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CONTRIBUTIONS ...FROM... MEDICAL EDUCATORS.

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THE PHYSICS OF REPRODUCTION AND THE DETERMINATION OF SEX.

THOMAS G. ATKINSON, M. D., CHICAGO, ILL.

We seem to have developed of late an unfortunate faculty of approaching our problems from a wrong direction and studying them from a wrong view point. Scientific investigators—particularly inductive observers—are very prone to overshoot the mark in one direction, and much valuable time and labor is likely to be lost in this way unless they frequently pause in their work to compare notes and balance up their findings with the rest of human knowledge. Not rarely, indeed, the scientist has to be halted and set right by some clear-headed layman, whose sense of proportion has not been lost by too long accommodation of his vision for his near point.

The problem of heredity has been investigated for many years on a cellular basis, and in spite of the length of time and the diligence of labor expended upon it by able men, our knowledge of the subject is still most meager and indefinite—probably because it is not a question of cells at all but of organisms, a process of ontogeny more than of phylogeny, a phase of the centrifugal influence of the mass on the unit rather than of the centripetal influence of the unit on the mass. By the same token, the problem of sex in offspring, always a subject of lively interest to both scientist and layman, has never reached a satisfactory solution—probably because it has always been investigated on an organic basis, whereas it is far more likely to be a question of pure physics, and to concern units rather than organisms.

The phenomenon of reproduction among organisms has come to be regarded as a peculiarly organic and complex function, appertaining to those biological properties which differentiate them from inorganic structures. This I believe to be a cardinal error, due to confounding complexity of circumstances with that of phenomenon. While reproduction is surrounded, in organisms, with a tangle of in-

tricate phenomena, it is in itself, on the contrary, a most simple and elementary phenomenon of physics, and being a purely dynamic phenomenon, constitutes one of the few points of community between organic and inorganic manifestations of matter.

Reproduction, naturally, cannot be studied in reference to life generally; for life in the abstract, i. e., activity of matter, considered as a whole, cannot have any relation to genesis. Special forms of life, i. e., special arrangements of matter and special manifestations of activity, are reproduced, and it is in relation to these special forms of life, in other words in relation to organisms, that reproduction must be considered. And if organisms be understood to mean special arrangements of matter, then every adjustment of matter into such special arrangements by the agency of already existing arrangements may properly be considered as reproduction.

The question immediately arises,—If reproduction be understood to mean the adjustment of units of matter, into similar arrangements, wherein consists the difference between reproduction and growth? Broadly speaking, the answer is that there is no difference, except in certain working details which will appear when discussing the causes and conditions of genesis. Broadly speaking, reproduction is the overgrowth of the individual,—a truth which is very lucidly illustrated in the method of reproduction of the simplest protoplasmic cell—that of division—where the process of growth is continuous with that of reproduction. On this point we shall have more to say a little later.

We pass to a consideration of the conditions of reproduction—conditions of time, cause, and influences—when, how, and under what conditions reproduction is effected. Concerning these questions, of course, nothing absolutely certain in the way of laws can be formulated. The best that science can offer is the likeliest hypothesis, built upon a careful and constant observation of inductive facts.

With regard to time, the most generally accepted hypothesis is that reproduction becomes possible when the reproductive cell is matured, in other words when it has reached the balancing point between attractional growth and frictional waste. That this condition is subject to modification is at once apparent from the contemplation of one or two circumstances. In the first place, it is at best only an uncertain condition of genesis, for although it has been verified in perhaps more cases than not, yet there are no means at hand of establishing beyond question that the reproductive cell has always

reached maturity, other than as a deductive conclusion from other and better ascertained facts.

And even if such a verification were possible, there still remains another and more serious objection to it as a basing point in the consideration of genesis; namely, that whereas a thousand different physiological combinations, representing as many varieties of function, sooner or later reach balancing point, they do not by any means all of them reproduce in the sense of genesis. From which it is evident that the mere condition of balance is one which reproduction requires in common with a thousand other functions, and can therefore hardly be said to constitute a vital or distinctive condition of genesis.

As a matter of fact, there are good grounds for believing that reproduction can be, and is, occasionally effected by cells which have not reached the place of equipoise—which are yet in the process of growth—and that, so far as this condition is concerned, any influence capable of upsetting the *tendency* to balance is capable of precipitating reproduction.

What I venture to think is a far more important and distinctive feature about the reproductive cells; a feature which is not accorded by biology anything like the importance belonging to it, nor any of the histological significance attaching to its influence in the function of genesis; is the fact that they are invariably absolutely unspecialized cells. For the present, and in order to spare the necessity of going too extensively into the subject, the application of the term "unspecialized" may be limited to the structural and functional differentiations which are effected by the various tissues of the parent organism upon the cells concerned in ontogeny. In other words, the polarity of the reproductive cell, as a unit, has not been differentially modified by the complex polarity of the mass.

Not only is this feature superior as a basal element in our study of reproduction in that it presents a constant and actual condition of genesis, while that of balance is uncertain and largely deductive, but it possesses further the advantage of being subject to no mathematical progression. It is absolute, the capacity for reproduction being absolutely dependent upon the utterly unspecialized condition of the cell, and the least deflection toward specialization being quite fatal to any reproductive possibilities.

In insisting upon the ultra importance of this unspecialized self-polarized condition of the cell, however, the comparison is only intended to apply from a standpoint of rationale. For when we

come to consider the actual process of reproduction the element of balance (or tendency to balance) plays an equally important part in the phenomenon. The two elements are complementary. So true is this, that in order to establish more clearly its natural corollary (that reproduction cannot take place without a disturbance of the tendency to balance) it is worth while to digress for a moment and unravel the somewhat confused teachings of technical biology on this particular point.

Biology has classed the process of reproduction with reference to two general methods: Gamogenesis, in which the necessary elements are supplied by two distinct organisms, and Agamogenesis, where the same organism furnishes all the necessary elements. The distinction, as viewed in the light of larger biology, is arbitrary and one of convenience only. Its raison-d'-etre consists in that idea of individualism, and arises out of that practice of studying natural processes in the light of highly specialized biological phenomena, against which the reader was warned at the outset.

