of the sexual passions are largely the effect of highly stimulating foods and drinks. Alcohol and tobacco no doubt goad this instinct into such a fever that it is almost uncontrollable. Highly seasoned foods do the same for those who do not use alcohol. Parents are responsible for this. The young need abundant food to develop a strong body, but they do not need highly spiced food, tea or coffee, all of which develop preternaturally the sexual passion. A whole work might be written on this subject alone. Neither do men in the prime of life need these things; and if they are needed at all, it is in old age, when the bodily powers are on the wane. I do not doubt that prostitution and sensuality would almost entirely disappear if proper attention were paid to the physiological education of the young.

But sexual hygiene includes more than purity, chastity, etc. It includes keeping the generative organs in perfect health. The object of these organs is procreation, not pleasure. That pleasure goes with their normal use is only a secondary matter, important, as stated in another chapter, but not essential to reproduction.

The importance of a healthy generative organism is simply that healthy children may result from its use. If it is diseased, its work will be less perfect, and children will be born accompanied with pain and suffering. No doubt childbirth without pain of any consequence will be the final result of the improved health of our race. This should be. Pain is abnormal, a result of disease, undesirable.

The health of the generative organs in boys and men is lowered by all practices which are unnatural, and by whatever lowers the general health of the body. Self-abuse in time brings on an irritated state which causes reaction on the brain and finally dreams which are undesirable. It is very true that similar dreams frequently occur in young men in apparently perfect health, in which case no uneasiness should be felt, no quack doctor consulted. But the dreams which result from abuse are different, and the young should avoid them. If acquired, a vigorous, healthy life, gymnastic training, cold bathing and common sense are better remedies than any medicines. Indeed, under gymnastic and athletic training alone they generally disappear. Anything that weakens the body, any bad habit or disease, any sedentary life that keeps one from air and light, any food that does not properly nourish the body lowers the health of the generative organs, and if children are now begotten there is some danger they will be feeble.

There are those who claim that the sexual organism is kept strong by use, and that if the person is unmarried, and does not indulge in intercourse, they will weaken. Men are very apt to make this an excuse for leading an impure life. No one would use the same line of argument for women. It would seem very strange if they, too, were to claim it for themselves. The sexual organs of both sexes will remain in perfect condition without use if the health is kept vigorous, just as the female breast does. The specific diseases which often come from this indulgence ruins not only the organs themselves, but frequently the whole body.

The generative organism of women suffers far more than that of men in some respects. It is thought by a few that the upright position assumed by man as the result of evolution places the female at some disadvantage. Parts have to be supported by frail methods which, if women, like animals, walked on all four limbs, would not need that support. It is on account of this that women are the subjects of so many female diseases believe physicians. I do not myself hold to this view. The evolution of man from some lower form was, no doubt, very slow, and he had abundant time to adapt himself to the new position, so that these organs in the female need give no trouble if the health is preserved and the habits are good. The reason why there are so many women who suffer from diseases of the reproductive organs is because they are not healthily brought up and their habits are bad. Where girls and women are educated to a robust, healthy life they are as healthy and enduring as men. But, as a rule, they are not so educated. Even schoolgirls suffer in considerable numbers from a weakened condition of the sexual organism. Dysmenorrhea and suppression of the menses are quite common. Why is it so? Because these girls have been living like hot-house plants. But little attention has been given to their diet, their physical training, arrangement of their clothing so that it shall not crowd down the pelvic organs and misplace them. The corset has done a world of harm to woman's organs of reproduction. I never see a corset store but I wish I had the power to annihilate it.

Then, too, girls and women in society disarrange their sleeping hours and keep their minds too much excited over fiction and fashion until insomnia, hysteria and menstrual diseases become permanently established, and then there is not much beauty, health or happiness for them, or any one connected with them.

It is the same with the shop girls and the women in business. There are now in this country some five million women in the various industrial occupations, in stores, factories, offices, as typewriters, etc., and far too many of them have more or less disease of their generative system. I know well enough that there are plenty of parents whose daughters are brought up to health habits, and plenty of them are sound, but too many are not sound.

I say it with feeling, women and girls should study and learn how to take proper care of their health so that part of their nature we are here considering shall be well. This part in health it will add to their beauty, their attractiveness, their happiness. Then if called upon to be wives and mothers they can be true mates and partners in life's journey. The moment they go wrong here, both beauty, vivacity, enjoyment are in a low state, and though they may marry they cannot be true partners to healthy men.

After marriage the same care is necessary, so as not to overtax the organs of generation by excessive indulgence, over-childbearing, or in any other way. Husbands should understand this, not only for their own sake, but for that of their wives. Self-control should be the rule of life. Self-control is the last part of man's nature which has been developed, and it is not as firmly fixed in the brain as it will be in the future. Animals have no self-control, that is, they simply act as they feel. Man often takes his actions under control, and makes himself do as he ought to do. In his sexual nature he is, however, far from perfect. Often he is worse than the animals below him. Self-control is a power which has been, and is, of great service to man, and he can make it of still greater use as evolution works on him. The chief reason why there are so many nervous diseases and so much insanity is because self-control has been entirely lost. The human mind is a good illustration of how useful it is and how much is lost when it is lost.

Finally, I repeat that sexual health, with few exceptions, goes with general health, and the reverse is also true. For this reason we cannot be too wise in educating the bodies of boys and girls into such habits as shall promote both.