of gas by *M. pinoyi* Cast., the presumption is that the liquid contained three sugars—glucose, levulose, and maltose. The explanation is found in the fact that *M. bulcanica* Cast. ferments with production of gas glucose only; *M. krusei* Cast., glucose and levulose; *M. pinoyi* Cast., glucose, levulose, and maltose.

There are, however, in certain circumstances some sources of error, but with these, as well as the precautions for avoiding them, and with the whole subject of the presence of more than one reducing substance, we propose dealing in a future paper.

Application of the Method to the Detection of Certain Non-reducing Substances.

The method, using certain species of fungi and bacteria, may be applied to assisting in the detection of certain other substances—saccharose, inositol, dextrin, etc. To help in the identification of saccharose, for instance, make a 1 per cent. peptone water solution of the substance to be examined, and inoculate two of the tubes of the solution with two germs (bacteria or monilias or saccharomyces) identical in all their biochemical reactions except on saccharose; for instance, inoculate No. 1 with *B. coli* Esch. and No. 2 with *B. pseudocoli* Cast. If after forty-eight hours' incubation at 37° C. No. 1 shows absence of gas, while gas is present in No. 2, the sugar is saccharose. With this subject also we propose dealing more fully in a future paper.

Use of the Method in Urine Analysis.

From a number of experiments we have carried out, adding to samples of urine various sugars and other carbohydrates, and also from a few pathological specimens, we can say that the method can be used in urine analysis for the detection and differentiation of certain sugars and other substances—glucose, levulose, lactose, pentose, etc.—provided that the amount of such substances present is not too minute (not less than 0.1 per cent.). The urine is distributed in sterile tubes containing Durham's fermentation tubes or similar devices and inoculated with the organisms mentioned in the table and key. Two points of considerable importance are (1) the urine must be aseptic; if it cannot be collected aseptically it should be sterilized as soon as possible—after distribution in the tubes—by heating in Koch's steamer for thirty minutes on two or three consecutive days. It should never be autoclaved, as this procedure may alter the characters of the sugars and other carbohydrates present. (2) It is of great advantage to add a third or the same amount of peptone water to the urine before inoculation, otherwise the organisms may grow very scantily, and there may be no production of gas.

A METHOD OF SKIN GRAFTING UNDER SEPTIC CONDITIONS.

BY

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THE difficulty which has arisen in connexion with skin grafting is recognized by most military surgeons. In a considerable number of instances grafts have not grown on account of the generally septic conditions prevalent. Hitherto the first principle of successful skin grafting has been the most rigid asepsis, without using antiseptic solutions on the raw surface of the wound, since efficient antiseptic solutions have proved as fatal to the delicate grafts as the bacteria which they sought to eradicate. As a rule, the only solution used by most surgeons has been normal saline. Another difficulty arises when a patient has multiple wounds and the wound to be grafted cannot therefore be retained in the best position possible, so that the grafts are sometimes pulled out of place in handling the dressings.

By the method here described I have been able to obtain successful grafts upon areas which, though "clean" to the naked eye, were still actually suppurating, dressings which had been left on for twenty-four hours showing a certain amount of pus, and even possessing an offensive odour.

The following is a case which seemed less promising at the beginning than any other I have dealt with:

The patient had been wounded in the arm, the head, the back, and the left thigh. The wound in the arm had necessitated a guillotine amputation in France, which had remained septic; the wound in the thigh had been excised in France, and when I received the patient in England it consisted of an area on the posterior surface extending from two inches above the knee to the natal fold. The outer border reached to about one and a half inches in front of the great trochanter, and the inner border to within about one and a quarter inches of the rectum—an area of approximately seventy-two square inches, in which all the skin, superficial fascia, and fat had been removed and had left the hamstring muscles exposed and still in a septic condition in very nearly their whole length. On first viewing this leg it seemed doubtful whether it could be saved, especially as the wound was of such an irregular shape that a plastic operation by means of which parallel strips of skin might be brought over portions of the exposed surface was not possible.

For ten days the wound was dressed on every third day with pure sterilized liquid paraffin containing one drachm of ordinary bipp to the ounce. At the end of this period the wound was quite clean at the edges and had granulated well over the muscles; a skin graft under the following conditions was decided upon in spite of the fact that the dressings were still somewhat offensive.