Gamogenesis and Agamogensis really mean no more to biology than induction and deduction do to logic. They simply denote detailed divisions of the same process. For there is actually but one process of genesis; namely, the displacement of an unspecialized unit from its balance, or from its tendency to balance, with the mass, by the agency of some external stimulus. In multicellular organisms this stimulus usually consists in contact with another unspecialized unit, also nicely balanced, of more or less opposite polarity to the first, the law being that the vigor of the disturbance varies directly as the degree of balance and the unlikeness of the polarities.

It is hardly necessary, I should imagine, to point out that both as an unspecialized unit exposed to the influence of a specialized mass, and also as a unit whose static and dynamic balance with the mass is displaced by another unit of opposite polarity, the reproductive cell is subjected in the process of genesis to the operation of the law of mutual attraction of matter. It is immaterial for the purposes of this article through what complex set of phenomena the principle operates, for complexity of medium does not in the least vitiate the causative value of a first principle.

Reference has been made to the similarity between the function of reproduction and that of growth, and it was pointed out that there was no difference between them except in certain working detail. Both are readjustments of atoms, by the agency of polar at-

tractions, in favor of one segregation of atoms and at the expense of another such segregation. But they must not be understood to involve the same detailed process, or to produce the same individual results. For whereas in the one case the influence is simply that of the mass over its own units, compelling assimilation (growth), in the other case it is the influence of the mass over another smaller mass, compelling the specialization of the latter's units into an arrangement similar to its own (reproduction).

It is entirely within the principles of dynamics that such influences of one mass over another do operate, and we see here a confirmation of the immense importance ascribed to the unspecialized condition of the reproductive cell, for it is only on this ground, namely, that in growth the cells are already tending to specialization, while in reproduction they are not, that we can explain the different influence exercised by the parent mass upon the fertilized germ from that which it exerts upon the ontogenetic cell. This consideration will emphasize the assertion that the slightest deflection on the part of the cell toward specialization is utterly fatal to reproductive possibilities. Such a germ might grow, as a part of the parent mass, but could never develop as a separate and similar mass.

It will be well to now enquire what bearing all this has upon the problem of the determination of sex, and in so doing we shall touch the fringe of a far wider and deeper question, namely, the nature and origin of sex itself.

Regarding mammals as the most complex exponents of the subject, we find that the essential and ultimate element in their reproductive function is the primordial cell. This cell is universally agreed to consist of simple protoplasm, to present identically the same structure in male and female, and to exhibit absolutely no tendency to structural or functional differentiation. It is, in both male and female, an utterly unspecialized cell. It is interesting and significant to note that the primordial cell originates in, or is derived from, the epithelium, which is the simplest form of ontogenetic tissue, and in which, according to Koelleker and Haeckel, polarity is most marked. In the higher forms of tissue this polarity is almost lost, being entirely surrendered to the complex polarity of the mass. We are, therefore, justified in assuming that the primordial cell, which is still more elementary than epithelium, is highly polarized. It is very important to keep in mind the distinction between specializa-

tion and polarization, the degree of the one being, indeed, in exactly inverse ratio to that of the other.

As Spencer has well pointed out, no forms of matter are so unstable as simple unspecialized forms; hence we cannot suppose that the primordial germ-cell, after its separation from the epithelium, remains long unmodified by its surroundings. It is no longer to be regarded as a unit, but as the potential nucleus of a separate mass. It will either develop as an independent organism, or perish. Given, then, a small, unspecialized, highly polarized mass, exposed to the dynamic influence of an enormously larger, complexly polarized mass, what should we expect as to the outcome of such a set of premises? Should we not expect the former's homogeneous polarity to be swung *in toto* into an axis corresponding to the resultant of the heterogeneous polarity of the larger mass?

But in our instance, what constitutes the complex polarity of the larger mass, and what determines its resultant? Its complex polarity represents all the differentiations of structure and function which have entered into the ontogenetic history of the individual. To a certain degree, i. e., insofar as they relate to specializations common to members of a species, these differentiations have been identical in both male and female, modified only by individual variations; and so far their polaric influence will be the same in both. But insofar as they relate to those specializations of structure and function which distinguish male from female, they will influence the germ from opposite poles. Their resultant will therefore differ, in male and female, by just the measure of those ontogenetic differentiations which constitute sex. Conversely, sex may be defined as the sum of those ontogenetic differentiations which antipolarize individuals of the same species, after eliminating those which are common to the members of the species, and deducting those attributable to individual variations.

The effect of the resultant influence referred to upon the primordial cell is to bestow upon it a polarity which is relatively positive and negative, in male and female, in proportion to the net sexuality of the individual. Positive and negative are, of course, interchangeable terms, merely signifying opposite poles of attraction.

It is probable that the dividing line between asexual and sexual reproduction is reached when the complexity of the organism exerts so diverse a polarity that fission is no longer dynamically possible, and polar displacement of unspecialized units becomes necessary.

But this opens out a phase of the subject too extensive to be discussed here.

The polarity of the reproductive cell,—or its sex, since sex is shown to be but the differential of ontogenetic polarity,—has thus been determined, not by anything inherent to itself, for at first the male and female might have exchanged primordial cells with impunity, but in the dynamic influence of the parent mass. And it is upon the relative intensity of their polarization at the time of union that the sex of the new individual depends. They are from this time on colloids, charged respectively with positive and negative electrons, and under conditions of reasonable propinquity, will rush together and fuse. And in that fusion, in obedience to a well-known principle of colloids, the polarity of the most strongly polarized ingredient will determine the polarity of the compound.

It would, of course, be foolish to attempt any detailed inductive proof of the theory here advanced. In the present state of our knowledge concerning the function and process of reproduction no theories on the subject are capable of experimental proof. There is not enough trustworthy evidence in any direction. The present theory must rest its claim for acceptance upon the general soundness of its physical premises, and the validity of its reasoning from them. Nevertheless, there are a few considerations which, while they afford no direct testimony, yet contribute to the theory such evidence as the lawyers term presumptive.

