Gregg (R. R.)
Compliments of the Author.

A

SIMPLE SOLUTION

OF THE

MYSTERY OF TUBERCLES,

AND

OTHER IMPORTANT QUESTIONS.

(ILLUSTRATED.)

By ROLLIN R. GREGG, M. D.

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Nothing can be more fruitful of Disease to us, than the Cells of Our Own Body, when they become Diseased, or get Misplaced.

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CHYLE-CORPUSCLES, RED BLOOD-CORPUSCLES, LEUCOCYTES, PUS-CORPUSCLES AND TUBERCULAR CORPUSCLES, SHOWN TO BE ALL ONE AND THE SAME, UNDER DIFFERENT CONDITIONS.

By Rollin R. Gregg, M. D., Buffalo, N. Y.

A group of chyle-granules, as first made in the lacteals from the albumen and fatty-matters furnished to them as digestion progresses.

A group of chyle-granules compacted ready to receive cell-wall.

A chyle-corpuscle after receiving cell-wall, but still showing its granular character.

A chyle-corpuscle losing its granular appearance to become a red blood-corpuscle.

A chyle-corpuscle having lost its granular appearance, and assuming color to become a red blood-corpuscle, as all chyle-corpuscles do in health.

All blood-corpuscles are made of chyle-corpuscles, and in the manner here illustrated.

Disc face and edge of arterial blood-corpuscles.

Disc face and edge of venous blood-corpuscles.

A red blood-corpuscle losing color, as they all do while dying, or after their death, whether of old age or disease.

A natural white blood-corpuscle, the same as chyle-corpuscle on first receiving cell-wall.

A leucocyte, or red blood-corpuscle, that has been fully decolorized and made transparent by circulating in a too watery serum.

A pus-corpuscle, or red blood-corpuscle, that has been decolorized to yellow by inflammation, and showing its granules.

A pus-corpuscle that has had its cell-wall dissolved away, or broken up, thus reducing it to a granular mass, the same as chyle-corpuscle just before receiving cell-wall.

Pus granules, or a pus-corpuscle broken up into its granules, which are the identical granules that the corpuscle started with to become a chyle-corpuscle when first made.

A transparent tubercular corpuscle, or red blood-corpuscle fully decolorized by circulating in the very watery serum of the last stage of consumption.

It is these corpuscles decolorized to entire transparency, then congested in the capillaries, that make the gray or *semi-transparent* tubercles of Laennec.

A globular tubercular corpuscle, showing granules; or the red blood-corpuscle decolorized by chronic inflammation, which brings it back to what it was as a chyle-corpuscle just after receiving cell-wall, and is then called a tubercular corpuscle.

It is red blood-corpuscles, decolorized to yellow by chronic inflammation that make *yellow* tubercles.

A distorted tubercular corpuscle, its distortion owing to pressure in the tubercular mass They take various forms under such pressure.

A tubercular corpuscle that has had its cell-wall dissolved away, thus showing the same granular mass and identical granules that it had as a chyle corpuscle just before receiving cell-wall to become a chyle-corpuscle.

Tubercular granules, or a tubercular corpuscle broken up into its granules, which are the same granules that the corpuscle started with as a chyle-corpuscle, to become a red blood-corpuscle. Chyle-granules and tubercular granules are all identically the same, the first at the beginning of their healthy life, the last at its premature close by chronic or subacute disease.

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SIMPLE SOLUTION OF THE MYSTERY OF TUBERCLES

AND

OTHER IMPORTANT QUESTIONS.

BY ROLLIN R. GREGG, M. D., BUFFALO, N. Y.

Nature is ever simple in what she does, as we find when we learn her metnods; and she is even more simple, if possible, in her morbid, than in her healthy growths. To show that this is the case, even with that hitherto greatest mystery in disease, namely, the growth of tubercles, the accompanying illustrations are given, and supplemented by the following explanation.

