

SOME IMPORTANT ETIOLOGICAL FACTORS UNDERLYING
MALFORMATIONS OF THE ORAL CAVITY, THE
FACE AND THE BRAIN*

BY WESTON A. PRICE, D.D.S., M.S., CLEVELAND, OHIO

I AM VERY HAPPY to have the opportunity to study with you a little while this evening the problem of the deformities, and as we study the deformities we must necessarily have in mind the normal development if we would see the abnormal. I am going to ask you then to consider with me for a little while some of the normal processes of development. What are the laws of heredity? What is heredity? Why am I what I am? What has made me such as I am? Is it largely the influence of my father or of my mother, or were they rather secondary? What is the great law of normal development? What are the laws of development? If we were to have asked that question twenty years ago we would have found, following the leadership of Lamarck, that the answer would have been: "Use and disuse," and they would have pointed to the giraffe and would say, "See the giraffe with his long neck; that long neck for reaching those beautiful succulent leaves on the tall trees is nothing more nor less than the result of his stretching his neck to reach the leaves." Therefore, the answer would have been, "Use and disuse." And if my ancestors would have been studied they would have said, "Necessarily the qualities which present themselves in this person as character are such because of use and disuse." A little later if we had asked the authorities as to the laws of heredity they would have said, "No, not the laws of use and disuse, but rather the survival of the fittest, natural selection in other words." And we would have had a leader like Darwin pointing to the swine and he would say, "See the splendid herds of swine we have today; they are the result of picking the fittest of this flock and the fittest of that flock and therefore we have by natural selection developed the ideal, the best that we have today." If we were to ask a later generation than Darwin among the biologists: "What are the laws of heredity?" they would have told us, "No, not the effect of use or the effect of disuse nor the effect of the selections of the best qualities and the best specimens." They would have said, "It is mutation now; mutation," they would say, "will be the development of some sudden changes in the line of descent where suddenly a new character comes in that has not been present in any of the former members of the line because of that coming in of a new element which transfers to its succeeding generations its characteristics, we have the development of what would be known to be the highest and more perfect forms." And if we were to ask some of the best biologists of today

*Stenographic report of a lecture before the Iowa State Dental Society.

we would find them taking a still more advanced attitude and they would say: "Not any one of these three, perhaps some of all of these three, but besides all that there has been developing in the human body a tendency to a mutation form, but a preparation for that mutation form going on through a long series of years or through successive generations; a preparation, so to speak, for a new type that is to come out." So that today we would have to harmonize all of those four theories. And as we come to a study in detail of the mechanisms that underlie heredity, I think we will see quite largely how those processes can be harmonized and we can understand in part, if not in quite a large part, where one begins and another leaves off.

I believe you will have to have in mind normal heredity in order that you may think of a diversion from normal heredity, for if we are going to study the deformities we must know the normal in order that we may understand the abnormal or the causes of the abnormal. I believe as you are thinking of the normal or normal processes of heredity you are thinking of the great underlying principles. We can express the three great foundation stones: One is that characters are inherited as units and traits may be divided up into ever so many characters and we will inherit any one of these traits, we will inherit any of these so-called character units, units of character, independent of all other units of character that we may possess. You have that then as one of the first of the three corner stones, that we are able to inherit units of character and the divisions of traits. Next, we do not inherit character at all; we inherit something that determines character. My son does not have my nose, for I still have my nose myself; he has a nose like mine, not because he inherited my nose, but because he inherited something from me that determined that he should have a nose of the same type. In other words, he inherited a determiner. That is the second. Now you have those two in mind; first, the inheritance of character in units; second, the inheritance of determiners that determine character. Now third:

My son does not inherit anything from me at all; he has a nose like mine simply because he is a chip off of the same block, we are brothers by different mothers; he is a part of that same protoplasm that I am a part of which has come down through our ancestry and I add almost nothing to that protoplasm as I pass it on to my son. I may take much from it, that is the important thing to remember, but I can add very little to it. Then remember that the parents transmit as you will see later, almost nothing that the parent does not inherit.

You all have watched the dog as he comes in and lies down on the mat, how he turns around three or four times. Why? He is not afraid of venomous serpents, or reptiles or anything that is going to bite or injure him. He knows nothing about that, but his ancestors did. His ancestors knew perfectly well that there were venomous serpents in the grass and during all the thousands of years, the many, many thousands of years that the foxes and wolves have lived, they have known of those venomous reptiles and they have learned to be wary of them, and have always looked about carefully

before lying down, and that has been transmitted down, but not because this dog's father or mother did it, but simply because they each are a part of that far distant practice. And you have all ridden behind a horse or upon his back and you have galloped or trotted through the country; suddenly something flitted out from behind a bush—a piece of paper or something, and your horse took to his heels; before he knew what was happening to him he was on the go; he had presented his heels and he had taken the attitude of escape. In other words, he had reacted to natural instinct for self-preservation; that is the thing to remember.

You all have watched the cat, and have seen a scrawny little kitten come out of the alley and a great big vicious dog come along by the alley, and the little kitten that was only a mouthful for the dog, instead of running, what would it do? It would turn and offer fight. That reminds me of a back-yard incident. Mrs. O'Riley looked over the back fence at her neighbor (she had been reading a little about ancestry), and she said to her neighbor, Mrs. O'Rourke, "Who did your ancestors spring from?" "Oh, be jabbers, I would have you understand that they never sprung from nobody—we always spring at them." Now there are people doing exactly what these animals do; some spring away and some spring toward others. The dog has his characteristics. The horse has his characteristic of self-preservation because all during the past centuries and æons of time the feline foes of the horse have been springing onto it in its unprotected state, and the horse had only self-preservation by escape and he presents his heels for a defense and instinctively when the paper flits out from behind the bush he turns his heels and takes an attitude of escape, not because he had seen what was coming, not because he thought it was a cat, but because he has inherited that fear from a far-distant past. And just so the feline type had their preservation in their splendid claws and when they were attacked there was no enemy of the forest that they need be afraid of. You know how the big dog will run from the little kitten because he dreads those awful claws in his face. That is, then, an illustration of how the far-distant past comes down into our lives just as it does into these horses and these dogs and the kitten.