First may be mentioned the over-truth that the development of sex is concurrent with that of complexity of structure and function. In the simpler and more homogeneous forms of life, such as we usually call inorganic, there are no manifestations of sex at all; and in the lower forms of organic life it is but feebly exhibited; and in proportion as the polarity of the organism becomes more diverse, the phenomenon of sex becomes more strongly marked. I hesitate to offer this as evidence, knowing as I do that it is rather in the nature of a corollary, and depends largely for its value upon a prior acceptance of the theorem which it is offered to support. However, if the corollary works back to the theorem it affords pretty satisfactory confirmation of the soundness of the theorem, although it cannot properly be included in its demonstration. So I let it stand for what it is worth.

The second item of evidence is drawn from my own observation, and is equally open to the observation of any one who will

take the trouble to exercise it, although it can be intelligently applied only among those with whom the observer is more or less intimately acquainted, so that the field of observation is somewhat limited. In a careful scrutiny extending over several years I have found, with a degree of constancy which is flattering to my theory, that in cases where the sexual personality of one parent plainly predominated over that of the other, the offspring invariably took on the sex of the parent whose personality was dominant. Where the sexual personalities of the two parents were about evenly balanced, so that one might reasonably expect transitory influences to raise or depress one or the other, the offspring invariably showed a more or less even distribution of sex.

I do not pretend that this rule has always worked out with perfect clearness, or to my entire satisfaction. The difficulty in the way of such observations among human beings is in the multiplicity and complexity of those qualities which go to make up sexual personality, and which are every generation becoming more involved. But in no instance where the premises were plain and unmistakable, either as to predominance or balance between the parents, have I been disappointed in the result.

In the third place, it has been found possible, among the lower animals, to control with tolerable regularity the determination of the sex of offspring. It has been found, with a reasonable degree of constancy, that when the male is put to the female at the commencement of heat the union results in female offspring, but if the male is applied toward the end of heat the offspring is generally male. Now, in the case of these lower animals it is possible to eliminate from the problem all of those obscure and complex mental and moral phenomena which make up so large a proportion of sexuality in the human race, and to consider their sexual polarity as a more or less simple matter of animal physics. Regarding the matter in this light, we may reasonably assume that, apart from the active sexual desire, the sexual polarity of these creatures is pretty evenly balanced as between male and female, and we must look to the element of active sexual desire for any excess of polarity that one may possess over the other. As a general thing, there can be no doubt that this factor is in favor of the male, the one exception occurring during the first few days of the female's heat, at which time I think it cannot be questioned that the actual sexual craving of the female rises to a higher intensity than that of the male, and dominates it. This is equivalent to saying that at such a time the reproductive cell

of the female is more highly polarized than that of the male, and the resulting fusion of the two colloids will assume the polarity of the female element. Toward the end of heat the sexual desire of the female has again dropped below the level of the male,—perhaps reaction depresses it somewhat,—and the polarity of the male germ predominates in the fusion. I may say in passing that theoretically the latter of these two conditions is not so constant as the former, and I believe breeders will testify to the fact that the outcome of the latter is not nearly so regular as that of the former,—that while the application of the male at the beginning of heat is pretty certain to result in female offspring, its service at the end of heat is by no means so certain to produce a male.

It will be seen that the theory here advanced does not offer very much encouragement to the voluntary control of the sex of offspring. In fact, one of the inevitable deductions from the theory is that the higher one goes in the scale of life the less practicable this becomes, for the reason that a more multiple and complex set of conditions enters into the determination of sex, and *per contra* sex represents the differential of a much more diverse polar system. In the case of the lower animals it is possible, within tolerably broad limits, to control the process,—and we know that it is largely controlled,—because the relatively simple nature of the determining factors enables us to take advantage of their periodic variation. Even in their case, however, it will be observed that nothing can be done to force the predominance of one over the other; we can only watch for and avail ourselves of the variations brought about by Nature, and frequently we are left in the lurch.

In the case of human beings, where such a complexity of mental and moral elements enters into the determination of sex and influences the porality of the reproductive cell, it is hopeless to expect to be able to recognize, in the great majority of instances, the variations of sexual polarity, let alone produce such variations at will by artificial means. In the comparatively rare cases where the parental polarities are in marked disproportion one can usually foretell the sex of the offspring, but not control it, and in such cases we are confronted with the impossibility of producing offspring of the other sex. In cases where parental polarities are to all appearances evenly balanced something might possibly be accomplished by timing the sexual union, according to the same rule as that observed by animal breeders, but the complexity of sexual influences in the human race

renders such a course very uncertain. Its chances for success would be greater in proportion to the animalism of the subjects.

One point in this connection is, however, established beyond question if the theory is sound, namely, that whatever steps are undertaken to control the sex of offspring must be undertaken before fertilization. After fusion of the two colloids has occurred the polarity of the compound is irrevocably determined, balance is destroyed, and growth and specialization have begun. Thereafter all attempts to influence the sex of the new individual *in utero* are as futile as those directed to the same purpose after the child is born.

LYMPH AND THE LYMPHATICS.*

CHARLES H. DE WITT.

This subject is one of intense interest and of great practical importance to the physiciain and to the student of medicine. In this article the writer will give the substance of his teaching regarding this important topic. In most instances the original source of his information will be given.

Ranvier very aptly compared the lymphatic system to a great gland which pours its secretion, the lymph, into the veins. The lymphatic system resembles the portal system in that glands are interposed along the course of the vessels which the afferent lymphatics enter and there break up to form a net work of lymphatic channels from which the efferent vessels leaving the gland or node are formed.

The lymph is a tissue consisting of a fundamental liquid intercellular substance—the lymph plasma—and of cells—the lymphocytes or leucocytes. In this tissue the essential part is the fluid part or the lymph plasma. Müller defines the lymph as blood minus the red cells. This definition is not strictly true, however, for, as we shall see, the lymph plasma does not have the same composition as the blood plasma.

