Clearing the Skies for the Sugar-Poisoned—By Woods Hutchinson, A.M., M.D.

IS THERE no treacle in Gilead; is there no physician there?" eagerly queried the dying warrior of Israel, and for tens of centuries the diabetic has echoed his tragic cry.

Later and more polished versions of Scripture changed the word "treacle" to "balm"; but this, though smoother and more poetic, lost the grip of the uncouth ancient word. A treacle, or theriacal, was a cross between an extract of menagerie and an elixir of botanical garden; half hash, half compote; but every "ingridiment" in it a sure cure for some evil that humanity is heir to. And as its ingredients were numbered by the dozen, the confidence reposed in it by both doctor and patient was something profound. It wasn't a shotgun, but a blunderbuss, and simply couldn't miss!

The famous Theriaca Magna had over five dozen ingredients, and such a hodgepodge! More like Macbeth's witches' caldron, with its

Fillet of a fenny snake,
In the cauldron boil and bake;
Eye of newt, and toe of frog,
Wool of bat, and tongue of dog,

than a respectable apothecary's gallipot.

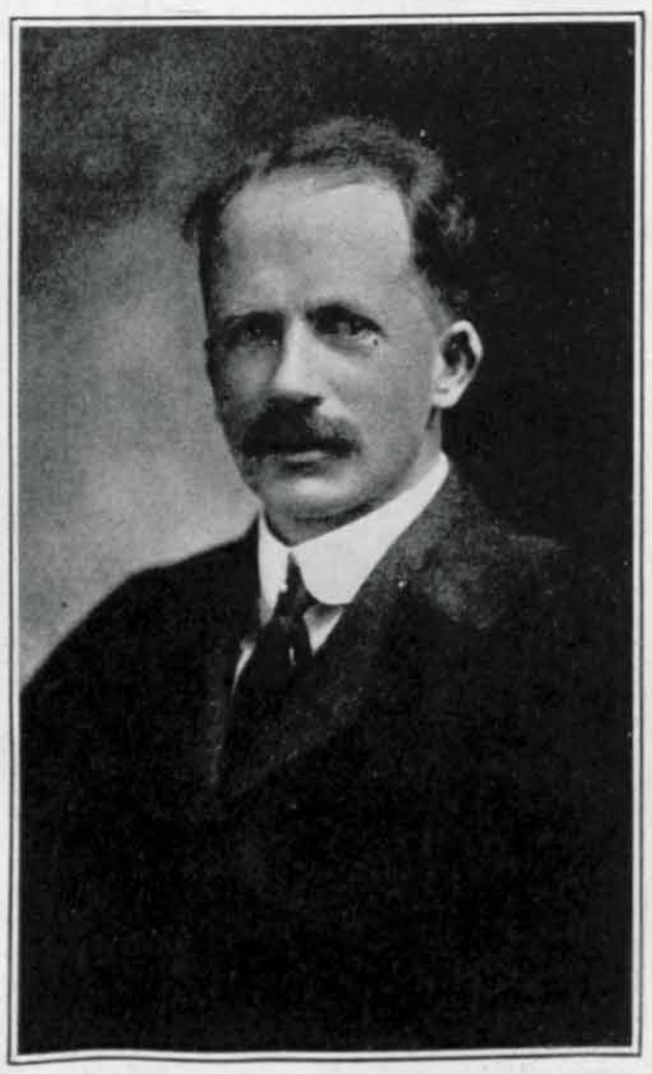
As we look back at such remedies now we smile in a superior manner at the childish credulity of our ancestors. But medical history strangely repeats itself; and when modern medicine is casting about for new and desperate remedies it flings its nets as wide and far as ever did the ancients, and all's fish that comes to them. It comes with something of a shock to find that our latest and most splendidly organized scientific search for a treacle against the deadly sugar sickness, diabetes, is actually trying out in its laboratory caldrons such extraordinary and widely scattered, such utterly unrelated sources or mother ores as sweetbreads, yeast cakes, codfish, sharks, sculpins, skates, dogfish and clams.

Sweet Poison

CERTAINLY there is no very evident family connection between them; yet they are being tested out for possible combination in a species of scientific haggis of the highest potency. For it bids fair to repair this most baffling of our internal breakdowns, where a physiological gear shift has somehow slipped into reverse and a vital fuel has been turned into a deadly poison. When our life stream changes from a balanced food mixture into a supersaturated sirup, trouble begins at once.