I wish we might for a few minutes study a little of the behavior of inheritance. Why am I like my father, or like my mother? I have said because determiners have come into my life and have made me so. These determiners are what? They are probably enzymes. They are probably a great deal like the digestive enzymes we were speaking of last night, protoplasmic forces infinitesimally small but as they divide up and go into every cell of the body, you and I represent certain protoplasmic force and energy that has been accumulating for thousands of years, transmitted to us and to which our father and our mother added almost nothing, but they transmitted it to us; and it is an enzyme of such sensitiveness that at certain periods it is so delicate that it can be destroyed or diverted and its whole tendency changed. I am what I am as regards the past simply because none of my ancestors have destroyed that protoplasmic force that was coming into my life.

Now the next natural question that will come up will be, what is the effect of a mutilation of my body on my offspring's body? Will the fact that I have a contracted arch make a contracted arch for my boy or will the fact that my body is deformed make a deformed body for my boy? I have said, and it is a thing we want to get clearly in mind, that my body has almost nothing whatever to do with my boy's body. That seems like an impossibility, but you will understand it a little later. I do almost nothing but simply transmit that protoplasmic force. I can very easily destroy the enormous potentiality that is wrapped up in that protoplasm in just a few moment's time by many methods, but the thing that we do when we have a normal inheritance, a normal heredity, is to simply follow nature's natural development, and there is developing in us mechanically almost exactly what is taking place in the plants. Now we must look into heredity then as having some very definite laws. What is the nature of those determiners we are speaking of? What are they? I have said that they were probably enzymes that come over with the protoplasm that has helped to make up the first unit cell. Why is it, for example, that my son has light hair? His father had light hair and his mother had light hair. Why didn't my son have dark hair? Why is it that you have dark hair and your husband has dark hair, and your son has dark hair; and perhaps you have got two or three or four sons that have dark hair, and you have one with light hair? There is a natural law. There are two kinds of determiners, rather two effects of determiners upon my body. I may have determiners that determine a certain quality which we will call positive determiners, and I may have an absence of determiners. I may transmit a protoplasm that has certain determiners lacking. Therefore my son may have light hair because of the absence of a determiner for pigment. That is the thought. And if we will take that one thing of color of hair or color of eye and follow it through in detail I think you will soon get the picture of the whole thing. We will say the presence of a brown pigment in the eye is the expression of a positive determiner for brown pigment. A blue eye indicates that there was no determiner for brown pigment. Now then, supposing that the father and the mother both have brown eyes and their parents both have brown eyes. Would it be possible for them to have a child with blue eyes? No. On the other hand, supposing one of the parents had brown eyes and the other blue eyes; what would be the effect? Brown is the expression of a positive determiner for pigment and brown would dominate so that probably two or three of the offspring would have brown eyes and the others blue. Let us follow it out; I want you to get it. It is the keynote of the whole situation, for what applies to the brown pigment in the eyes applies to the whole process of heredity. Let us suppose that both parents have a determiner for brown pigment; then the offspring will get a determiner for brown pigment from both parents. Just try to get this word, they have the determiner in duplex; that is not a hard word to remember, and let us remember it; they will have that determiner in what we call duplex. Now, let us suppose

that one of the parents has brown eyes and the other has blue eyes. The offspring would have from one parent a determiner for brown pigment, but would not have it from the other. Therefore, instead of having the determiner twice, or in duplex, they would have it just once, or in simplex. Now, the mother having that determiner in simplex would produce in her children half with blue eyes and half with brown eyes. That is the way it goes. Supposing a person having a determiner that was in simplex would marry one that was in duplex; what would their offspring have? Three would have brown eyes and one would have blue eyes; we have that law running right through.

Here is a very fundamental law and it is not a difficult one to remember, and it is called Mendel's law. It applies just the same to plants as it does to animals, and it is that, when you produce from a combination you have three different kinds of offspring; one will be a hybrid, a mixture and a blending of the two; and the two others will be like either one of the two parents; and if you will look about you you will see how it works out. Here is one child not like either parent. It is not like both, even; it is a hybrid. Here is a boy just like his mother and a daughter just like her father, which happens so often, but it may not always cross the sex. There is the fact. That is Mendel's law that occurs in all biological processes. There will be from every combination a hybrid, which is a combination of the two, and for every hybrid there will be one for each one of the parents making that hybrid. That, then, is Mendel's law. That is something you ought to remember.

As we go to a study of these deformities we will come back to the application of this thing that I have been speaking of; we want to study the types of deformity that comes to your attention and mine. What are the serious deformities that come to the dental profession? I would not say they were confined at all to contractions of the arch. I think they are largely facial and mental. It is very important that we get clearly in mind the things that determine those defects that have to do with bone development and that have to do with the glands of internal secretion and functioning development.

If we might have the slides at this time and have the lights out we will take up this problem in some detail. The first that we will see will be a boy with defective enamel of his teeth. We call it hypoplasia of the enamel; it has so often been spoken of as Hutchinson's tooth, or syphilis tooth. It is not Hutchinson's tooth. It is due to a disturbance of nutrition during the early period, usually of babyhood, and it can be produced with syphilitic infection, it is true, but in some two hundred cases that we have histories and models of, we find that nearly all have no history of syphilis. It is then not the type of deformity that would be due to heredity. It is an acquired deformity. This is a characteristic hypoplasia due to faulty baby feeding. This boy and his sister both have teeth that are the shape of screw drivers—thin and flat on the end but thickening as they get farther down, and this type of deformity is quite common and can be traced to baby feeding.