The lymph is usually described as a colorless fluid. It may have a reddish or yellowish tint, while that of the lacteal lymphatics becomes white after taking up the fat from the intestine during digestion. It is somewhat viscous, usually inodorous, slightly alka-

*In justice to the author, and by way of apology to our readers for the faulty make-up of "Lymph and the Lymphatics" in the April number, the correct and amended form is presented in this issue.—ED.

line in reaction, and having a specific gravity varying between 1012 and 1045. Blood plasma is more alkaline and blood possesses a specific gravity of from 1055 to 1060. The total quantity is variously estimated. Krause gives it as one-third of the body weight, while other observers say that it is about one-fourth the body weight, that is, three or four times that of the blood. The quantity depends somewhat upon pressure and the cell activity of the body, much more lymph being formed during a state of activity than in one of rest. Moussu states that ten and even twenty times as much may be collected during a given period of activity as during the same period of rest.

The chemical composition of the lymph plasma is very variable, depending both upon the vessel from which it is drawn and upon the general condition of the animal from which it is taken. It also differs in its chemical composition from that of the blood plasma. The proportion of water is greater, it is less rich in proteid substances, the proportion of sugar is less than in the blood plasma, while the salts are about the same as in blood plasma. Lymph contains an amylase, yields less fibrin upon coagulation, and coagulates more slowly, than does blood plasma.

The toxicity of the lymph plasma is greater than that of the blood, since it contains excretory products of cell metabolism which it received as it passed slowly through the tissues. That these toxic substances are present has been shown by Asher and Barbers, who injected defibrinated lymph plasma into the carotid artery of a dog with the result that the circulation was markedly affected. The injection of defibrinated blood plasma produced no effect, proving conclusively that the lymph plasma possesses toxic substances not possessed by the blood plasma.

The formation of the lymph plasma is not as yet thoroughly understood. Ludwig demonstrated the influence of blood pressure and taught that it was formed by filtration and diffusion through the capillary walls into the intercellular spaces. Bernard showed that if potassium iodide were injected into the blood it passed immediately into the lymph. Cheuveau found much less glucose in the lymph plasma than in that of the blood and called it a process of *selective* filtration, and not of mechanical filtration. Heidenhain concluded, as a result of his experiments following the sub-diaphragmatic ligation of the aorta, that it must be a product of endothelial secretion, since the lymph formed and circulated several hours after the ligation of the artery. He also found that the injection of

lymphagogues increased the flow of lymph without producing any appreciable change of blood pressure. He contended that the action of these substances could only be explained by supposing that "they called upon the fixed tissue cells for a supply of lymph." He also found that for some time after the injection of sugar into the blood the percentage was greater in the lymph than in the blood.

Now, from our knowledge of physics, we know that if a mixture of such substances be filtered through a thin membrane, the percentage of the substance in the filtrate is never greater than that present in the original solution. Hence, while it is doubtless true that filtration may play a part in the formation of the lymph plasma, we must consider it not as a "simple product of filtration, but as a *secretion, the genuine result of cellular activity.*" There are those who believe that, as we come to understand our physics and chemistry more thoroughly, we will be able to eliminate the "vital activity" phase of the question.

According to Delamere, the cells of the lymph are to be considered merely as "casual guests." It is not within the scope of this article to give an extended account of them. The number of leucocytes is greater after the lymph traverses a gland, and hence the number of cells is greater at the center of the lymphatic system than at its periphery. The leucocytes are lighter than the red cells, but heavier than the plasma of the lymph. They are somewhat viscous and adhere to the smoothest surfaces. It is now definitely known that they produce, or contain, soluble ferments which digest foreign substances, such as bacteria, that are taken up by them. Experiments with granules of litmus seem to show that this digestion occurs in an acid medium.

All of the leucocytes are not phagocytic, the eosinophile cells being only slightly phagocytic while the small mononuclears do not seem to possess this power at all. While Metchnikoff and some other observers hold that certain forms of white cells are phagocytic toward certain bacteria, as the polynuclear cells taking up the streptococci of erysipelas, we cannot with our present knowledge suppose that each type of cell possesses a special chemotaxis, for Delamere states that *none* of the substances used in his experiments seemed to attract one variety of leucocyte more than another.

Some red cells may be found in lymph, the presence of which may be due to a reflux of venous blood into the thoracic duct. Certain things indicate that under some conditions, at least, they may be formed in the lymph nodes.

The Lymphatic Vessels.—The lymphatics begin in lymph capillaries which are lined by a single layer of endothelial cells. They never penetrate the epithelium, and the form and calibre depends upon the texture of the connective tissues in which they are found. The capillaries of origin are thus placed at the beginning of the lymphatic system, and not interposed between two sets of vessels as in the blood vascular system. As to the origin much has been said. Bartholin, Sappey and others taught that minute "capillicules," arterio-lymphatic capillaries, were placed between the arterioles and the lymphatic capillaries. Rechlinghausen tells us of his "juice-canals." Mascagni held that the capillaries communicated with the intercellular spaces by means of minute openings in their walls. Delamere, in summing up the results of experiments, says that no one has ever seen such openings into the intercellular connective tissue spaces, and that both in the fœtus and the adult they terminate blindly in absolutely closed cul-de-sacs. (I think the best proof that can be given is the fact that when we inject the lymphatics by subcutaneous puncture, the intercellular spaces do not become filled with the injection fluid, as we would expect were there any direct communications.)

Summary from Delamere: "The lymphatic capillaries are *invariably absolutely closed*, and they communicate neither with the connective tissue spaces, nor with the serous membranes, nor with the blood vessels. They are, however, none the less, in very intimate *physiological* relation to these various structures."

The lymphatic vessels are all afferent as far as their relations to the terminal collecting trunks are concerned. Considered with reference to the lymph glands they may be divided into afferent and efferent vessels. The superficial lymphatics are subcutaneous, while the deep vessels are sub-aponeurotic or beneath the deep fasciæ. Sappey taught that the superficial and deep vessels of the extremities were absolutely independent. However, the deep vessels have branches entering them from the superficial vessels, though practically they may be considered as independent of each other. The visceral superficial and deep vessels anastomose more freely.