The edges of the wound and the skin of the buttocks, whence the graft was to be taken, were sterilized with iodine; the surface of the wound itself was sprayed with zoel, which the manufacturers inform me is made by mixing 1 lb. of 78 per cent. electrolytic caustic soda ground to pass through a sieve with ten holes to the linear inch, with 1½ lb. of No. 20 pure salt; to this is added 5½ lb. of granulated borax and the whole well shaken together. Combination of the caustic soda with the borax takes place rapidly, resulting in a mixture (zoel) containing 19½ per cent. sodium chloride, 3 to 4 per cent. of sodium diborate, and 76½ to 77½ per cent. of sodium monoborate. I then raised small portions of the skin of the buttocks with forceps and dissected off portions about a quarter of an inch in diameter and one-sixteenth of an inch thick in the centre. I passed a single stitch through each graft and through the granulation tissue, suturing each graft in careful apposition; in all I planted about thirty-five grafts in this way. Again I sprayed with an atomizer a solution of zoel upon the grafted wound, and then dressed the whole with gauze soaked in sterilized paraffin, so that the dressing should not dry and tear off the grafts or cause bleeding when it was changed.

The paraffin dressing was left on for forty-eight hours without removal, but was moistened from time to time with fresh paraffin in order to prevent it from sticking. At this period the dressing had begun to smell, and the edges of the dressing had become green. I therefore re-dressed the wound, and sprayed it again with a 2 per cent. solution of zoel, afterwards again placing over the surface gauze soaked in paraffin. This procedure I repeated from time to time on the average every twenty-four hours, and at the end of twelve days every graft had not only taken but had spread to more than twice its original area.

I have used this method on other cases, of which that quoted is typical, and the success of the technique I ascribe to three outstanding conditions:

1. The fixing by means of sutures of the grafts, so that, although in an awkward position, they cannot be removed when the wound is dressed.
2. The use of liquid paraffin as a medium for the dressing, which prevents any adhesion, and hence movement of the grafts.
3. The use of an antiseptic spray which is efficient in its germicidal powers, and yet non-irritant and non-poisonous to such delicate tissues as skin grafts; this last is, without doubt, the most important of the three.

A NOTE ON SKIN GRAFTING.

BY

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THERE appears to be a tendency among surgeons to avoid the operation of skin grafting chiefly because, with the usual methods adopted, no great measure of success is obtained. With proper care and attention to certain details there should be very few, if any, failures. The details to be attended to are:

1. The raw surface must be in a good condition for skin grafting—that is, it must be covered with healthy granulations and as free as possible from discharge. If there is much discharge many pieces of grafted skin are raised and so fail to "take." To prevent this the wound should be dressed with 1 in 1,000 flavine for four to seven days before operation. In the cases I have treated by this method

there has been no discharge whatever between the grafts, although I had regarded them as very unsuitable cases before the application of flavine.

2. The grafts should not be covered with any dressing and should be properly protected. At the suggestion of Dr. Culverwell I have used inverted boxes of various sizes and shapes cut to fit the contour of a limb if necessary. A jeweller's or instrument maker's cardboard box is the most suitable. The edges should be slightly padded, and the box should be amply large, so that there is no risk of the padding touching the wound.

3. The technique I have used is as follows: The surface from which the skin is to be taken is prepared in the usual way. The wound is covered with a simple gauze dressing, and when this is removed care is taken to disturb the surface as little as possible. Two razors are employed, so that one can be dipped into boiling water while the other is being used; thus the freshly cut surface heals without any suppuration. The grafts are cut about the size of a postage stamp, and with practice can be cut to almost any shape. The skin and razor are kept thoroughly wet with normal saline, so that the grafts can be more easily cut and removed from the razor. The graft is conveyed to the wound on the razor, and slipped off it with the help of a blunt probe. The grafts are generally placed about one-eighth of an inch apart, but can be closer together in a very clean wound. The box, sterilized beforehand, is adjusted to the part and fastened down by long strips of rubber plaster; the ends of these are thoroughly bandaged, the bandage being brought up to the box as close as possible on all sides, but not over it. As a further safeguard against any chance of slipping the bandage is always used in the form of a spica whenever possible. It is then pinned to the box with a liberal supply of safety-pins. The box remains quite firm for three or four days, when it can be removed. The grafts are then found to be firmly fixed, and any dressing, such as fomentations or red lotion, can be applied.

Lectures

ON

THE ANATOMICAL AND PHYSIOLOGICAL PRINCIPLES UNDERLYING THE TREATMENT OF INJURIES TO MUSCLES, BONES, AND JOINTS.

GIVEN AT THE ROYAL COLLEGE OF SURGEONS OF ENGLAND,
NOVEMBER-DECEMBER, 1917.

BY

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IV. THE INTRODUCTION OF TENOTOMY.

THE events which led to the introduction of tenotomy as a measure of surgical routine had nothing to do with Hunter's experiments; they occurred nearly thirty years after he was dead.