(To be continued)

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(Continued from page 524, July Summary)

A GAIN, I want to emphasize that it is not the type of deformity we wish to study which we recognize as being due to inheritance. This, however, is entirely different. This girl at sixteen years of age has the roots of her teeth but has no crowns on them. She has inherited a deformity. Her father did not have enamel on his teeth. Her grandmother did not have enamel on her teeth, and so for five generations we have the record that the enamel was missing from the teeth in at least one child in the family. Note, please, that the gums are perfectly developed, the roots are in place in the gums and the deformity is entirely due to the enamel; the other structures of the teeth are perfectly normal. The determiner affected the enamel without affecting the dentin, the number of the teeth, the shape of the teeth or any other quality of the teeth. Incidentally, this girl had artificial porcelain put on the same roots so that finally she was able to look quite respectable. That deformity follows almost the same line that color-blindness does.

Here is another type. This is known as a Mongolian idiot; if you would go to any of your state hospitals for the feeble minded you would find from a dozen to several dozen. So perfect is this type that they would be classified all together. The middle third of the face is always imperfectly developed.

Here is still another type of deformity which is due to the glands of internal secretion. I want to stop and speak on the other later, as we will come to it in another slide. Here is one due to thyroid defect. This would be a Cretin. She looks idiotic and the reason that she is only partially normal is that the gland in the neck producing the particular secretion known as the thyroid secretion and parathyroid secretion has not developed; and by giving this little girl thyroid from an animal she becomes normal, as you see her here. That then is one possibly inherited in some cases, but in most cases it is due to the lack of iodine in the soil and therefore is found in certain localities. That lesion predominates in the Missouri Valley. You will very seldom find it east of the Alleghany Mountains or west of the Rockies. Here is another of the same type and after being fed thyroid extract, this little girl became normal; we would differentiate that from inherited deformity.

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Here is an Indian girl, which is an entirely different case. This girl was found in one of the passing shows near Cleveland, and we prevailed upon the director of the show to let us make some radiograms and pictures of her head. She was only about one-half of my height, as you see, and at twenty-two years of age she is almost infantile in all her mental and physical development. She did not come to adolescence until she was, I think, twenty years of age. Her father and mother, following the custom of their tribe, put boards on each side of her face and let the head develop between that compression, making a pressure laterally and inward, which seems to have affected the pituitary body, for this girl was infantile until she was nineteen. She did not come to the period of adolescence, you understand, and therefore followed the type of deformity that we know as the Mongolian idiot, which type is sometimes infantile still at forty years of age. When we study the body we find that the central fingers of the hand do not have the bones in proper shape as you will see here, and this can all be traced to a lack of the functioning of the pituitary body. The pituitary body is a little gland in the base of the brain, and in all probability in her case, as in the case of Mongolian idiocy, the gland is forced upward, which is due to a lack of development in the middle third of the face.

Here, now, we have the slides of an important case, an important link in the studies. This boy at sixteen years of age was entirely infantile. That means, to speak frankly, that his sex glands had not developed any more at sixteen years of age than should be the case at four or five years of age, and he had no mustache. His second permanent molars which should have developed at twelve years of age, were not in sight and we have in this boy a mentality of about three or four years of age. He wanted little children as playmates. The left nostril was entirely closed and occluded. He probably had never breathed through it. You could not get air or water through it, and the result was a mouth breather, since he could not breathe through his nose. The boy was a hopeless dependent and harmless, but an idiot. The process of treatment was to move the maxillary bones apart laterally and open the median suture, thereby opening the nares, but more important than that, or quite as important, moving the maxillary bones downward and forward. Here we have a lateral view of the head. Here you will notice the relation of the upper incisors to the lower; the uppers are one-half inch back of the lowers; the upper arch went within the lower arch completely. After we moved the bones downward and forward the upper teeth went outside the lowers, and this is shown to have moved downward here, the various bones in the middle third of the face are pushed downward and forward. Within ten days the boy could breathe through his nostrils and there was a great difference in his mentality. In thirty days we have the widening of that arch, which was moved apart, I think, nine millimeters, and that boy could soon breathe through the nostril. In thirty days he could maintain himself through the nostril that was entirely closed when we began. But the most important thing, we considered, was

the change in the mentality; I think the next slide will show the difference. Here is the boy from two views—front and side views—and here he is thirty days later. Here he is just a lump of protoplasm, and there he is a boy with considerably more spunk and pep and a great deal more personality. What shall I call him? A human being, I guess, would be a good name. He was more like an animal. Within thirty days his mustache began to show a tendency to grow. Within two weeks that boy's sexual glands developed so perfectly that he passed from an infant to a man. His whole tendencies and desires and playmates were completely changed. Instead of wanting to play with little children and with blocks and things of that kind, he wanted to come with the big people. I could not keep him from wanting to put his arm around my secretary's neck and being very attentive to the two or three secretaries in the office. He wanted to take one of them to the beach to a dance, and his interest was that of a young man, though he did not have all the intelligence of a young man. He did not understand all his normal reactions, but the boy was no longer an infant, but a man in a great many respects. What had made this change? Apparently a stimulation of the pituitary body in the base of the brain, for immediately we found developing changes in that boy that corresponded precisely with the changes that take place with the stimulation of the pituitary body or gland. This is another view, and you will notice particularly the nose in these two pictures, and notice the difference in the middle third of the face.

The next type we want to take up will be the effect of the thyroid operation. Here we have two goats that are brothers. One had its thyroids removed when it was a few days old, and the other did not. This has remained an infant, so to speak, and has also remained an idiot, as you see from its very expression and lack of thought. The difference depicted there is brought out in various forms of life, particularly in tadpoles. Swung has done great work in studying these glands and their effect on forms of life, such as tadpole life, and he finds, as others have, that the feeding of thyroid glands to tadpoles will make them remain tadpoles, if they have no other feeding, for months and months, but at any moment that he would give them one feeding of thymus gland they would cease to be tadpoles; they would drop the tail, put out legs, differentiate and become frogs. So he could have full grown frogs in five days or great big tadpoles as large as his hand, just according to the way he would feed them. We all know that the thymus gland just behind the collar begins to function at about six years of age and ceases to function at about sixteen, and then atrophies. In all probability it has largely the function of determining adolescence. It in turn is controlled largely by the pituitary body and it is a matter of very great importance that this pituitary gland in the base of the brain is connected with the thyroid and thymus glands by an independent nervous system, and also with the adrenalins, and it is a matter of very natural sequence then that the pituitary body, if not functioning properly, would disturb

the functioning of the other ductless glands. It is in effect the governor in a large measure of the other glands.