The primary cells, or the so-called tubercular corpuscles, of which all tubercles are constituted, are diseased blood-corpuscles, or blood-corpuscles changed into tubercular corpuscles by disease, as the illustrations indicate, and as will more fully appear as we proceed. But before we can fully comprehend all the steps in this change, we must first understand more about blood-corpuscles, the process of their making, and their intimate structure; and also something of their demeanor under other and various circumstances, which we will now proceed to consider.

To begin with, then, I will assert that all red blood-corpuscles are made of chyle-corpuscles. That is to say, the blood-corpuscles are made in, or by, the mesenteric glands, from the albumen, fatty matters, salts, etc., in the chyle, that is carried to those glands by the lacteals, from the small intestines, as digestion progresses. This is their formative stage, and in that stage they are without color, and are then called chyle-corpuscles.

The illustrations, as will be seen, begin with a group of chyle granules, as first made, and follow them on through their more conspicuous stages of development, as, becoming more compact to receive their cell-wall, then,

after receiving their cell-wall and becoming a chyle-corpuscle, next the chyle-corpuscle losing its granular appearance, then receiving color to become a red blood-corpuscle, and, finally, as a fully developed arterial or venous blood-corpuscle.

As stated, these corpuscles are colorless when first made, but after passing from the mesenteric glands through the large lacteal trunks, to the thoracic duct, they begin to receive color, and also to flatten upon opposite sides from the globular form to more or less of the disc-shape, and are then called, or we then first begin to call them, blood-corpuscles; which are perfected as they pass on through the thoracic duct into the left subclavian vein and general circulation.

Thus it will be seen, that the chyle-corpuscles are but the formative stage of red blood-corpuscles; and, according to what seem to be the most reliable calculations that can be entered upon, more than *five hundred millions* of them are made, on an average, during *every minute* of adult healthy life. Being made so rapidly and in such enormous numbers, it will be seen that the manufacturing organs must be in immediate and direct connection with an unfailing source of supply of fresh material out of which they are made; and if so, what more natural arrangement than that they be made in and by the mesenteric glands from the pure and fresh chyle brought to them directly and rapidly by *four millions* of lacteal vessels? Instead of their being made by the liver out of stale and impure venous blood returned to it from the abdominal organs and the lower extremities, as some have taught; or by the spleen, from its indirect and deficient source of supply of the proper materials, as others teach.

To judge properly on this point it must be borne in mind that the derangement to health would be great, and death speedy to all, if the blood-corpuscles were not made with great rapidity, and in sufficient numbers for the inexorable demands of life upon them, to free the system of

the rapidly accumulating effete carbonic acid gas, and to supply oxygen freely to all organs and parts. Therefore, I repeat, the supply of material for their manufacture must be the most direct and certain of all nature's provisions in nutrition. And what so well adapted to the purpose as the machinery pointed out?

It is one of the functions of the spleen and liver to decolorize the old and worn out blood-corpuscles and otherwise prepare them for excretion, but not to make new ones.

Then, as all blood-corpuscles have a definite period of existence of but a few weeks assigned them, when they die of old age and must be removed from the circulation to avoid putridity, and to give place to those which are being so constantly and rapidly made; and as it is clear that ample ways and means must have been provided for the excretion of the debris of their disintegration at the end of their natural life, and *that only*; it is equally certain that when disease destroys them faster than they would die a natural death from old age; or when, from any cause, they are brought into excess in the blood; or when disease interferes with the excreting organs, so that the corpuscles, or their debris, cannot be cast out as fast as it should be; then it is certain, I repeat, that acute or chronic congestions must be produced by them, which are always more or less dangerous to life.

And this brings us to consider one of the strange and unaccountable oversights in pathology, namely, that not the slightest attention has ever hitherto been given, or investigation entered upon, by the profession, to see what becomes of the red blood-corpuscles when they are killed prematurely by disease; or when they are brought into a relative excess to the other constituents in the blood, as they frequently are; or when disease assails or interferes with the excreting organs so that their debris cannot be cast out of the system, or circulation, as rapidly as they are brought to old age, and die a natural death. Of course,

if the blood-corpuscles are made as rapidly as stated, or not more than half or quarter so rapidly, they must die of age in the same ratio of rapidity as made, and be disintegrated and excreted as fast as they die from that or other causes, else great danger might and does frequently arise to any organ in which they may become congested.