Could anything more unlikely, more monstrous, be well imagined than that sugar, our priceless fuel, the chief source of all our energy and heat, should suddenly refuse to burn in our body furnace as if it were slate instead of anthracite—indeed, well-nigh smudge out the vital spark itself? Yet this is literally what happens in this strange malady, diabetes; and the splendid sweetness of our food, instead of keeping the flame of life burning bright becomes as gall and wormwood to our system, filling the blood and brain with acids and flooding the muscle motors with sticky, unburnable sirup.

Nor can we follow Marie Antoinette's naïve advice when told that the poor of Paris were starving for lack of bread—"Why, how foolish of them! If they can't get bread, why don't they eat cake?" If we can't digest sugar it's no use to eat starch, because all the starch we eat—bread, rice, cereals, puddings, potatoes—has to be turned into sugar—glucose—before we can burn it in our muscles. Our body engine is a sugar motor.



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In fact, there is scarcely a food that comes on our tables which doesn't contain starch or sugar in some form or trace. Of course, all these innumerable and priceless starches and sugars of our food are simple combinations of carbon, oxygen and hydrogen, as their name carbohydrates implies, and we might in despair try some other form of carbon outside of the usual food lists—coal, for instance, or diamonds, both of which are pure carbon in different forms. But we should find them both a trifle gritty as well as indigestible, and the latter rather expensive. Starch and sugar are literally sweet diamonds in the stomach of the diabetic. As everything King Midas touched turned into gold, so his staff of life turns into diamonds in point of digestibility. It is a case of sugar, sugar everywhere, but never a scrap to burn, with the luckless diabetic. His problem is a distressing and difficult one—how safely to cut out of his diet the one fuel which normally gives him nearly two-thirds of his energy for work and for life. And to make matters worse, all the nonstarchy foods which can be substituted, chiefly meats and fats, with green vegetables for filling bulk, are much more expensive than the great white coal of our normal body engines.

But Nature is a wise and resourceful old mother. And partly by speeding up the draft of the body furnace, partly by draining away the surplus sugar through the kidneys, aided by reasonable regulation of the diet, a sort of tight-rope balance is caught and held, in spite of much swaying, which enables the term of the malady to be counted in decades and half decades instead of years and months. And there the matter has hung for centuries, for diabetes is by no means one of the so-called penalties of modern civilization. It is not even in the class of recently discovered research diseases, so termed by some cynic, who declares that research workers are doctors whose business is to invent new diseases for the other doctors to treat. It was recognized and given its graphic name—which means "siphon" or "pouring through" in Greek—from its most striking symptom, quarts and even gallons a day of liquid waste, more than fifteen hundred years ago.

Groping Toward the Light

SINCE then every conceivable change has been rung upon modifications of diet and drink; but without much success, except in delaying the chronic course of the disease and making the patient's condition more comfortable. We had cut down the starch supply with some benefit. We had even, with childlike directness and *naïveté* of logic, tried to cut down the water supply, with most disastrous results, piling up the irritating unburnable sugar and poisonous wastes bred by it still higher in the blood, and making the poor patient utterly wretched. We had apparently determined that the disease was not communicable to others, nor due to an external infection. The attack from without had failed.

But a few decades ago our knowledge of the chemistry of our bodies and of that marvelously efficient and ingenious stream of backward and forward interchanges between our food and our body stuffs, our work and our wastes, our buildings up and our breakings down, which we term metabolism, had become sufficiently accurate to enable us to attack the disease from the other end of the line, so to speak. By peaceful penetration from within, we strove to discover the internal cause of the trouble, to put our finger upon the weak spot in our body chemistry, the warped cog in the body machine. And although the processes concerned were extremely complicated and progress correspondingly slow, we are now happily able to announce the first positive step toward the answer of the fateful riddle, one that bids fair to give new hope to all diabetics.

This is no less than the discovery of the hormone—Greek for stimulator—or spark juice, which enables our bodies to burn sugar and whose absence makes us diabetic. And what is of vital practical value, this hormone, or

internal secretion, procured from the bodies of animals and injected into the veins of diabetics, will clear their blood of surplus sugar, enable them to digest an almost normal amount of starch and sugar in their diet, and greatly improve their condition in any respect for a period of some months at least. Some patients, in fact, have already regained their full normal weight and strength and gone back to work on ordinary diet.

It is, of course, far too soon even to mention the word "cure" in a long-lasting and obstinate disease like diabetes. All that can be claimed is marked temporary improvement, and to raise false hopes of anything further in the bosoms of our quarter of a million diabetics in the United States would be deplorable. But we can fairly say that this improvement is of a different type from any won before, and that, whatever its permanent effects, the new remedy, as will be explained later, is almost sure to be a great practical addition to our methods of treating the malady.