The man who can best serve as a guide, as we follow the march of events, is William John Little, the son of parents living in comfortable circumstances in the East End of London. Little was born in 1810, and was therefore a contemporary of Hilton. In his infancy he suffered from a fever which left the extensor muscles of his leg (so he informs us) paralysed. As he grew up his left foot became inverted, the heel raised, and a typical talipes equino-varus developed. At the age of 16 he was apprenticed to a neighbouring apothecary, but two years later, in 1828, his indenture being cancelled, he began the study of medicine at the London Hospital. He entered his studies with the fixed intention of discovering what could be done for the relief of such a condition as he suffered from. He found that club-foot was regarded as lying outside the legitimate scope of surgery, and, in the opinion of his teachers, was properly confided, as his own case had been, to the care of bonesetters and sprain rubbers, who treated the condition with manipulations or instruments, often with a fair degree of success. A man whose chief object in devoting himself to medicine had been the alleviation of a personal infirmity—one with which his senior contemporaries Lord Byron and Sir Walter Scott were

afflicted—was not likely to remain content with the comfortless promise of his time. All through his time of study at the London Hospital he sought every opportunity of making himself acquainted with the actual condition of parts in deformed feet; he had a facile command of the French tongue, and during his studenthood followed medical progress in the literature of Paris as well as in that of London. He became particularly interested in the work of Delpéch of Paris, who had proposed and carried out in 1816 section of the tendo Achillis for the cure of club-foot. When he had passed through the curriculum of his own hospital he went to study in the *post-mortem* room at Guy's Hospital, under Thomas Hodgkin, and to study comparative anatomy under Dr. Robert Grant at University College. It was in that year (1834) that he settled to a city practice in Billiter Street, and was appointed lecturer on comparative anatomy and physiology at his own hospital—the London. In 1834, being then 24 years of age, he became a Member of this College, but in that year was his failure to obtain a vacant assistant surgeoncy at his hospital. He therefore resolved, as is not unusual under such circumstances, to become a Licentiate of the College of Physicians, and devote himself to medicine. For that purpose it was necessary for him to spend two years at a university. He chose Berlin, drawn thither by the great fame of Johannes Müller. In 1834 we see this lame and somewhat sensitive Englishman set out for Berlin armed with a letter of introduction to Müller from Grant of University College and supported by the status accorded to him because of his office of lecturer in comparative anatomy. When Little entered Müller's laboratory he found there Schwann, Henle, Remak, and the other young men who, a few years later, were to reveal the cellular constitution of living matter. Little had every opportunity given him in Müller's laboratory of continuing his dissections of deformed feet. The condition revealed by his dissections supported the conclusions he had drawn from his investigations in England—namely, that surgeons were in error in believing club-foot to result from an inherent defect in the growth of the bones of the foot; the cause of the deformity lay in the soft parts—particularly in a disordered action of the muscles. With that conclusion Müller agreed. He also concurred with Little in regarding the condition as one which should be amenable to surgical treatment.

Before leaving England Little had read of a young surgeon at Hanover, Stromeyer by name, who had modified Delpéch's operation, and was cutting the tendo Achillis for the rectification of club-foot. Müller agreed with Little that such an operation had a rational basis. Hence we find Little, in the summer of his second year of study in Berlin, and the twenty-sixth year of his age, visiting Stromeyer in Hanover.

Stromeyer was only six years Little's senior. He was born in Hanover in 1804, the son of a surgeon there who had strong leanings towards the art as practised in England. After spending almost a year in England, young Stromeyer commenced practice in his native town in 1828. From the outset of his practice Stromeyer applied himself to the treatment of physical disabilities and deformities. He fitted out a small private hospital, but found the establishment of the kind of practice he desired an uphill task. In 1831 his opportunity came. The son of a local schoolmaster, a boy of 14, was the subject of club-foot—intractable, painful, the despair of his relatives and medical attendants. Stromeyer gave the lad a bed in his hospital, and settled down to give his case eighteen months of unrelenting attention and care. As a last resort, he cut the tendo Achillis by a new—a subcutaneous—method; he found that the foot could then be flexed (dorsiflexed) and that the cut ends of the tendon separated for three-quarters of an inch. The gap evidently frightened him somewhat; at least he again extended (plantar flexed) the foot until the ends were in apposition, before he fixed it in a splint. At the end of six days he found on bending the foot that the cut ends of the tendon did not separate, but moved together. He gradually dorsiflexed the foot, thus, as he supposed, stretching the scar in the tendon, so that in eight weeks the heel was brought down to its proper level and all trace of the equinus deformity removed. Stromeyer ascribed his success, not to the eighteen months of unrelenting attention he had given to the case, but to the operation he had thus introduced into surgery. Tenotomy, he declared reduced the