It is, therefore, to show what disposition is made of the blood-globules, under the morbid conditions named, that the illustrations are given; but we must first understand more fully than some do, how they are disposed of in health, when they reach the end of their usefulness, and can no longer serve the purposes of life, or of their creation.

In health, the red blood-corpuscles are all first *decolorized* as fast as they die of old age, then disintegrated, or broken down, into the granules that they started out in life with as chyle-granules, and then their refuse, or debris, that is, these granules are excreted through the bowels as natural fæcal matter; while the hæmatin that is dissolved out of them in the process of decolorization, is excreted in part through the kidneys, thus giving the natural color to the urine, in part through the bowels, giving normal color to the fæces, and it also furnishes the coloring matter of the bile.

It must be borne in mind, also, in this connection, and with reference to what is to follow, that the blood-globules break down after their death, in the exact inverse order of their original construction; being first decolorized to show nothing but a mass of granules, with a cell wall holding them together, like chyle-corpuscles; then having their cell-walls dissolved away, and liberating their included granules, but leaving them at first more or less in a mass like a mass of chyle-granules, which are then carried along to and excreted through the bowels as so much refuse matter.

WHITE BLOOD-CORPUSCLES.

This brings us to the consideration of the white, or colorless, blood-corpuscles of health—for there are healthy and unhealthy colorless blood-globules.

The white blood-globules of health, there are many reasons for believing, are nothing more nor less than red blood-corpuscles, dead of old age, then *decolorized* by the liver and spleen, ready to be disintegrated and cast off through the bowels—they being found in much greater numbers, or in much greater proportion to the red corpuscles, in the splenic and hepatic veins, than elsewhere in the system, and no doubt preparatory to their excretion as refuse; while a few of them stray off into the general circulation, or, perhaps, keep on going the rounds in this until they are there decolorized. But be they what they may, from this on through the balance of the illustrations our course is clear and steps certain. And it should be understood that up to this point we have been dealing solely with healthy corpuscles, or those of healthy life; while from this out our concern will be as exclusively with unhealthy corpuscles, or those of diseased life. For instance:

ALL LEUCOCYTES,

so-called, or the colorless blood-corpuscles of disease, are red blood-corpuscles which have been decolorized prematurely (that is, before the time for their natural death and decolorization from old age), by circulating in a too watery serum, precisely as every other organic structure of color is faded or deprived of more or less of its color and finally dies prematurely, when compelled to live in a too watery medium.

The law of endosmosis, it must be borne in mind, is the absolutely governing law, or force, under all such circumstances. That is, when, through disease, the serum is made too watery, as often happens, and especially if much too watery, then all or many of the red blood-corpuscles

past middle life, and those in middle life or younger, but of weak organization, absorb water from the too watery serum, are thereby distended from discs to globules, have their hæmatin dissolved out of them, which, of course, leaves them colorless; and if the serum is very watery, as in leukæmia, many of them are made perfectly transparent thereby, and many others ruptured by over-distension and thus wholly destroyed.

Remember, that it is a law of nature that does all this, and that there is no possible escape from the mandates of the law under these circumstances; hence we can rely upon the facts being as claimed, with as absolute certainty as upon the best established fact in science.

The middle-aged and all young blood-globules of strong organization, resist, for a time, what has destroyed their weaker comrades, and are held to perform the functions the red globules were created to perform, and without which the patient would speedily die; until they too, these stronger corpuscles, are more weakened by age, and then destroyed. But if the serum becomes excessively watery they are all destroyed rapidly, or quite so, and with them the life of the patient thus afflicted.

PUS-CORPUSCLES.

We come next in the order of our illustrations to *pus-corpuscles*. Here, too, we have a decolorization of red blood-globules, but by a different process, to make pus-corpuscles. The red globules, in this case, are first congested in the capillaries and smallest arteries and veins of a part, then decolorized by the resulting inflammation, and in that way brought to a yellow color, or to pus-corpuscles so-called.