The story of the new finding and the events which led up to it is a fascinating one. Following our age-old habit of blaming everything that we couldn't understand upon the liver, our earliest suspicions fastened upon that large and long-suffering organ. But as long ago as the late '50's and '60's the brilliant work of the famous French physiologist, Claude Bernard, showed that although a great storer and distributor of sugar, the liver was not the prime cause of diabetes.

It would take the sugar—glucose—from the food of the diabetic, change it into glycogen, or animal starch, for storage, turn it back again into the blood as sugar again, when the muscles were hungry. But when the sugar reached the muscles it wouldn't burn! Either something had happened to it before it reached the liver or something was wrong with the muscles.

The Islands of Langerhans

SUSPICION next gathered round the pancreas, or sweetbread, the great gland behind the stomach, about the size and shape of the outthrust tongue. This manufactures and pours into the intestine the powerful digestive juice which deals with nearly three-quarters of our food, especially the starches and fats. What more probable than that some defect in it caused that inability to burn starch sugars, which is the hall-mark of diabetes? A careful series of post-mortem examinations showed the gland to be diseased in a certain per cent of diabetics, and we eagerly hastened to supply our patients with various forms of its digestive extract, known as pancreatin. But the results were utterly disappointing. The excess of sugar in the blood was lowered for a brief time in some cases, and the digestion improved in others; but no radical or lasting relief was given.

The problem was attacked more intensively by experimental methods, and about thirty years ago a brilliant Polish investigator, Minkowsky, showed that if the pancreas was removed—under ether and the strictest surgical antiseptic precautions—from dogs, the animals recovered, but quickly developed all the symptoms of diabetes; not only high surplus sugar in blood and kidneys, thirst, weakness and wasting, but also great susceptibility to infections of all sorts. If only a part of the pancreas were removed, the animals showed a much milder form of the disease, and could hold their own after a sort, even if half the gland had been excised.

Evidently the pancreas poured into the blood an internal secretion which enabled the body to burn sugar, in addition to pouring its digestive secretions into the intestines. The question was, what part of the pancreas does this come from, and how can we collect it separately for use? It had long been known that scattered through the mass of the pancreas, like raisins in a cake, were little masses or islets of tissue quite different from the rest of the gland and not connected with any of its ducts. These were known as the islands of Langerhans, after the anatomist who first described them. What could be more likely than that these were the sources of the internal secretion? But they were so small and so scattered that for nearly twenty years it baffled the ingenuity of all the researchers to isolate or separate their precious juice for trial. Various attempts were partially successful, and it was found that if the duct, or discharge tube, of the pancreas was tied in an animal the great mass of the gland—the digestive part—wasted away, leaving only a small shriveled remnant, consisting solely of islands.

Finally, to make a long story short, in 1920 it occurred to a young Canadian scientist, Doctor Banting, that if enough of these island remnants were collected, and an extract made from them, perhaps a sufficient amount of the long-sought missing-link internal secretion could be secured. Work was begun at once, with the coöperation of Professor MacLeod, Professor Best and others of his colleagues in the University of Toronto, and in July, 1921, to everyone's delight, an extract was secured strong enough promptly to clear of excess sugar the blood of several diabetic dogs. The ferment, or hormone, was given the appropriate name insulin, from the Latin *insula*, an island, after the islands of Langerhans, from which it was extracted.

PHOTO. BY UNDERWOOD & UNDERWOOD, N. Y. C.
Dr. F. G. Banting, of the University of Toronto

But why could not these results, even in the weakest degree, be secured from extracts of the entire pancreas?

Another idea occurred to the investigators. They mixed a dose of their strongest insulin with pancreatin and found that its value was utterly destroyed. The powerful digestive ferments had digested the insulin and spoiled it completely, and the puzzle of three decades was cleared up.

All that was needed now was to treat a fresh-taken pancreas with some reagent like alcohol which checked the activity of pancreatin without injuring the islands, and the insulin could be separated out alive and active. It was a case of "Against mine enemies I can defend myself, but who will protect me from my friends?"

The complex and delicately balanced insulin had formerly been attacked and literally eaten alive by its at least twenty times bigger and stronger relative, pancreatin, the moment the animal pancreas was removed from the body. So that unless guarded by alcohol to paralyze the pancreatin, every trace of insulin disappears long before any extract can be completed, and its place is taken by greedy pancreatin, licking its lips over the cannibal meal that it has made.

Incidentally, it may be said that this is not an unusual or exceptional process. All the digestive organs—stomach, salivary glands, liver—begin to digest themselves the minute that the blood ceases to circulate through them; and one of the standing puzzles of physiology is, why they don't do it during life.