Dr. Harvey Cushing, of Boston, has done some wonderful work in the study of the pituitary gland, and he finds that when he removes the pituitary body from dogs that certain characteristics are produced, and one of them is that they remain infantile. Here we have two brothers and two sisters all from the same litter and from one brother and one sister he has removed the pituitary body by operation, and he has left two of them normal to compare with the others. In a given number of months the brother and sister that were not operated upon have become adults. Their sex glands have normally developed, but the others remain infantile, as you see; there are no mammary glands developing in this female and no more sexual organs in this male than in early puppyhood, precisely as occurs in that type of deformity that we speak of as the Mongolian idiot, and that type is in large part a deformity of the pituitary body or a lack of the functioning of the pituitary body.

I presume the most important work that has been done along the line of the study of artificial disturbances of these determiners has been done by Dr. Stockard, who has found that when animals are subjected to certain chemicals, such as alcohol, that the offspring are always affected, even though the animal itself is not seriously affected. Here is the cage in which he did this treating. A little alcohol was poured onto a plate beneath the grate and the animals were allowed to run around about the grating and breathe the air in which the alcohol was present. He found the remarkable effect that when these animals were mated, the offspring of these mated animals were always under size and that they always had in their second and third generations tendencies to deformities. The next slide will show us a typical deformity. Here is one totally blind coming in the third generation, even though its own parents did not have any treatment. The next slide will show a different type where one eye is developed perfectly but on the other side no eye at all. He found certain types of deformities, brain and nervous troubles, which were particularly produced in these succeeding generations. Here are some of the deformities in the limbs of these animals and he found very definitely that the line of descent would be changed completely by the administration of alcohol to one of the parents. You will notice that the ophthalmic development is entirely lacking in one and only partially developed in the other. He also found in the third and fourth generations definite deformities coming out as are shown here in these limbs. We will not stop to discuss this in detail, but note particularly the effect of alcohol on these various animals. When the alcoholic male was mated with a normal female he found that in 90 matings there was early abortion in 37, still-born litters 10, still-born 20, living litters 43, young dying soon after birth 35, and total dead 55, surviving 47, two of which were defective. This was when the male alone was allowed to breathe the alcohol. When a

normal male was mated with an alcoholic female the results were not serious. In 33 matings there were 7 negative results and 21 surviving young. When he mated an alcoholic male with an alcoholic female there were 41 matings, 20 negative results and 4 still-born litters, 8 still-born young, 17 living litters, 12 young dying soon after birth, 20 total dead and 14 surviving. There should normally be from one to two living and growing to adult age in each case of mating. Now we will compare that with the second and third generation. Note this particularly; that in the second generation the female was treated during pregnancy and in four cases there was practically no effect of the alcohol on the offspring. When the second generation was mated with the normal there were 46 matings, 10 cases of negative results, 3 still-born litters and the number of still-born 8, and 6 defective of this 8; there were 37 living litters, 29 young dying soon after birth, two were paralyzed, total dead 37, only 25 surviving, out of which three were deformed. There were 25 where there should have been twice 46, the significant thing being that even though the second generation did not have any treatment with alcohol, nor did the one with which it was mated, there was that very great difference in the offspring. When the second generation was mated with an alcoholic, a very serious result was produced. There were 53 matings, 63 negative results, 8 still-born litters, one very badly defective out of 17 still-born, and out of 29 living litters there were 22 young dying soon after birth, leaving only 28 total for development of which several were defective. The third generation was even more defective than the second, even though they themselves were not treated with alcohol nor were their parents treated with alcohol, and if you follow that through in the third generation you will find one had deformed legs, one was paralyzed, six had defective eyes, and so on through these deformities that came out in the third generation, even though, as I stated, only a grandparent was treated with alcohol.

Now, it is exceedingly important when we take the third generation and mate them with alcoholics; we find we have serious defects, for out of these matings there was only one living offspring. In other words, they tend to die out and eliminate the race in the second and third generations, or probably in the third and fourth. It is just exactly what happens in the human family that the descendants of alcoholics die off in the third and fourth generation. But here is one of the most significant things as to relative effect of alcoholizing the male as compared with the female. When the father alone is alcoholized you will find this large percentage of deformities. And when the mother is alcoholized in the second generation there are no deformities. Do you see the very great significance of that? Exceedingly more serious when the father is treated with alcohol than when the mother is treated with alcohol. And when we go through and find the relation of an alcoholic grandfather as compared with the relation of an alcoholic grandmother, it comes out again about as eight to two. And yet the alcoholic grandmother comes out by transmitting her defects to her sons, for her sons were carrying the deformity, a matter of exceeding importance. Now he

also found that these various amounts of alcohol such as would be found in the body of these animals, being added to sea water, the fish eggs that were developing developed deformities of the eyes and the nervous system. Here is one with the eyes far apart and one with no eyes; here two eyes grown together, one with only one eye. These are simply characteristic types that were produced and the amount of alcohol, as I say, was practically that contained in the body. Now, here is something very significant. He also found that within twenty minutes after alcoholizing a guinea pig he could get the alcohol in the seminal fluid almost in the same proportion that it was in the blood.