We will take common boils to illustrate this important fact. These result from the smallest blood-vessels beneath the skin, or in the superficial muscles of a part, becoming greatly congested with red blood-globules. When the congestion is once fully established, no further

movement of the corpuscles therein takes place, at least in all the central portions of the congested mass, until they are let out at the end of suppuration as pus-corpuscles.

Lance the boil at any time before suppuration has commenced, and nothing but red blood-globules and a little serum is obtained as a discharge therefrom. Lance it at the close of completed suppuration, and what do we then get? Nothing but pus-corpuscles and a little serum, besides some natural cells from the dissolved tissues. What, then, has taken place to cause the change? Why, nothing but a decolorization by inflammation of the red corpuscles congested there, and through which they are changed into pus-corpuscles.

Every pathologist knows that there are no movements in the red blood-globules of an inflamed part after congestion is once fully established therein, until resolution, or suppuration, removes them; hence, in the case of suppuration, there is no other possible scientific explanation of the result, excepting that the red corpuscles are decolorized and thus changed into pus-corpuscles by the inflammation. This does fully explain the matter, and furnishes another of the strangest oversights in pathology, viz.: that this only true explanation of the suppurative process was not seen as soon as the microscope revealed the existence of pus-corpuscles in the discharges from all abscesses. Of course, the process of the formation of pus-corpuscles is precisely the same in all acute and chronic abscesses, not tubercular, whether internal or external, and in all ulcerations, whether deep or superficial, as it is in boils.

The next step with the pus-corpuscle, if it shrivel from partially drying under the heat of the inflammation, or from other causes, is that it then becomes granular in appearance, and exhibits the identical granules that it started in life with as a chyle-corpuscle, just after receiving its cell-wall; only of a more yellow color, from having had hæmatin developed in it, and this not being fully dissolved

out, as is done with many or most leucocytes. Or, if its cell-wall is ruptured under suppuration and its granules thereby released, these flow out in a less compact mass, much as they were as chyle-granules just after first made, and before receiving the cell-wall; but now they are dead and disorganizing bodies, instead of living and progressively organizing structures for higher purposes, as in the first instance.

Here, too, we have a breaking down of the corpuscles in a manner similar to their disintegration after their death of old age, in health; for it is a law of all organic bodies to disintegrate, or break down, under various processes, into their primitive elements, when undergoing dissolution, in the inverse order of their original construction. Hence the red blood-globules, when changed to leucocytes, or pus-corpuscles, are first distended from the disc to the globular form, then lose their color in further retrograde metamorphosis, then show their granular structure, then the cell-wall is ruptured and the included granules liberated in clusters, precisely as they were originally as chyle granules, only now dead instead of living bodies, as just stated. All this, too, shows why leucocytes and pus-corpuscles are globular, instead of disc-shaped like the red blood-globules, if any question should be raised on that point.

TUBERCULAR CORPUSCLES, AND HOW MADE.

Next, and finally, in the order of our illustrations, come the tubercular corpuscles and their explanation. They, too, as all the facts and philosophy bearing upon them show (when properly collated and examined), are nothing more nor less, in any case, than red blood-corpuscles, decolorized by chronic or sub-acute disease; and through this and subsequent shriveling, changed into what have been so long mis-named tubercular corpuscles. If this be true, the important question next arises: How is it all brought about, and why are they different from pus-corpuscles and leucocytes? Let us see.

All, even the laity, know that the blood of the consumptive is "poor" and "thin,"—that is, too watery. This is patent to the most casual observation, and it is a scientific fact as well. We will, therefore, enter upon a little further inquiry to see what must be some of the effects of this too watery serum upon the blood-corpuscles, and why different from leukæmia; also to see if we do not find some of the most important facts in this direction, to be found in pathology, upon which to base a true science of tubercles.