Even the muscles partially digest themselves after death, which is why beef and mutton and chicken become tenderer and more palatable by hanging, or ripening, for a few days before cooking. Only the mysterious influence of life, of the vital spark, keeps three-quarters of the cell citizens of our body state from eating each other—binds them over to keep the peace, as it were—if, indeed, what we call life does not precisely consist in this gentlemen's agreement to live and let live, to coöperate instead of ruthlessly competing. And when this pact is broken comes the anarchy which we term death.

The Test

ONCE it had been discovered how to rescue the wonder child insulin from the clutch of its wicked uncle, the cannibal pancreatin, the way was open for direct action. A regular supply of fresh pancreases was arranged for from a great packing company. These were extracted with alcohol and the insulin tested and graded upon rabbits. After seven months more of hard work the investigators felt sufficiently sure of its value and familiar enough with its possible risks to venture a trial in the hospital wards.

Finally, in February, 1922, ten cases of severe diabetes were selected from a pitifully eager throng of patients, and the hopes and fears of two years of tireless teamwork were put into the fiery crucible of actual results. The test was a brilliant success; every patient was distinctly improved, and the new magic worked like clockwork, as hoped for, in almost every detail. All the changes for the better produced by insulin in diabetic animals were reproduced with extraordinary fidelity in human diabetics, even including the unpleasant symptoms caused by too large or too active a dose.

The excess of sugar first disappeared from the blood, usually within a few hours; then it ceased to leak out through the kidneys; then the acid poisons—called ketones—vanished out of the blood and fluids of the body. More gratifying still, the patients soon began to give vocal and delighted testimony to their joyous sense of

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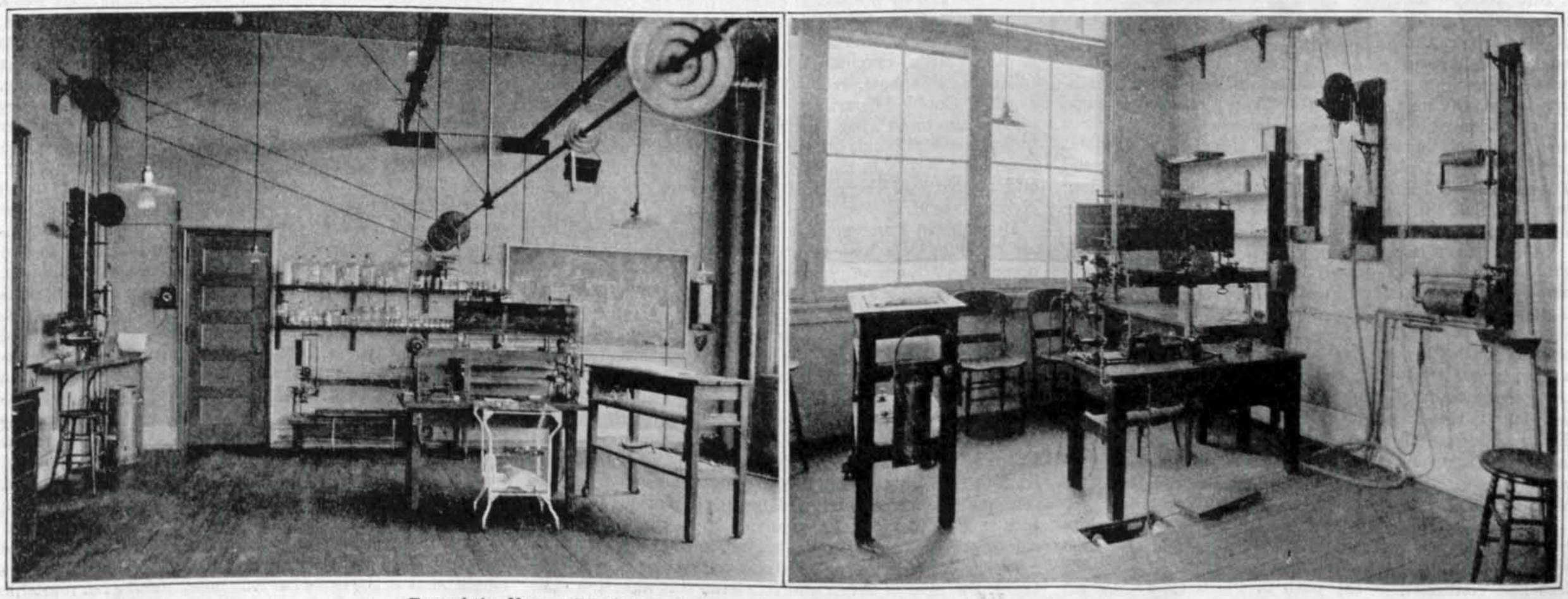