The vessels anastomose very freely in the subcutaneous connective tissue by what are known as convergent anastomoses. As a result the vessels drain more or less definite regions known as lymphatic territories. Of course, these territories are not absolutely independent. The great majority of all the lymphatic vessels

traverse one or more lymph nodes before emptying into the terminal ducts by which the lymph enters the veins.

The Lymph Nodes or Glands.—Lymphatic glands are ovoid, irregular or bean shaped bodies having one side depressed, known as the hilum. They vary in size and color. The color is usually a grayish pink, but it depends upon the vascularity and activity of the gland as well as to its position. The glands of the liver are often brown in color, while those of the lung are blackened by the deposition of particles of carbon in their cells. In regard to their general structure they have a connective tissue framework supporting lymph sinuses, lymph follicles and cords, blood vessels and nerves. The framework of a gland consists of a capsule of fibro-elastic tissue, and in some cases having a few unstriped muscle cells in it. From this capsule primary trabeculæ arise and converge toward the hilus, where they anastomose and become again continuous with the capsule. From the surfaces of the primary trabeculæ secondary trabeculæ arise which anastomose to form a network within the spaces formed by the primary trabeculæ. The secondary trabeculæ have endothelial cells covering their surfaces and they terminate by forming finer threads known as tertiary trabeculæ. These tertiary trabeculæ form, by their anastomosis, a fine network in the lymph cords and follicles, the interstices being filled with lymph cells.

The lymph sinuses are found beneath the capsule and around the primary trabeculœ, which thus form their boundaries on one side, while the other side is formed by the lymph cords and follicles. The secondary trabeculæ pass through these sinuses, converting them into a sort of sponge-work, through which the lymph passes. The afferent lymphatics of the gland penetrate the capsule and enter the cortical or subcapsular sinuses, and the efferent vessels leave the sinuses at the hilum.

The lymph cords and lymph follicles are placed between the lymph sinuses. They are composed of lymphoid cells occupying the stroma or reticulum of the tertiary trabeculæ. The cords and follicles are similar in structure, the difference being one of form. The follicles being rounded or oval masses between the sinuses of the cortical portion of the gland, while the cords are the strands of lymphoid tissue occupying the medulla of the gland.

The lymph nodes or glands were formerly thought to be closed glands, similar to the thyroid, and it was thought that they were capable of modifying the lymph, an idea not entirely erroneous, as we shall see, for we have reason to believe that the toxic products

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Professor of Surgery.

of tissue metabolism and of bacterial infection are modified during the passage of the lymph through the node. Some held that the glands removed and retained certain constituents of the lymph plasma, while others believed that they added products of their own secretion to the plasma of the lymph.

These nodes are centers of leucocytogenesis, as is shown by the fact that more leucocytes are found in the efferents of a given node than in its afferents. The microscope reveals mitotic division of cells within the node, indicating cell proliferation. The lymph node thus becomes cytogenous in function like the testis. Comparative anatomy brings to light the very interesting fact that while in the vertebrates these structures are distinct, they are blended in some invertebrates, forming a lympho-sexual gland.

That the lymph node may act as a substitute for bone marrow seems likely since Rindfleisch states that he found the cells of Neumann in the lymph nodes of a rachitic child in whom the red marrow was wanting. While it does occur at times, the best authorities say that it is very inconstant, or at least intermittent. This may account for the presence of some of the red cells mentioned above. which are sometimes found in the lymph. The lymph node becomes a sort of center for bacteria and non-living particles brought to it by the afferent lymphatics, a common example of the latter being the anthracosis of the bronchial lymph glands. This is due primarily to the fact that a great number of phagocytes are present, and, secondly, to the fact that the lymph passes very slowly through the nodular capillaries and lymph sinuses.

"The normal gland may contain germs, and it is possible that these germs may be connected with the production of the soluble ferments of the gland, which are now being studied."—Delamere. Perhaps these ferments help to modify the toxic substances of the lymph, for ferments capable of digesting bacteria may be capable of changing the toxic chemical products given to the lymph plasma as a result of cell-metabolism.

The thirst after operations, where ether is used, is much allayed by giving an enema of one pint of normal salt solution, 100 degrees Fahrenheit, introduced with a rectal tube. It should be given before the patient leaves the table.

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EDITORIAL

The issuance of this number of THE AMERICAN marks the beginning of a new and notable epoch in the history of the school. With a complete reorganization of the management and faculty and an entire re-casting of its policy and methods, the school steps at once into a larger and loftier field of activity and influence, and takes its place beside the first-ranking medical schools of the country. THE AMERICAN, which represents the character and esprit of the college, enters upon an equally enlarged and progressive era. It will be its aim and effort to keep pace with the new order of things, and present to its readers each month a faithful and worthy reflection of all that is best in the thought and work of the school, with enough of infusion from the outside medical world to keep the strain healthy and robust.

The editor extends to everyone connected with the school an earnest invitation to assist in making the magazine a success, for he well understands that without co-operation from faculty and students the enterprise must be a dismal failure, and he desires to impress upon these departments of the college a sense of their responsibility for the upholding of the journal. As soon as the classes are organized and class editors are appointed, special space will be set aside in each issue for class news. The pages of this magazine are open at all times to any matter of interest to its readers either from a local or a general viewpoint, and it is requested that contributors be concise and pithy in the presentation of their subject. Among the new features of the journal will be a reform in the matter of

DR. ROSS C. WHITMAN,
Professor of Medicine.

time of publication. It will issue promptly on the fifteenth of each month, and all matter for inclusion must be in the editor's hands not later than the fifth of the month. All contributions are of course subject to the judgment of the faculty.

With these brief remarks we launch THE AMERICAN upon its new career. Hands all round, and success to our school! A long pull, and a strong pull, and a pull all together!