In every department of healthy nature means are exactly adapted to ends, and all associated things to each other and to their environment. This exact, or nearly exact, adaptation is what ensures health to all living things, and nothing else does. The salt-water fish, for instance, is made to live in salt water, and dies if compelled to remain long in fresh water. Why? Because the latter is too dilute a medium for the nature of that fish to exist in. Here, too, that important law of nature, viz., endosmosis, governs and compels the result, and there is no possible escape in any case from its mandates, when violated. The fish is constructed to live in a medium of a fixed or nearly fixed density; but if it be placed in a medium of less density, that is, too watery, or which contains less than the normal quantity of salt required by its nature, then successive portions of water are absorbed into its body, which bloat it and render it dropsical, take away more or less of its color, and finally its life.

Well, our blood-corpuscles are also constructed to live in a medium, healthy serum, of a fixed, or nearly fixed, density. Very probably moderate deviations either way, for a few hours, or possibly for a few days, may be tolerated by the corpuscles, as the salt-water fish might live a few days in water somewhat less salt than natural, without serious injury. But, when the blood becomes much too watery and continues so, as with all consumptives, and their blood-globules are thus compelled to live continu-

ously in this too watery medium, very similar results are wrought upon them as upon the salt-water fish living continuously in water which does not contain sufficient saline ingredients.

That is to say, many, or all (according to the degree of dilution of the serum), of the older and weaker corpuscles, and also many of the middle-aged and young globules as well, not possessed of marked vigor of life, begin at once, or soon, to absorb portions of water from this dilute serum, which distend them gradually at the sides from the disc to the full globular form, and dissolve their hæmatin out of them, thus bringing them directly back to the appearance of white blood, or chyle-corpuscles.

By this process, too, the globules are made viscid, or sticky, upon their surface, so that when they reach the capillaries in their onward circulation, the smaller or smallest of these vessels that will admit them, in any organ, will not allow such changed corpuscles (being now of full globular form and sticky) to pass on through them, but they stop them, and are blocked up by them. Then the force of the circulation from behind drives other corpuscles (both those not decolorized as well as those that are, and generally many more of the former than of the latter, in the earlier stages of the disease), into all such obstructed capillaries, where they remain permanently congested. The walls of each and every capillary so congested are then gradually distended by the congestion, (and under the continued pressure from behind), from a vessel of parallel sides and uniformity of size throughout its whole length, as are all capillaries in health, into a bulging or protuberant sac, which is filled at first partly with decolorized and partly with colored blood-corpuscles under the congestive action described—but with many more of the latter in the early stages of consumption, and more with the former in its last stage, when the blood becomes very watery, and a much larger proportion of its corpuscles are rapidly decolorized. But all the colored

corpuscles thus stopped and held in congested capillaries are also decolorized soon, or finally, by the dilute serum percolating among and through them, or by the inflammation they excite, as effectually as were the others before being congested therein.

The blood-corpuscles *cannot* escape these consequences upon them when compelled to live in a too watery serum,* as they are in every consumptive's blood, any more than we could escape bloating and losing color if compelled to live in a continual fog, or in very damp cellars; or any more than the salt-water fish could escape similar results if kept in fresh or nearly fresh water.

The protuberant sac named, or the congested capillary of decolorized corpuscles, then becomes the nucleus of a tubercle. That is to say, the distension of the one, or of several contiguous capillaries, presses upon all surrounding and adjoining capillaries to the extent of obstructing them and preventing the free passage of corpuscles through them, when they also become congested with both colored and decolorized blood-globules—the former being all finally decolorized as already described—and thus the mass becomes gradually developed into a tubercle, which grows from the first one or few of them obstructed, as a center, or focus, outwardly from capillary to capillary, to any known size that tubercles ever attain.