Two of the Mammalian Research Rooms, Department of Physiology, University of Toronto

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improvement and well-being. Their feelings kept pace with their chemistry. Their headaches lessened, their depression and drowsiness lifted, their raging thirst decreased, and healthy appetite took the place of ravening hunger; within a week they began to gain weight. Insulin was not simply a pretty laboratory theory; it was a blessed bedside reality. It worked. For the first time in history we had got hold of a lever that would move the foundation stone of sugar sickness, that could lift the diabetic out of his slough of despond and set his feet on solid ground once more. How long he could be kept there, of course, remained to be proved. But we were headed in the right direction. We didn't yet know how far we were going, but we were on our way.

The center of the stage was now cleared for the working out of this problem, while the laboratory men were kept busy in the wings, seeking wider sources and less expensive methods of insulin production. As the supply was extremely limited and very costly, for reasons which will be seen later, it was decided to limit the treatment to grave and advanced cases of the disease, which in spite of careful diet regulation were losing ground steadily. Even these forlorn hopes, after admission to the hospital, were given another sifting by being put on a carefully adjusted diet of green vegetables, meats and fats—a modified so-called Allen treatment. Then, if their sugar could be cleared up and a reasonable balance of comfort maintained, they were advised to keep themselves, so to speak, in cold storage for a time until more liberal supplies of insulin could be obtained.

Reports on Fifty Cases

Now just recently has come a report of progress upon fifty such selected cases, which have been treated with the new diabetic white hope for from one to nine months with most gratifying results. To show how little they were looking for an easy triumph, out of these fifty *morituri* who were accepted no less than ten were completely unconscious, in that deadly coma which closes the scene in some two-thirds of all cases of diabetes, when they were carried into the test ward of the Toronto hospital. All were brought out of their coma; but four of them died of gangrene, of pneumonia and other hopeless complications—about half the ordinary death rate of coma—and were the only fatalities occurring during the whole series of fifty. Six recovered, and at latest reports one is now free from sugar leakage on an almost full normal diet, without insulin! The other five have remained free of sugar leakage and have been relieved of discomfort on daily doses of insulin and dietetic treatment. Truly brands snatched from the burning!

Of the forty less desperate cases, all have been distinctly improved, several have regained weight and strength and returned to work within a month or six weeks, and kept comfortable and vigorous since on small daily doses of insulin. One or two most interesting cases have recovered, returned to work and gone for weeks free of sugar, on full ordinary diet, without insulin. So that there is at least a hopeful possibility of some recovery of secretion on the part of the pancreas when once relieved of its overload.

In addition to restoring power to burn sugar, insulin has greatly reduced the susceptibility of these advanced cases to infections of all sorts, such as crops of boils and common colds. What usually happens in diabetes is that after the sufferers have painfully won a temporary balance and held it for months, along comes some pestilent vagabond cold or sore throat and throws them into the slough again. They usually scramble out, but seldom back to the same level as before. Thus they keep on desperately adjusting themselves to lower and yet lower levels of comfort and vitality until finally they can no longer rally, and sink into the closing coma.

Here, as so often elsewhere, the proper enemy of mankind is colds. But with insulin all this is changed. The Toronto observers specially note, with decorously repressed delight, that their patients throw off and recover from colds or other mild infections almost like normal individuals, without disturbance of the sugar balance or lowering of their level of adjustment. This is most significant, for the final attack of coma often follows close after a cold; and any remedy which can both tide the diabetic safely over his chief danger periods of stray infections, and bring him out of coma six times out of ten, is almost safe to increase not only his comfort but his chances of continued survival from 25 to 50 per cent—which might mean five or even ten years more of life and work. Insulin may become a veritable lightning rod literally to insulate the diabetic against the lightning stroke of coma, even if it should not prove a cure. And it may yet go far in that direction. For the most hopeful and encouraging feature of this admirably cautious report is that, first, when the sugar-burning balance had been restored by the calculated dose the patient could usually be kept sugar-balanced and rapidly improving upon from half to one-fifth of the beginning dose. Second, that a group of patients had already recovered normal vigor and comfort and then gone back to work, on full working diet, including considerable amounts of starch, for several weeks without insulin, thus showing most hopeful signs that the pancreas, even in far-advanced cases, still had considerable powers of repair and new growth when once relieved of its terrible handicap and given a vacation period. Even the pancreas is improved by play spells. And if this be the case in these battle-scarred veteran survivors, how much more may reasonably be expected of early or mild cases of the disease?