When we compare the effect of other poisons than alcohol, say lead, we find it acts the same way. Here are histories which have been taken of females working in the lead foundries of France, and it has been found that where they were working in the poisonous fumes of lead, in 4 women with 15 pregnancies there were 13 abortions, only 2 living births, only 1 of which lived more than 24 hours; 1 out of 15 children lived more than 24 hours. They also found that in 5 women who had previously had normal pregnancies, but were now subject to lead poisoning in their systems, in 5 cases out of 36 pregnancies there were 29 abortions or premature still-births, 4 living births, of which 1 died in the first year, leaving 3 of the 36 children where the mothers were working in the presence of the lead poisoning. When these women were working intermittently the effect was almost as great, but note this: When there was only a blue line on the gum, but no other symptom of lead poisoning, they found in 6 cases, 6 women with 29 pregnancies, there were 21 abortions or premature births and 8 living births, but here is the important thing of all: Where the male alone was subject to lead poisoning there were 32 pregnancies, 12 of which resulted in premature births, 20 living births, and of those 20, 8 died the first year, 4 the second and 5 the third—17 out of 20—leaving only 3 of 32 children to live where the father alone was subject to lead poisoning. Why? Because the lead, like alcohol, in the system destroys the determiners, that element that is transferred from one parent to another and which carries forward the element that will make normal inheritance.

Here is a case from my own practice. This boy is a Mongolian idiot, and by following up the history I found that his father was a painter and had a definite lead poisoning at that time. This boy was like the other children you have seen. His father gave up the painting business and went into another business where he was not subjected to the lead poisoning and the later children are perfectly normal. My own belief is that the child is a Mongolian idiot because the determiners were destroyed by the presence of lead in the father's system.

Here is a significant illustration: Dr. Woerber has done splendid research work as to the developing of poisons in the human system. When the kidneys are not functioning properly, this relates to the mother; often-

times the offspring are poisoned and poisons are liberated in the system. He has found that the same defects can be brought out precisely with these body poisons as are brought out with alcohol and lead—a very significant thing. I have several case histories where the children are defective in part or in large part where the mother during pregnancy was suffering from a very serious kidney disturbance.

If you are studying the mechanism of this process we will study first the ordinary vegetable cell, and have in mind that all cells are the same whether vegetable or animal. They each have a protoplasm, they each have a nucleus and the method of division will be by the division of the nucleus, and the method of feeding or metabolism will be through the protoplasm of the cell. Here is the keynote of the whole work. Here is the point at which the determiners are injured most frequently. When the ordinary ovum in the female cell is fertilized we find it going through certain changes. (This is not any work of my own; it is copied from an ordinary text book.) The chromatin forms in shorter and shorter bands until it makes a definite series of bars as in this picture. The bars are called chromosomes and the number will largely determine the specimen. In man there are 24; in certain animals a hundred, in others 2 or 3 or 12, and so forth. Whenever there is a cell division by fertilization, or any normal cell division, there is a division through these chromosomes and half of the chromosomes goes to each one of the two new cells, and finally we find part of the original determiner going to every one of the subsequent cells. Therefore, every cell of my body today has some of the chromosome material that was in the first cell of which my body was made. As you see these in the motion pictures you will readily observe all these various processes taking place—the fertilization, the division into two, four, eight, sixteen, and the whole process right before your eyes of this formation as it takes place, and you will see this original structure as unit cells floating in the field. The male element takes a large number of forms according to the form of life; this is the human, this the deer, this the swan, and all the various other forms. The part of the cell that carries the element of life is in the neck, here. The most important part, or the important part, is the spira in the neck of the spermatozoan, the other is only the tail, used for the purpose of propulsion.

The next most important period in which there is great sensitivity next to the moment at which the fertilization takes place is the period at which one form goes into another form, the differentiating types. Remember that all forms of vertebrates are so perfectly alike during the first third of their life that you cannot tell one from the other. You cannot tell a human embryo from that of a fish or from that of a chicken or from that of a rabbit or tortoise embryo the first third of their life. They are there all in that row. In the second third you get the differentiation of the several forms. A fish becomes a fish with its gills, and the rabbit and the tortoise and the chicken carry forward the types each of its own and they differentiate in

their second period. Now supposing some disturbance takes place in the body at the moment of this differentiation. In a human the offspring may carry a defect like that of a fish, a gill on the side of the neck, and lots of people are born with a cleft in their neck like the gill of a fish because of something taking place at that moment. This is because of the great sensitivity of embryonic life at these periods of differentiation. Here is the human embryo, and if you will compare it in your mind with those you have just seen, you will note here the first and second stages are like the others, but in the third stage we get the differentiation coming over to the human type.

What is the relation of the parents' body to the child's body? So often we hear people say, "The mother saw some terrible catastrophe and it was marked on the child." No, it was not; that is all wrong. As a matter of fact the human parent body has almost nothing to do with the type of the offspring, as shown by this simple experiment. The offspring of two white guinea pigs will always be white. It is the absence of a determiner for color; therefore they must always be white. Now, from this female guinea pig the ovaries were removed and in their place were put the ovaries from that black guinea pig. What would the offspring be? Two white guinea pigs, and we say white guinea pigs always produce white offspring. All the offspring were black because the entire mechanism that determined the color and type of this offspring was contained so far as the mother was concerned in the ovaries, the cell that made the germ, or the tissue that made the germ, and the mother had nothing to do with it, and therefore all three of these succeeding families, three different families from that one pair, were black. Then what is the result of mating a black guinea pig with a white guinea pig? White is the absence of color. This white guinea pig mated with that black guinea pig had two offspring and these two were black offspring, for they would always be black in that case. They carry a determiner for black and the absence of a determiner from the other parent. Therefore their offspring would have in four offspring three black and one white; that would be the law. Blondes never could have brunette children. Brunettes could have blonde children provided that one of their parents had determiners that were lacking in that color—the black.

You are all familiar with the same processes in the vegetable kingdom; how in the corn field you get the same type of color of the corn and it is all carried on like Mendel's laws says, and precisely as it is in the animal kingdom. And this presents a most important and beautiful illustration. We have said that the most sensitive period in the life of the embryo is just at the period of fertilization. Just so in plant life we have a sensitive period. All plants are like their preceding generations and this plant should have been like that one, but why is it not? Just at the time the pollen was put upon the blossom it was exposed to sulphate of zinc and we find a change in the determiners, and the whole type of the plant changes and all the succeeding generations from that plant take the new form instead of the old form, an illustration of the sensitiveness of the plant life.

The next shows us the same thing by exposing the plant to radium, which forms this plant into a new type because at the time of fertilization it was exposed to radium; and that is a beautiful illustration of the sensitiveness of this period.