These knots of congested capillaries holding decolorized blood-corpuscles, are the "knots," "foci," or "tubercle granules" of Virchow, which he says "never

* If the reader should suppose from what precedes that *leukæmia* should furnish the most conspicuous examples of tuberculosis, he has only to remember that, in leukæmia, the blood is so very watery and the capillaries are all so relaxed by it, that the corpuscles are washed on through them; or if they do lodge therein, they are then destroyed in situ, by this very dilute serum percolating through them and dissolving away or bursting their cell-walls, when their granules are liberated, washed on, and finally excreted as refuse. Besides, the corpuscles are much more rapidly distended to bursting, and thus destroyed, while yet circulating, in leukæmia, than they are in the less watery serum of the consumptive, excepting, perhaps, in the very last stages of the latter disease, when the serum becomes excessively watery.

attain any considerable size," as, of course, they individually could not, beyond the distension of each capillary's walls into a protuberant sac, as described; and which he wrongly says are nests of proliferated connective tissue cells, though how such proliferation is brought about he entirely fails to give a satisfactory account.

He further says: "You will generally find the tubercles in the brain described as being solitary, but they are not simple bodies; every such mass (tuber) which is as large as an apple, or even not larger than a walnut, contains many thousands of tubercles; it is quite a nest of them which enlarges, not by the growth of the original focus (granule), but rather by the continual formation and adjunction of new foci (granules), at its circumference;" which is precisely the way, and the *only* way, tubercles can grow, being, as they are, an aggregation of great numbers of contiguous capillaries filled with decolorized blood globules.

While thus forming, fibrin is poured out through the capillary walls into the interstitial spaces between them, from the excess of it in the blood in all such cases, where it, the fibrin, organizes and makes the firm and partially fibrous mass that slowly-organizing tubercles generally are in their first stage, or before the changes that lead to their softening.

When inflammation is aroused by the tubercle, and goes on to suppuration, then—that is, during the inflammatory period—a portion of this excess of fibrin in the blood is poured out all around the tubercular mass, where it organizes into the firm and dense fibrinous wall that outlines every tubercular abscess, or cavity; and which separates the tubercle from the surrounding healthy tissue, and confines its suppurative and destructive processes to itself and the immediate tissues in which imbedded. But for this wise provision a small tubercle in the apex of either lung, for instance, might, and often, if not always, would, rapidly destroy that entire lung, by the more fluid

portion of its poisonous pus percolating down through the interstices to all parts of the lung, carrying inflammation, suppuration and destruction everywhere in its course.

Sometimes tubercles grow rapidly, as we see in acute tuberculosis, but generally they are of slow growth, gradually extending outwardly from capillary to capillary as delineated. This affords time for the corpuscles to give up to the surrounding tissues the water that has distended and decolorized them, and especially under the heat of the inflammation they finally excite, when they shrivel into the "angular," "jagged," "elongated" and other distorted shapes that tubercular corpuscles are found in, and which both shriveling and the pressure of the gathering mass contribute to bring about.

This drying down of the corpuscles, and the absorption of the capillary walls and tissues between, under the pressure, are what lead to the tubercle becoming "cheesy"; and generally the older the tubercle, or the longer it is growing, other things being equal, the more cheesy it becomes; unless, indeed, it is so slow in its growth, as sometimes happens, that all, or nearly all, the constituent elements of the corpuscles are absorbed, leaving the fibrin of the mass organized and occupying the space, as a harmless fibroma. Or, again, the distinctively organic, or animal, elements of the corpuscles are sometimes all absorbed when "cretification" of the tubercle is the result; that is, the inorganic elements or salts of the corpuscles are left as a chalky deposit and remnant of the tubercle.

When the tubercle, on the contrary, excites inflammation and suppuration, as is almost always the case, all the tissues between the capillaries, and their walls as well, are broken down, the corpuscles flow together, in mass, and then slough their way through into some natural passage like the bronchi, if in the lungs, when they are coughed up and thus secure their exit from the body. But for the diseased conditions behind, or the active continuance of the causes thereof, that go right on organizing more and

more tubercles to destroy more and more of the lungs, recovery from any ordinarily large tubercle, or from several small ones would be complete even without medication. But the causes and process go on when once begun, and more rapidly the more tubercles form, until the organ or organs are sufficiently destroyed to take life, unless stopped by stopping the cause.