But no knife has ever yet been invented which will not cut its owner's fingers, and the new remedy has certain risks which must be guarded against. It sometimes works not wisely but too well, and not merely reduces the sugar in the blood to the normal level but far below it. One would have thought that this would be welcomed by the body as a blessed relief after the long torture of oversaturation; but not so. The moment the glucose in the blood falls to about half the normal percentage, trouble begins. The patient complains of a sense of uneasiness and anxiety, of shortness of breath and confusion of ideas. He breaks into a profuse sweat and may even become incoherent in speech, half unconscious and mildly delirious. Fortunately the workers were keenly on the lookout for trouble of this sort and knew just what to do. For quite similar disturbances had been produced by overdoses of insulin in rabbits, often going as far as complete unconsciousness in the earlier tests before the cause of the difficulty was known, though always ending in recovery.

The moment a patient complained of this sort of discomfort he was given a drink of orange juice well sweetened with glucose to restore the sugar balance. This usually gave prompt relief, but if not absorbed quickly enough a solution of glucose was injected into a vein, thus reaching the blood directly and clearing up the trouble as if by magic. Or a hypodermic of adrenalin would be helpful in some cases by virtue of its power of causing the liver to pour sugar into the blood.

Encouraging Results

This curious reaction seemed most probably due to individual susceptibility, or excessive response to insulin, as it most commonly occurred after the first dose. This, though calculated and adjusted more carefully, naturally cannot always hit the precise personal equation of every patient; especially as even with the most expert standardizing each new batch of insulin may vary slightly from the others in activity. However, no serious or lasting unfavorable results followed; and when once the reaction had occurred, and the patient was familiar with the symptoms so that he promptly reported the very first tremors of the earthquake, the disturbance never went beyond feelings of anxiety and uneasiness and slight confusion of ideas. But it furnishes an amazing illustration of the extraordinary delicacy of adjustment required to maintain that balance which we call life.

Who could have dreamed that the almost infinitesimal difference of one part of sugar in two thousand in the blood could possibly upset the balance of the whole body in this extraordinary fashion, and even cause the mind to totter on its throne? And the earthquake varies precisely with the falling per thousandage of sugar, the first quiverings starting at one-third below par—.07 per cent—and the last crash sounding at two-thirds below—.04 per cent. Is our boasted intellect a confectionery product, and the clearness of our thought dependent on the refinement of our glucose?

To sum up, the showings of the new food spark under the acid test of actual hospital use have been most encouraging—so far. Not only has it repeated its laboratory or chemical feat in animals of clearing the blood of excess sugar but it has at the same time markedly improved the condition of the patients, in comfort, in appetite, in sleep and in recovery of strength, so that they have made a splendid start on the road back to normalcy. It does not effect one of these cures in which the disease gets better but the patient gets worse, as in the classic story of the famous French surgeon who was reporting a most delicate and difficult operation for brain tumor which he had performed a few weeks before. He proudly described the details of every step in its successful removal, from first incision to final suture. His colleagues were deeply impressed; and one of them, after congratulating him, courteously asked how far the patient had recovered from his pressure paralysis.

"Ah, the patient! Unfortunately he died three days after the operation. But he died cured!"

The Problem of Production

Two other things it has done, which, even if it does not permanently relieve, will be of great practical value. It has restored and set back on the upgrade nearly two-thirds of the cases of probably fatal coma or unconsciousness in which it has been used, and it has tided diabetics safely over attacks of infection, which are usually the clubs that batter them down to lower and lower planes of comfort and working power. It has also shown a distinct tendency to continue its helpful results even when given in steadily diminishing doses. So there is no inherent reason why life and vigor should not be kept up for years by weekly or bi-weekly doses of insulin; just as myxœdemic, or subthyroid, patients are kept healthy and comfortable for decades by regular doses of thyroxin or thyroid extract.

And now comes one of the most serious and difficult problems of all, the securing of a good supply of pure and active insulin. As has already been seen, the process of its production is a most complicated and delicate one. How much so may be roughly grasped in practical terms by the statement that each dose or unit costs in the neighborhood of from three to five dollars, so that the expense of treating a patient for a month is about one hundred dollars; and this without allowing anything for the time and expert services of the investigators or the overhead and interest on the cost of the elaborate and expensive laboratory plant. Moreover, the delicate and precise methods of the laboratory are utterly unsuited for quantity production, and if attempted in commercial establishments would result in either a breakdown or the putting on the market of unreliable and even most dangerous products.

Not only is there the danger of collapse and convulsions from cutting the blood sugar down too low, but unless the greatest pains are taken to free the insulin from all traces of protein or nitrogen stuff there may be shock and severe shortness of breath, or furious itching hives from poisoning by foreign protein, such as occurs in hay asthma and in food poisonings.