I spoke of the father transmitting certain things to his daughters and not to the sons. Here we have a chart as to the enamel of the teeth; the red is the female, the white the male. This mother had faulty enamel of the teeth. She transmitted faulty enamel to her sons but not to the daughters. In the next generation we find the majority of the defects are in the daughters; it has crossed over to the other sex. In the next generation it is mixed again, but the tendency is to cross. Why? Because the same chromosomes that carry sex determination carry the character determiner for enamel for the teeth. It is not a surprising thing when you compare it with color blindness.

Here is the progeny of a family of feeble-minded persons. Here is the woman, who was feeble minded. She married a normal man. Their offspring were all normal, but one of them was alcoholic. Now when you add alcoholism to a lack of a determiner for character, you will find those children all inherited a weakness from that mother, even though it was dominated by the determiners from this normal father; you find that this alcoholic son had in his offspring two feeble-minded daughters. Notice this same feeble-minded woman married a man who was an alcoholic and a sex offender, and note their children; every one of the descendants from that feeble-minded woman and this alcoholic sex offender are feeble minded, alcoholic and sex offenders without exception. It could not have been otherwise, and every one of the following generations from that family are defective, because the determiners were killed, were destroyed by the presence of the alcohol in the system of that father.

To Be Continued

Chimes for West Point

Troy, June 29.—What is said will be the most costly chime of bells in America and one of the most musical sets in existence is being made at the foundry of the Meneely Bell Company, in this city, for the massive tower of Cadet Chapel at the United States Military Academy, West Point, as the gift of Mrs. James M. Lawton, in memory of her father, the late Major General Robert Anderson, who was graduated from the academy in 1825, and who commanded Fort Sumter at the outbreak of the Civil War.

There will be twelve bells in the chime, the largest weighing nearly two tons and measuring fifty-six inches at its mouth.

COMPLIMENTARY DINNER IN HONOR OF DR. L. L. BARBER
AT COMMERCE CLUB, TOLEDO, OHIO, OCTOBER 13, 1916

AT THE COMMERCE CLUB, Friday evening, October 13, 1916, the Toledo Dental Society tendered a complimentary dinner to Dr. L. L. Barber, president of the National Dental Association, attended by some fifty of his local associates and friends and a number of prominent guests from out of town.

The committee of arrangements, under the chairmanship of Dr. J. W. Hartshorn, left nothing undone to make the affair most agreeable to all in attendance. The dinner was one of those perfect little events that help to smooth the pathway of life and break the monotony of the workaday world.

Dr. Everett M. Cook, president of the local society, acted as toastmaster and acquitted himself very creditably. Following is a stenographic report of the proceedings following the repast:

DR. E. M. COOK, Toastmaster: This is one of those pleasant occasions when everybody present is glad that he is there. And I am personally glad to meet and greet all of you, assembled as we are for the purpose of doing honor to a member of the Toledo society and of the Ohio State society.

When word reached us that our Dr. Barber had been elected president of the National Dental Association, an idea occurred to a number of us simultaneously; the idea that we would like to get a few of his friends together and give him a little dinner. Then we thought a little more about it and concluded that the local society would like to take up the matter as a society. We didn't stop thinking at that stage, as it occurred to us that Dr. Barber had a good many friends in this vicinity or not too far away, who would be glad of the opportunity to come here and show him that they, too, appreciate the honor conferred upon him; and I think that this goodly gathering shows that our last thought was the best, that we had the right conception of the feeling toward Dr. Barber, not only here at home, but over quite a wide neighborhood in this section.

Most of you know that I am not a speech-maker; even if I were, you are not here for the purpose of listening to me. We have many eminent men with us tonight, and we expect to hear from them. First of all, I am going to call upon Dr. Otto U. King, of Huntington, Ind., a man whom all of us know, secretary of the National Dental Association.

DR. OTTU U. KING: Mr. Toastmaster, Brother Barber, Members of the Toledo Dental Society, and Friends: I want to assure you that I feel greatly honored in being invited as one of your guests this evening, and to Dr. Barber let me say that no greater honor can come to a man than to have his home friends offer him such a testimonial of respect as this. I can appreciate such an event the more fully because of something similar that came to me a few years ago when members of the Indiana State Society made me a present of this diamond ring, something that I never should have had otherwise. Of course, I appreciate the ring very highly, but above all I appreciate the spirit that prompted the gift, and that it came from men who know me and know me best—men with whom I had worked and am working to the best of my ability for the uplift of our profession and the welfare of humanity.

SOME IMPORTANT ETIOLOGICAL FACTORS UNDERLYING
MALFORMATIONS OF THE ORAL CAVITY, THE
FACE AND THE BRAIN*

BY WESTON A. PRICE, D.D.S., M.S., CLEVELAND, OHIO

(Continued from page 587, August Summary)

WE will now have the motion pictures which will show you developing in detail that process. While he is getting the film ready to run I want to give you one or two important illustrations. In Switzerland they have made a canvas of the defectives to find in what districts they occur and what has been the origin of them, and strange to say they found out of 8100 of them the majority were born in the wine districts and a further investigation established the remarkable fact that there were more born in one month than in any other month, and that month was just nine months after the national annual feast. (Motion pictures.)