In this process, too, many of the tubercular-corpuscles have their cell-walls destroyed, or ruptured, which releases their inclosed and constituent granules in clusters, and which are the same granules, again, that the corpuscles started in life with as chyle-corpuscles, but now dead and undergoing retrograde metamorphosis. In other words, here, again, the blood-corpuscles, as tubercular-corpuscles, go to pieces under the softening of the tubercle, precisely as they disintegrate after their death of old age, in health, and as they do as pus-corpuscles under suppuration; in this instance also, making good our illustrations and making this hitherto terribly complicated subject and greatest mystery in pathology, the tubercle, one of the most simple in all science.

Here comes up another important fact. Ever since the time of Lænnec, at least, it has been well known that two kinds of tubercles are developed in all, or nearly all, cases of consumption, viz.: the gray or *semi-transparent* and the yellow-tubercle. Of the former Gross says:

"In several cases of chronic inflammation of this membrane," (peritoneum), he has "discovered tubercles in every possible stage of development, some of them—evidently deposited only a day or two before the individuals expired—being of a soft viscid consistence and perfectly transparent appearance, others semi-concrete, yellowish, and consequently more or less opaque, and lastly, another set perfectly dense and firm, like fibro-cartilage, organized and covered by an accidental serous membrane of the most delicate texture."

Now, there has never been any satisfactory explanation of this difference in tubercles; but it would nevertheless appear to be a very simple matter. The "perfectly transparent" tubercles are made of blood-corpuscles that have been first decolorized to entire transparency by circulating in the *very* watery serum of the last stage of tuberculosis, then congested in contiguous capillaries, bulging these out at the sides into protuberent sacs, until a mass, or tuber, is formed of perfect transparency, and as otherwise described.

Those that are "dense and firm, like fibro-cartilage," are such as have had a good deal of fibrin extravasated (from its excess in the blood) into and around them, and there organized to make a firm structure of the whole mass.

The semi-concrete and yellowish tubercles, in this case, were probably such as had been organized some days or weeks, or long enough to have the transparent corpuscles give up by endosmosis, to the surrounding tissues, much of the water that had decolorized them, when they would shrivel and become yellowish.

Whereas, yellow tubercles generally, at least those of much size, are caused by the blood-corpuscles being congested in a mass without first losing their color and then being decolorized by chronic or sub-acute inflammation, which does not take the color out of them so completely as does their circulating in a very watery serum. Let it hereafter be remembered, then, that semi-transparent tubercles are made of red blood-globules decolorized to entire transparency *before* their deposit, by circulating in the serum, whenever this becomes very watery; while the yellow tubercles are made of red corpuscles first congested in mass, then decolorized by the resulting inflammation.

It is a curious fact, too, and equally susceptible of the simplest scientific explanation, that the various organs of the body are ravaged by tubercles in almost the exact ratio of the nearness to each other of their capillary blood

vessels. Thus, the lungs are more frequently destroyed by tubercles than any other organ, or organs of the human body, and their apices more frequently than any other part of either lung. And it is in their apices that the meshes between the capillaries are the smallest, consequently the latter lie the closest together there of any organ or part of the body, excepting the choroid coat of the eye. While from the lungs outwardly, the frequency, or, rather, the rareness of tubercles, is in almost exact proportion, as already said, to the distance between the capillary vessels; the farther these are placed apart, the less frequently is the organ disturbed by tubercles, until we come to the bones, which show the greatest distance between their capillaries, and the *least* frequency of tubercles of any vascular tissue; and, finally, to the cartilages, which have *no* capillaries and *never* develop tubercles.

This fact of no capillaries and no tubercles in cartilages, while all the other tissues containing capillaries suffer from tubercles, and in the ratio of the profusion of those vessels therein, is the strongest evidence that can be adduced of the direct relation of capillary blood vessels to tubercles; and that the former *must* be the channel to carry the tuberculous matter, decolorized blood corpuscles, into a part to make the latter. Where the capillaries lie closest together will be the very parts where the conges tion of one, or a few of them, will press upon and obstruct the free passage of corpuscles through the greatest number of adjoining capillaries, and these be the parts that will show the most frequent destruction by tubercles; thus showing an unmistakable and indisputable *physical* fact at the foundation of this question of the frequency or infrequency of the tubercular destruction of various organs.