Indeed, the earliest injections years ago of extracts of the whole pancreas caused such discomfort and alarming symptoms in the patients that they had to be given up, even though they produced some slight effect upon the blood sugar. Nature seems to guard her secrets with jealous and even vengeful care.

After broad and careful study of the situation it was decided that a patent should be taken out on insulin by the University of Toronto, to be held by it in trust for the community; first, to prevent the flooding of the market with worthless or dangerous forms of the remedy, to the bitter disappointment and detriment of thousands of poor diabetics, before it was even certain that it would permanently help them; also, before a practicable method of mass production had been worked out. Second,

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when a reliable wholesale method had been discovered, to be able to compel all producers of insulin to keep it up to proper standards of purity and efficiency.

As soon as a workable commercial process is discovered it will be issued under license, free of charge, to reputable producers, the only conditions being that the output must conform to the standards established and the price be reasonable.

The patent rights for England were offered on the same terms to the great National Medical Research Council, that splendid body of public-spirited experts created and endowed by Lloyd George's health-insurance scheme, whose achievements have already been worth all the cost of the system. After careful consideration they accepted the patent on behalf of the nation; but not without loud protests and grave misgivings on the part of the more conservative English doctors, to whom the very name "patent" is anathema.

The moment that this most promising vein for research had been located and legally protected, small amounts of insulin and full details of its production were sent from Toronto to five or six universities and research institutions in Canada and the United States which had both hospital wards and adequate laboratories. Tests were begun on selected patients, while the laboratory staff produced more insulin and at the same time attacked the problem of a wholesale process. The same steps were taken in England by the research council. So that the battle line now stretches from the Pacific to the North Sea, drawn up in three platoons of eager experts, hospital doctors, research workers, chemists and biologists, all keeping in touch with one another and all in generous rivalry in the solving of this puzzling problem, with its wonderful possibilities of relief of human suffering; while a keenly interested public watches the bulletin boards for lists, not of pitiful casualties, but of glorious cures.

Never have we seen a finer and more creditable exhibition of broad-minded, unselfish, intelligent teamwork for the advance of human knowledge and the saving of human life. It is the spirit of modern science at its best.

But, someone may ask, why call in the biologists and the chemists?

Simply because the leaders of the main offensive in this battle are, in the language of the day, overlooking no bets. Our present method of extracting insulin from the pancreases of our domestic animals is so complicated, and involves such heavy expense in time and labor, that the investigators early began casting about for some new source of the magic hormone. Perhaps in some species of living creature Nature may have laid down the gold-bearing islands separate from the rest of the pancreas; sifted the raisins out of the cake, so to speak. So they turned to the biologist for advice; and pay dirt has been struck already, but whether rich enough to be worth cradling remains to be seen.

Insulin From Fishes

Certain of our distant relatives who wear scales and live in perpetual wetness even in these days of drought, the fishes, have been found to "wear their rue with a difference"; that is, to carry their insulin-bearing islands separate from the mainland of their pancreases. And from these insulin is readily extracted, without our being compelled to take all the troublesome and elaborate precautions against its destruction by the digestive ferments. These islands are naturally very small, but they can be easily collected and safely preserved without fear of self-digestion; and the supply of fish is so enormous and so cheap that "mony a mickle" fishy island might soon "mak' a muckle" continent of insulin at very moderate expense. Moreover, these island lobes have been found very distinct in several fishes, such as dogfish, skates and sculpins, which are almost worthless for food, but could be caught by the ton if they had any commercial value. And the fishermen would take a special zest and unholy joy in this pursuit on account of the havoc they work among their nets and lines with their razor teeth and the way they break up and drive out to sea the schools of herring, mackerel and other peaceable food fishes, like wolves among sheep.

If this fish insulin be not too fishy to fit as a spare part in our human machine—and all these internal secretions, or endocrines, seem to be interchangeable through a wide range of animal forms—this newfound sheaf from the great harvest of the sea, which needs neither sowing nor plowing, may go far to meet the enormous coming demand of the hundreds of thousands of diabetics in England and the United States for their new hope of life, if once its value is established. To think of impressing the ravening shark—for the dogfish is a pocket edition shark, and a man-eater might have an island as big as a coconut—into the service of man would inspire dear, devout old Doctor Watts to a new version of his famous Hymn of Praise:

Ye fishes all and monstrous whales
Your Maker's praises spout,
Up from the deep ye sharklets creep
And wag your tails about.