COLLEGIANA

A great many changes will be found in the personnel of the executive staff and faculty of the college this year, all of which it is confidently expected will militate toward the better interests and success of the institution. Professor Roe now occupies the office of secretary of the college. Mr. Roe's executive skill and indefatigable activity have been felt in the progress and policy of the college for many years—in fact ever since its establishment—and his appointment to the secretariat ensures a vigorous and progressive administration of its affairs. Dr. Walter R. Schussler assumes the office of treasurer, and those who know Dr. Schussler are satisfied that he will ably and faithfully discharge this important function. The appointment of J. A. Hynes as registrar is simply a formal recognition and official endorsement of the position held and work done by this gentleman in past years in an unofficial way, and is but a just and logical culmination to the indispensable value which has gradually attached itself to Mr. Hynes' influence and services. The college is to be congratulated on the executive combination which the personality and ability of these new officers represents.

THE FACULTY.

The management has been successful in lining up a faculty for the coming year which for strength and effectiveness it will be hard to beat. Besides the retention of all of the strongest and most effective members of the former faculty, several additions and changes have been made in important branches which cannot fail to greatly enhance the teaching efficiency of the school. As these new men are all of them prominent specialists in their respective lines, and more or less in the public eye, we shall content ourselves with a

brief introduction of each of the new heads of departments. We have been fortunate enough to secure the photographs of most of them, and these will be found accompanying the short sketch of their careers.

Dr. Victor J. Baccus is the new head of the surgical department. Dr. Baccus is a Belgian by birth, and received his preliminary college education and degree of B. S. at the Université Libre in Bruxelles. His medical schooling and diploma were gained at the Northwestern University in this city. Following his graduation he was an interne in the surgical service of Mercy Hospital. For five years he was associated in surgical and pathological work with Professor Henrotin. Dr. Baccus is a man of vigor and decision, a skilful surgeon and an able teacher, and under his administration the surgical chair cannot fail to become a power in the school.

Dr. Ross C. Whitman, who assumes charge of the department of medicine, is a University of Michigan man, having received his medical diploma from that institution. He served an interneship in the Worcester (Mass.) Hospital for the Insane, and later was resident physician in the Sanitarium at Lake Geneva, Wis. He is at present professor of pathology at the Chicago Polyclinic and head of the bacteriological department of the City of Chicago. He is attending physician to Frances Willard Hospital. Dr. Whitman, as his record shows, is a diligent student and a man of energy and ability. He is an eloquent and lucid lecturer and will make the department of medicine in this college both interesting and profitable.

Dr. Henry F. Lewis will be the new head of the department of obstetrics. He is a Chicago man, but graduated both in arts and in medicine at Harvard University. He served interneships in the Boston City Hospital and Cook County Hospital. He was professor of physical diagnosis in the College of Physicians and Surgeons of this city in 1893 and 1894, and afterwards assistant professor of obstetrics and gynecology in the same college. Dr. Lewis is the present secretary of the Chicago Gynecological Society and attending obstetrician to Cook County Hospital.

Dr. Henry G. Anthony, who will head the department of dermatology, enjoys a national reputation in his specialty, as well as being an able expositor of it. Dr. Anthony is a graduate of Rush Medical College in 1884. He holds the position of professor of skin and

DR. HENRY F. LEWIS,
Professor of Obstetrics.

venereal diseases at the Chicago Polyclinic, and is also dermatologist to the Chicago Children's Memorial Hospital, and a member of the American Dermatological Association. His connection with the American College cannot fail to add to its prestige and usefulness.

Dr. Leonard L. Skelton, the new head of the department of neurology, graduated at the Chicago Medical College (now the medical department of Northwestern University) in 1889. Besides his professorship here, he holds the chair of nervous and mental diseases in the Illinois Medical College, and of Medicine in the Chicago Clinical School. He is also professor of physiology in the Chicago Dental College. He was assistant physician at the Illinois Hospital for the Insane, Kankakee, in 1890-1891. Dr. Skelton has the reputation of being a profound student, and a progressive teacher and practitioner, and his influence is bound to be a decided and beneficial element in the advancement of this institution.

Dr. Robert H. Good, who assumes responsibility for the department of rhinology and laryngology, is a Canadian by birth. His preliminary education and B. S. degree were obtained at Albion, Mich., his medical training at Rush Medical College, where he received his M. D., and at Northwestern University, where he obtained the degree of M. S. He served as clinical assistant in otology and ophthalmology at Rush Medical College, and as chief surgeon in the ear, nose and throat department of the Evangelical Hospital. Dr. Good also fills the post of instructor in physical diagnosis at the Chicago Dental College which is now affiliated with this institution.

The constitution of the faculty has been arranged not solely with regard to the prominence and reputation of its members, which of itself so frequently means the delegation of the actual work to assistants, but with a view to their teaching ability. The gentlemen comprising the teaching staff are not only men of the highest attainment in their several specialties, but are teachers of long experience and ripe judgment, who know how to inculcate into the minds of others the knowledge they themselves possess. This has been the salient policy of the executive board in the selection of a faculty, and this is what ensures the truest success of our institution as a school of medicine and surgery.

The University has been fortunate in accomplishing an affiliation with the Chicago Dental College, which not only gives to each

school the double benefits of a common interest and a united faculty, but furnishes the advantages of an interchangeable curriculum in such subjects as are common to both branches of science.

Everything has now been done by the college to provide its students with a first-class up-to-date institution and course. It remains with the students themselves to avail themselves of the advantages thus offered them, and to do their part toward vindicating the dignity and usefulness of the college. We confidently look to them to hold up their end.