THE CONSTITUENT ELEMENTS OF TUBERCLE.

Wood says of the tubercle and its microscopic constitution:

"The constituents, before the softening of the tubercle, are *first*, a hyaline formless substance; *second*, molecules or molecular granules in great numbers; and, *third*, peculiar and characteristic corpuscles; the two latter being held together by the translucent material first mentioned. The corpuscles are quite distinct from all others. They are seldom perfectly round, but are irregularly polyhedral with rounded angles, approaching sometimes the spherical and sometimes the oval form. Their diameter varies from about $\frac{1}{5000}$ to $\frac{1}{2500}$ of an inch. Within the transparent envelope is a somewhat translucent matter, probably of a solid consistence, in which are imbeded from three to ten or more granules. Water does not change them. Acetic acid renders them more transparent, and enables us to determine positively that they contain no nucleus." * * * * *

"When the tubercle softens, the cementing hyaline substance liquifies, and the corpuscles thus set free imbibe apparently a portion of the liquid, become somewhat larger, and assume a spherical shape. In the progress of the change, the cell-wall ultimately dissolves, and the included granules are liberated, thus increasing this constituent of the tuberculous mass."

It would be difficult for language to describe more accurately than this does, the intimate structure of a knot, or mass, of decolorized blood corpuscles congested in the capillaries as previously described under chronic or subacute action—the corpuscles remaining there in their investiture of fibrin until they give up a portion of their water to the surrounding tissues; or, to better describe the effects of softening or suppuration upon just such a mass.

The "cementing hyaline substance" is more or less of it fibrin, exuded into and around all tubercles to outline them from the surrounding healthy tissues, and thereby confine the destructive results of their softening to as small a compass as possible, as before stated.

The "molecular granules in great numbers," are the granules that decolorized blood-corpuscles had been broken down into, by circulating in the too watery serum of the patient, *before* their deposit in the mass to help make the tubercle; and which are the very granules that their parent

corpuscles started out with, as, first, chyle-granules, then aggregated into chyle-corpuscles, next as red blood-corpuscles; and now, through decolorization and disintegration of the latter brought back to present the identical forms or granules, but without life, in which they were brought into existence.

The "peculiar and characteristic corpuscles" are the decolorized blood-corpuscles, given the "irregularly polyhedral," and other forms, by shriveling and by pressure in the mass, as already sufficiently pointed out. (Wood should have spoken of thirty to forty or more granules, instead of three to ten or more, as the number in all tuberculous-corpuscles.)

Then, again, if dissolving away the cell-wall of the characteristic tubercular-corpuscles by the softening, or suppuration, of the tubercle, and liberating their included granules, increases by so much "this constituent of the tuberculous mass," as Wood says; and if such granules exist therein "in great numbers," free, or separate from the corpuscles, *before* the softening of the tubercle; it must be certain that other like tubercular-corpuscles, (decolorized blood-corpuscles), had had their cell-walls dissolved away, or ruptured, and liberated their included granules, before the deposit of such granules with the characteristic corpuscles, to make the tubercle. And this being so, what explains it all so well as that decolorized blood-corpuscles had been ruptured in the circulation of the consumptive, and there had their granules liberated, to then be deposited with other decolorized corpuscles that had not been ruptured, to constitute the tubercle?

The diameters, as well as the forms, of shriveled decolorized blood-corpuscles, correspond very closely to those of tubercular-corpuscles; the want of action of water, and the peculiar and powerful action of acetic acid, is the same upon the one as upon the other; and suppuration also re-

sults the same to each. But the most remarkable proof of the identity of the two remains to be given.

The blood-corpuscle has no nucleus, and the tubercular-corpuscle has no nucleus; and yet, of all cell-structures in the organic world, whether in animal or in vegetable life, these are the *only* two without a nucleus. Thus the comparisons and similarities are complete throughout, and the cycle rounds out and perfects a great scientific reality in pathology, and gives us a *true* science of tubercles.