Here we have the star fish, and in these forms of life which we are studying, a large part of the body, about four-fifths, is given either to the production of eggs or sperm. The star is about the size of a person's hand; the eggs are about as small as can be seen by the naked eye, and there would be 500,000 to 1,000,000 of the eggs in one animal. We take the egg and fertilize it by putting the sperm into the field. Here is the male element. Only one male element gets into that egg. The remarkable thing is that a thick, tough layer comes around it so quickly that the second one cannot enter after one has done so, and this egg is going through the same process that each one of us went through. Here is the division into two cells, then the division into four and during this period the additional sperm are swimming around through the field, attracted to the egg but cannot enter it because of this fertilization membrane which has formed about it; here you have eight cells and here sixteen cells, and they are very regular and methodical and perfectly designed. Here you will notice a large number of the male elements adhering and clinging to that fertilization membrane, attracted to the egg by a chemical affinity that we call chemotaxis, and in a short time you have the form of the sperm swimming about the field. Here you have the inner layer of cells, another layer of cells here and a layer between, the three primitive structures producing the various tissues of the body. This is a typical and normal sea urchin. This is the egg before ripening, and part of the process of ripening in all forms of life is that half of the chromosomes must come from the female element to make place for the male chromosomes to come in. Here we have the sperm swimming about the field. Watch that one come in. In this type of egg part of the chromosomes come off and here we have the extra chromosomes of the female

*Stenographic report of a lecture before the Iowa State Dental Society.

elements that have come away to make place for the chromosomes of the male element. Here we have several eggs that have not been fertilized and others that have. Here we will watch this one divide, watch the division as it takes place about at the same rate as the other, but the sperm are swimming about the field sometimes for hours after the egg has started its division process. Here you have the formation of the nuclei, and we have the four cells here. Keep in mind this is precisely what took place and does take place with the human embryo in the human embryonic development as to each one of us. Each one of us was a one-celled animal, then a two-celled animal and then a four, and so forth, differing only from those protozoa that we saw last night in that they continued to be one-celled and we became multicelled animals. Here is the polar body carrying the extra chromosomes that have come off to leave room for the male chromosomes—part of the marvelous process of fertilization. Here are some fertilized and some that are not, but the thing that impressed me was to find how exactly those divisions took place.

I might be pardoned for saying that this is the first time I know of that these processes have been reproduced in motion pictures. At least they told me so at Woods Hole where we were making the studies last year. Very soon now you will see the sixteen cells. It is a beautiful process to note it developing and it is almost identically as you see it here. Here you see in that organism the development of the skeleton by the calcification taking place in certain spots. That is normal and later you will see the abnormal. Here we have the sperm highly magnified. Do you see that one entering the egg? Now no other than that one can get in because immediately the skin toughens around the egg by the chemical action. Here we have a very good view. Here is the polar body forming. This is a different type of egg and that developmental process will go in this egg differently than in the last because it takes food in to one part of the egg to become the food for the embryo. This will be our first division, and you see that now more plainly here and that one-half of the egg is larger than the other; but we have the division just the same. You see the notch entering the side for the division.

The next is a very interesting process. Nearly all of the fertilization processes that you notice take place either in sea water that we have been looking at or within the body. This type fertilizes in the body and in four seconds ejects the eggs into the sea and each one has sperm within it. In four seconds from the time of the fertilization, which is taking place now, this little worm-like organism ejects a million of those eggs. I cannot imagine a chemical process so rapid as this, for each one of these forms a jelly-like mass around it so quickly that the second sperm cannot enter it.

We will study this process with this egg, as it is an unusually clear one, and note when the fertilization takes place the eggs will start to move apart, not because of the formation of a tough membrane in this case, but because of the formation of a transparent jelly which pushes the eggs apart.

sometimes as far apart as the width of the egg itself. This boundary line that you see forming between them, that dark line, is made up simply of the male elements or sperm that are pushed back here in their effort to try to get to the egg, a marvelous provision of nature to keep the egg free from more than one entry, which would make for deformities. This is a coalescing of the little droplets as you see here. This in a few hours starts to swim about the field.

The normal and abnormal development of fronds and squid embryos is here shown. Here is the head of this little fish shown perfectly plain and with it you will see in the same field a deformed fish, deformed by placing alcohol in the sea water. Notice the deformed head, due to adding a very small amount of alcohol to the sea water and ninety per cent. of the embryo can be made to be defective if just the right amount of alcohol, which is a very small amount, is added to the sea water. Here we have the developing form and note the beautiful rhythmic motion and it goes through several different forms; some of them are very beautiful and very interesting. Here is one form of the cilia and a little later it will take on a more advanced form. Those little whip-like masses whip the sea water into the gills. Here you have the division. This one you see is just developing the extra mouth and here we have the second mouth perfectly formed in a very short time. Now we will magnify that a little more highly and you will see in the structure of that body the various muscular movements almost identically like the human stomach movement. Do you see the muscular movements taking place? And yet that organism is only, perhaps, one-tenth the size of the head of a pin, almost too small to be seen with the naked eye, and when we magnify it we find this perfect development of the gills. Note the heart beating; there is the heart of that microscopic embryo. This is the squid and one of the most beautiful small organisms that we can study. These are very beautiful as they change their color, but the interesting thing is that that organism is developed with a sucking bottle; this is an actual sucking bottle filled with food and finally it appears attached to the mouth. If we take that fellow more highly magnified we will see that he has no sucking bottle; he is too old, does not want one any more. Here is one with a sucking bottle as large as his body, and watch this one drinking out of his sucking bottle. And yet that whole organism is smaller than the head of a pin.

We can produce artificial fertilization with certain chemicals, but rarely if ever do they grow beyond the first generation. Frogs have been able to live for a year, but here we have organisms that are normally developed; and I want you to note the deformity of the same organism by treating with certain chemicals when in the embryonic form. That is the normal and here is one treated by adding a little alcohol to the sea water, or muriatic acid, which forms in the human body when the kidneys are out of order, or acetone. Here we have a pair of twins and the interesting thing is that they try to swim in two different directions—one is trying to go one way and the

other the other, and it is very difficult to keep them in the microscopic field; there is that jerky motion all the time as they undertake to go in different directions. This is produced by adding chemicals to the sea water in which they are developing. Here are other deformities, different types of deformities produced by adding those same poisons to the sea water. The mechanisms that I spoke of last night are shown beautifully with the paramecia when the galvanic current is passed through them. You notice that they are now entirely beyond the control of the current. Note particularly that they are now swimming in any and all directions. As soon as the current is passed through the field they all start in one direction; then as the current is reversed they go in the other direction, and they cannot help themselves. It is entirely a mechanical reaction.