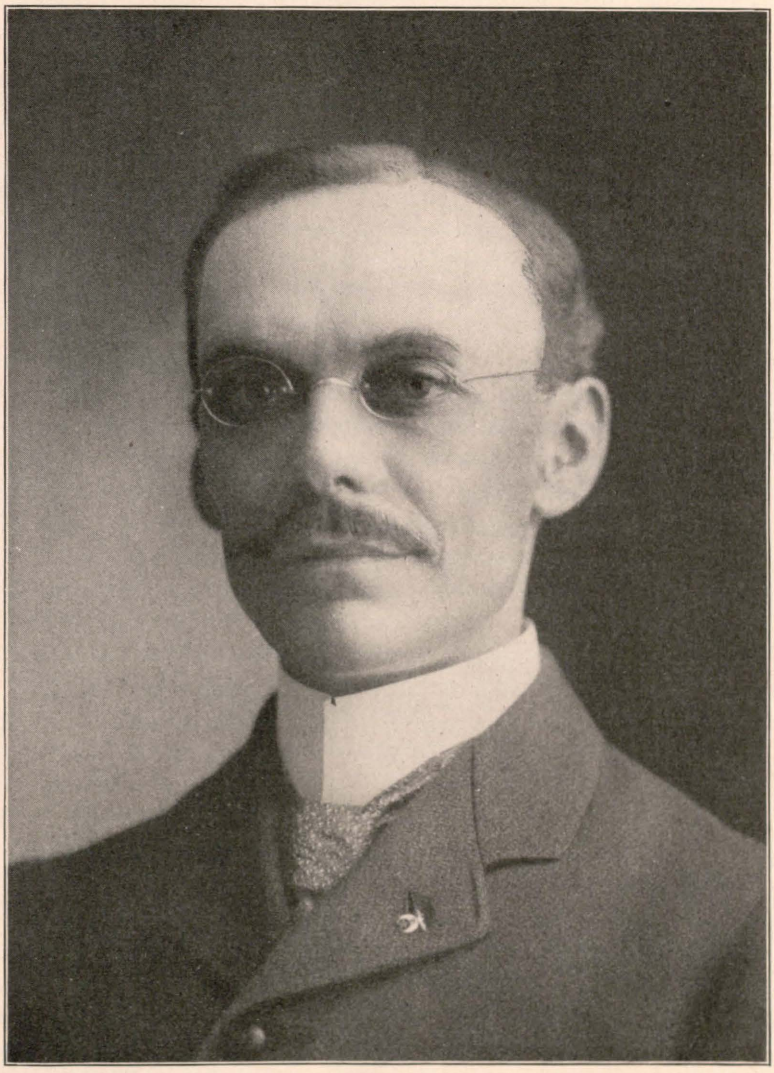
PERISCOPE

HYPEREMIA AND HYPERSECRETION OF THE PROSTATE.

G. FRANK LYDSTON, M. D., CHICAGO, ILL.
Professor of Genito-Urinary Surgery and Syphilology, State University of Illinois; Attending Surgeon St. Mary's and Samaritan Hospitals.

The lime of demarcation between prostatic hyperemia and inflammation is often rather indefinite. From a pathologic, and more especially from a clinical, standpoint there are, nevertheless, many cases of prostatic disease that are essentially active or passive hyperemia rather than inflammation. That hyperemia predisposes to, and is likely to terminate in, true inflammation is well understood. Especially is this true of prostatic diseases involving local circulatory disturbance. This proposition is therefore taken for granted as a preliminary to the discussion of prostatic hyperemia. In perhaps the majority of cases of prostatic disease the diagnosis of prostatitis, acute or chronic, is made and passes without question. That no harm thereby results in the majority of cases is simply because the principles of treatment are essentially the same in both conditions. In some cases, however, a true appreciation of the conditions present would be of direct benefit to the patient, as in certain cases of passive congestion from venous obstruction. Measures that relieve passive hyperemia are likely to prevent the development of true inflammation.

Etiology.—Active prostatic hyperemia has its point of departure, as a rule, in perturbation either of the sexual function or of the



DR. LEONARD L. SKELTON,
Professor of Neurology and Psychiatry.

physiologic act of micturition. The prostate is, from time to time, the seat of physiologic hyperemia, as is true of all glandular organs. This attends sexual excitement, however such excitement may be produced. Under normal conditions the circulation resumes its usual status as soon as the excitement ceases. Its return to a normal circulatory state is still more rapid when the sexual function has been naturally performed. Prolonged sexual excitement without gratification is the most prolific source of prostatic hyperemia. Frequent masturbation and sexual excess will also produce it. The periods of rest between the acts of ejaculation are so short that the circulation cannot regain its normal equilibrium. Sexual excess and masturbation are even more potent in the production of pathologic hyperemia when associated with erotic mentality, alcohol, high living, and a gouty or rheumatic diathesis. If hyperemia be long-continued, subacute or chronic inflammation will probably supervene.

The relation of sexual excitement to prostatic disease demands great consideration. It should be understood that physical continence may be associated, so to speak, with psychic incontinence, with a resulting prostatic hyperemia that may produce both functional and organic disturbance. The importance of avoiding sexual stimuli, psychic and physical, cannot be too strongly emphasized in the management of all prostatic and vesical diseases.

More or less prostatic hyperemia is probably almost always present in urethral and bladder disease, acute or chronic, being due not only to inflammation of the vesico-urethral mucous membrane *per se,* but also to frequent micturition produced by irritation of the vesical neck. The termination of the act of micturition is characterized by reflex spasm of the cut-off muscle, which is greatly exaggerated by hyperesthesia of the posterior urethra incidental to inflammation or reflex irritation of the part. So exaggerated is the spasmodic contraction of the physiologic cut-off that actual traumatism of the prostate results. There is marked disturbance of the circulation, and not only active hyperemia, but lessened power of resistance of both glandular and muscular structure to infection.