As if to show how extraordinarily widespread throughout the animal kingdom insulin is, and how literally one touch of sugar makes the whole world kin, comes a recent report of the discovery of insulin in workable amounts in the sociable and convivial clam. This is not wholly surprising, because the plumpest and most delicate lobe of both the clam and the oyster, sometimes called the stomach, consists chiefly of liver and pancreas combined. And if clam and oyster insulin should prove active in the human economy, pearls will cease to be the most precious product of both these admirable bivalves, and the sky is the only limit as far as abundance of supply is concerned.

Can it be that our keen appetite for and rapturous delight in the luscious clambake and the toothsome Cotuit on the half-shell have had a deeper and sounder basis than their mere delectableness? And that the lonely oyster in the church-sociable stew was, all unknown, a gem of purest ray serene of life-saving insulin? At all events, we may score one for the soundness of our instincts. It is our luxuries that keep us alive.

So much for the biologist's contribution. Now comes the chemist with his penny for the collection plate.

New Fields of Study

It may be remembered that after the starch of our food has been turned into a sugar called glucose by the digestion ferments of our intestines, chiefly from the pancreas, it goes to the liver to be prepared for use by the muscles. English chemists working in this research at the Cambridge University laboratories have recently discovered that this prepared sugar is not the ordinary A or B glucose, but a specially refined and particular brand, which they have named, to distinguish it, after the third letter of the Greek alphabet, Gamma, or G glucose.

When the pancreas is removed the liver can no longer form this particular brand, and the muscles will not burn any other. Which raises the bare but interesting possibility that one day a brand of G glucose may be manufactured outside the body that even a diabetic can burn in his muscles and other tissues.

More interesting and suggestive yet, in their attempts to produce G glucose these chemists used yeast, and happened to inject some of this into a rabbit; when, to their astonishment, down went the blood sugar and on came convulsions, just as if insulin had been used! Of course, this is only a negative feat and may only mean that yeast breaks up the blood sugar directly, instead of enabling the muscles to burn it, as insulin does. But it at least raises an interesting possibility that this wonderful little vegetable, to which we are already indebted for bread and vitamines, may perhaps help to piece out our scarce and costly insulin by clearing the diabetic blood of excess sugar—which is the first step toward a cure. And it is not beyond the limits of possibility that yeast may contain insulin, or a hormone resembling it, for its budding cells contain the digestive ferment pepsin, and both the pineapple and the pawpaw are so rich in pepsin that they will digest beef or white of egg almost like our own gastric juice.

Oddly enough, yeast has long been used in diabetes—by the mouth, in the hope of relieving the crops of boils which are often so troublesome; and dissolved in water as a lotion for the eczemas and other itching skin eruptions caused by the irritation of the sugar which leaks out of the blood. In these it often gave great relief by its simple power of splitting the tormenting sugar into alcohol, carbon dioxide and water, which

are soothing and antiseptic, thus literally turning a poison into a healing balm. But no one had ever happened to think of injecting it under the skin; and, of course, taken by the mouth it would be digested and destroyed like insulin.

Even though yeast has lost its job in breweries and distilleries in these United States, there is no danger whatever of its joining the ranks of the unemployed so long as it holds the secret of its little sugar-splitting trick. On the contrary, so great is the demand for it by bakeries—to say nothing of these new insulin-aiding possibilities—that there is already serious talk of converting breweries into yeast factories and using the alcohol as a waste product for fuel purposes, thus veritably beating swords into plowshares.

One of the charms of trail-blazing discovery work is that you so often find more than you are looking for; or, to vary the metaphor, you never know how many different locks your new-found key will fit. As if one magic power was not enough for our tiny hormone, it was discovered quite early in the research that the shy and sensitive insulin sprite also exerted a powerful influence upon the burning of our second main fuel food, fat. This was of great value to the diabetic, because very quickly after he has lost power to burn sugar he begins to fail to burn fat properly. As a metaphorically minded physiologist expressed it, "Fat will only burn in the flames of sugar." Indeed, most curiously, the deadliest poisons formed in his blood, which finally cause the fatal coma, are acid substances coming from half-burned fats, and not from sugar at all! And insulin sweeps these out of the blood just as swiftly and as surely as it does excess sugar; which is the secret of its wonderful success in most cases of coma.

Already the hope is cautiously expressed that full knowledge of insulin may give us priceless control over fat-burning and fat-depositing in the body, as well as over the transformations of sugar. From Toronto, indeed, comes the frank and matter-of-fact statement that if it is desired to increase the weight of a diabetic, all that is needed is a more liberal diet, with insulin to match, and he will tip the scales almost to order.

Will the reverse prove true and insulin become a ray of hope for the adipose-laden also? But that, as Mr. Kipling says, is another story, which only the future can tell.