The man who has recently invented the submarine that is controlled by wireless has also invented an artificial dog that will follow him all over the house or the yard when he carries a lantern at night; simply the same mechanism that this is—that he allows the light to act on the selenium cells which will operate the mechanical muscles in the two sides of the animal in different ways.

If we take the same organism and reverse the current so rapidly that they cannot get into motion, you will notice that they just vibrate in the field; once in a while one will break loose.

These mechanisms are very beautiful and when we study the cilia of the human throat, a frog's throat, or an animal's throat, we will find they are almost identical with the smaller forms of life. Here is the tissue taken from the throat of a frog, and you will see that it swings about the field because of the mechanical movement of the cilia themselves. We think of lots of these processes as being due to some instinct or something of that kind on the part of these forms of life, but it is not. It is not due to instinct; it is due simply to reaction to mechanism. I think there are a great many of these processes we have looked upon as being due entirely to instinct and have come to understand finally that they are due to mechanical and physical processes and the danger will be that we will not think that, because we can understand them, therefore we do not need to have a God, we do not need any providence to provide for them. I look upon it simply as seeing the footprints of God and I think there is all the more need of providence.

Just a little as to the application of this work. It is rather significant that human biological experiments correspond entirely to these laboratory experiments. As an illustration: A certain woman who is known very well, had as her first husband a man with a splendid character and a splendid ancestry. They had three splendid children, all of whom made splendid citizens. Unfortunately, that husband died. She married a lion of society, a man who liked the social glass. They had three children. One was a degenerate morally, another was a nervous wreck and another was an imbecile. Fortunately, that husband died, too. She married the third husband, but the third husband was also a man of good character and good ancestry

and good habits. They had two children, both of whom were splendid citizens with splendid characters. That was not an accident.

Another illustration: In New York state there is a history of a family known as the Jukes. Mike or Jacob (or whatever his first name was) was a criminal who co-habitated with a woman who was of a questionable ancestry—questionable in her habits of all kinds—and of their three children they had three types of descendants. One line of descent is largely if not entirely tending toward sex offenders, another toward pauperism and the third toward criminal tendencies. That one family descending from that criminal has cost the state of New York one and a quarter millions of dollars for legal proceedings and for caring for them. Not one character in the entire line of descent in over a hundred years has been a good character. Now take another and a parallel case: Elizabeth Tuttle, the grandmother of Jonathan Edwards, an ancestor of twenty college presidents, not one of the descendants of whom ever cost the state one penny. Is it an accident? No. The state of New York is spending \$7,000,000 annually to take care of the feeble minded. The United States as a whole is spending \$200,000,000, and an increasing amount year after year. Why? Simply because we are systematically allowing the splendid protoplasm that has been passed down to us by a long line of ancestry of the past to be injured by poisons like alcohol chiefly, lead poisoning, the defects of kidney poisoning at the time of motherhood, and so forth, and we are causing these defects because of the extreme sensitiveness of the determiners just at that particular time.

If we were to go to certain districts of the country, like Martha's Vineyard, for example, we would find in a certain locality one in every twenty-five of the people with cataract. In another district one in twenty-five are deaf mutes. In certain other districts a large percentage have certain other deformities. What does it mean? It means that when the determiners are lacking in both parents—and that is the result of the marrying of cousins for instance—where each has lacking in the system the same positive element, and they put into their descendants a lack from both sides instead of only one side, we find developing then certain defective characteristic types and traits, certain positive deformities. I think that is one of the greatest needs of this whole problem of the study of defectiveness—to eliminate as far as possible these removable poisons. Education, in other words.

When Christ was marching down towards Jerusalem with His disciples one day, He said to them, "Ye shall know the truth, and the truth shall make you free." He seemed to be looking down to this time when one after another of these great scourges would be swept away. He seemed to realize that people would know how to take care of their bodies and have no more yellow fever, and that if they kept the mosquitoes from biting them they would not have it, and they would not have any sleeping sickness, and a great many other things. But it seems to me that particularly He

seemed to think of this time when we seem to be just getting the truth as to what is demoralizing our population, our humanity.

If the people of today knew the truth they certainly would not allow alcohol to be sold to destroy what it has taken providence whole countless æons of time to build up in protoplasmic force and put into your bodies and mine, to be destroyed in one moment or in an hour of time, so that all of our descendants are deprived of the benefit of that protoplasmic force that has come down to us through a splendid ancestry. We need, and we need immediately a national temperance. We need more than that. We need a conscience in the hearts of men and women. We need men to know the truth that unless they are worthy sponsors of that protoplasmic force that has come down to them they cannot expect to transmit to the coming generations the splendid ancestry or legacy of the past. And I know of nothing that we as a dental profession could do that will be more potent for the future than go into the study of this vital problem and get at the truth. You take its relation to these diseases that you and I are subject to. I myself have in my body a lack of determiners for a protective fluid for fighting the organisms of the streptococcus group. In other words, all my ancestry, so far as I can get the history, have been subject to rheumatism and heart infection. My boy early got heart infection and died of it. My mother died of heart disturbance. A large number of my relatives have been subject to streptococcal infection. Why? There has been destroyed in my ancestry somewhere the determiners that would give me a resistance to that particular type of organism. But I have strong determiners against tuberculosis and pneumonia. You may not have it and may have others. You may have no resistance to some other organism. It has been destroyed somewhere in your ancestry.

What we want is the truth. Oh, may God speed the day when we will know more about biology, when we will know more about physiology, when we will know more about bacteriology; in other words, know the truth, the blessed truth, the perfect truth that will make us all free and whole.

“Where there is no vision the people perish.” Then spake the wise old clock-maker. “A vision,” quoth he, “is something good and lofty and desirable which the soul may see, and having not may reach forth to obtain. Without a vision the body may live, but the soul is starved. It is life in death.”

“Where shall I seek?” asked Anton. “At thine own work-bench,” was the answer. “Do thy daily work, Anton, and let thy vision find thee working. Then shalt thou be ready to receive it, and the meaning of thy life and work will be made clear to thee.”—*Walter A. Dyer.*