Symptomatology.—One of the most characteristic symptoms of prostatic hyperemia is a sense of fulness in the perineum and a voluptuous sensation as of impending orgasm. There is likely to be a sensation of fulness in the rectum, with possibly erotic sensations and more or less tenderness during evacuation of the bowel. An urgent desire to urinate is almost invariable excited

by defecation. There may be considerable prostatic engorgement, without much, if any increase in the frequency of micturition. If, however, the point of departure be direct or reflex, irritation or inflammation of the posterior urethra, frequent and painful micturition is an inevitable result. Even in cases in which micturition is not increased in frequency the patient will very likely complain of some pain and a bruised sensation in the perineum following the act. If the hyperemia be long-continued, prostatorrhea is likely to supervene as a consequence of hypersecretory activity of the prostate glands. In some cases the floor of the prostatic urethra becomes so hypersensitive that frequent seminal emissions occur. Rusty or bloody semen is occasionally observed; but as a rule this symptom is indicative of seminal vesiculitis. Pain during the paroxysmal spasm of seminal ejaculation is a frequent symptom. On the other hand, many patients state that coitus is beneficial. In such cases it is very safe to conclude that the condition of the prostate is one of simple hyperemia. Even in such cases, however, it is not unusual for the patient to experience only temporary relief from coitus. Often repeated indulgence results in aggravation of the symptoms. Rectal examination may elicit some fulness and tenderness of the prostate. This is not always present, as there may be quite a degree of passive hyperemia without much increase in the size of the prostate. This symptom is quite apt to be unreliable, because of the variability of the size of the prostate as felt per rectum and the varying degree of digital expertness in rectal examinations. Passive hyperemia of the prostate associated with circulatory disturbance in the lower bowel, or dependent upon a gouty or rheumatic diathesis, is occasionally associated with hematuria. I have observed a number of cases of hematuria with the expulsion of the characteristic fusiform clot found in prostatic hemorrhage in which no cause could be determined other than passive prostatic congestion, which attention to the assumed etiologic factors speedily relieved, measures to relieve portal congestion having been especially efficacious. This is worthy of consideration in cases of hematuria of obscure origin.

Treatment.—The first principles of treatment of prostatic hyperemia involve all of the rules of genito-urinary hygiene. Briefly, the urine should be rendered unirritating by the administration of bland fluids, of which distilled water or the various saline mineral waters may be taken as the type. Akaline remedies may be administered where simpler measures are not sufficient to neutralize urinary acid-

DR. ROBT. H. GOOD,
Professor of Rhinology and Laryngology.

ity. The diet should be unstimulating. All sources of sexual excitement, both psychic and physical, should be removed. Exercise should be restricted, and if necessary, prohibited altogether. Athletic feats, cycling, horseback-riding, and climbing are particularly to be enjoined. I would especially call attention to climbing exercises, as practiced by young lads and some athletes, as especially injurious. The danger of the conditions becoming chronic should be impressed upon the patient. Instrumentation of the urethra is, in general, to be avoided in acute hyperemia.

Numerous internal remedies are more or less serviceable in prostatic congestion. Mercurial and saline cathartics and laxatives are especially beneficial by relieving hepatic obstruction, thus indirectly removing obstruction to the pelvic circulation. Ergot and gossypium are of undoubted value, directly tending to correct the circulatory disturbance. Sexual excitement is best combated by the bromides in combination with gelsemium. Monobromide of camphor, hyoscyamus, and other anaphrodisiacs are likely to be of service. Suppositories of ice and enemata of cold water are often valuable, cold sitz baths being an excellent adjuvant. In prostatic hyperemia dependent upon anorectal or vesical disease, attention should be given to the primary condition.

In cases of chronic prostatic hyperemia associated with so-called prostatorrhea special attention should be paid to the psychic disturbances present. Rarely, indeed, are such cases presented to the reputable practitioner before a number of quacks have been consulted. The patient is thoroughly convinced that he has spermatorrhea with an allied train of serious nervous disturbances, and last, but not least, he believes himself impotent. Instruction in sexual physiology and hygiene is absolutely necessary for this class of patients. Particularly must they be impressed with the fact that they are not losing semen in the urine, else all of our efforts will be set at naught by their morbid psychic state. By far the larger proportion of cases suffer from constipation. The relief of this condition usually causes the prostatorrhea—the most prominent symptom, in the opinion of the patient—to disappear. Ergot and the bromides are exceedingly useful internal remedies. Hamamelis and hydrastis are serviceable from their known influence over unstriated muscular fiber, and incidentally by controlling vascular supply. Tonics—such as preparations of strychnine, iron and arsenic, and the mineral acids—are very likely to be useful in this class of cases. The occasional passage of a cold sound or the psychrophor is a valuable local measure.—*The Medical Age.*

NORMAL TINCTURES

THEIR EVOLUTION AND MANUFACTURE

In 1870 the late William S. Merrell, A. M., M. D., gave to Professor John M. Scudder the pharmaceutical data contained in his book called Specific Medication. At that time the fluid medicines of the Eclectic school were known as Essential Tinctures—preparations which were certainly in advance of the times. Gradually, from this beginning, the ethical and scientifically correct Normal Tinctures were developed. (In designating these preparations Normal Tinctures we followed the nomenclature expressed in the work called "Digest of Materia Medica and Pharmacy," by Albert Merrell, M. D., formerly Professor of Materia Medica and Pharmacy in the American Medical College of St. Louis, Mo. This book was officially adopted by the National Eclectic Medical Association, June 17th, 1885.)

The *unit of strength* is termed "Normal," the letter "N" being used for its abbreviation. A tincture which represents the drug from which it is made, *minim* for *grain*, would thus be a "normal" tincture, and its strength expressed by the symbol $\frac{N}{1}$. A tincture one-half the strength of the drug from which it is made, i. e., *two minims* of the tincture equaling one grain of the crude drug would be expressed by the symbol $\frac{N}{2}$, and so through the list. The simplicity and exactness of this method is at once apparent.

Upon each label is expressed the relation which the finished Normal Tincture bears to the crude drug from which it is obtained. PURITY, CLEANLINESS and EFFICIENCY are their leading characteristics. A trial in practice will convince any observant medical man that they stand pre-eminent in all those qualities so essential to the success of the physician. The labels are especially designed to aid physicians in prescribing according to specific indications. The dose, frequency of administration and direct indications are upon each bottle. However, the dose of a remedy, within certain limits, and the frequency of its administration, are often questions which the physicians must decide, according to his judgment and experience.

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