CASE XV.—Operation was done March 27th, too recently to report anything more than the primary result. The husband, himself an experienced medical man, writes, June 10th, 1879: "The menopause is complete. I am very sanguine of a perfect recovery of mind, as soon as she is accustomed to the great change from the operation."

THERAPEUTICAL EXPERIENCES WITH THE DIGESTIVE FERMENTS.

By F. ARNOLD LEES, L.R.C.P., M.R.C.S., F.L.S.;

WITH A REPORT OF EXPERIMENTS,

By GEORGE BROWNE, F.C.S.*

REPORT ON THE DIGESTIVE FERMENTS.

THIS research was undertaken with special reference to the observations of Dr. W. Roberts, published in the BRITISH MEDICAL JOURNAL of November 1st and 8th, 1879. It is therefore, as far as possible and necessarily, a repetition of his chemical experiments, supplemented by additional ones, in order that modifying circumstances and the variety of natural adjuncts to digestion might be considered and taken into account.

For convenience, the tabulated order of digestive juices and their ferments given in Dr. Roberts's paper was followed in the present research.

The experiments upon salivary digestion were performed with both human saliva and that obtained from the salivary glands of the pig, diastase, and extract of malt.

The first portions of saliva ejected from the mouth were almost invariably acid, possibly in consequence of oxidation of the ferment or of the food last taken; the freshly secreted juice was either neutral or feebly alkaline. The acidulous saliva was found, however, to act most powerfully on starch-paste, converting it rapidly into sugar and dextrine. Efforts were made to identify the acid, but the quantity was too minute for complete identification. We have reason, however, to believe it to be lactic acid, from the following experiments: (1) neutral saliva, feebly acidified with lactic acid, acted more rapidly on gelatinised starch than an equal volume of non-acidified saliva; (2) neutral saliva, acting upon starch-paste, rapidly became acid; and (3) neutral saliva, acting upon bread-paste, formed lactic acid as one of the products.

Five hundred grains of human saliva, when "scaled" upon glass below 80° Fahr., gave 6.1 grains of solid residue in the form of semi-transparent horny laminæ, producing a viscid albuminous fluid with water, and giving precipitates with aqueous solutions of mercuric chloride, tannin, and alum. For convenience, we call this substance ptyalin; it is obviously impure, but the impurities are the natural constituents of the saliva, and could not, therefore, be ignored or rejected from this investigation. With this ptyalin or saliva-residue, the following experiments were made. Temperature, 98° Fahr. Time allowed, four hours.

1. Ptyalin, 1 gr.; whole starch, 50 grs.; water, 500 grs.
2. Ptyalin, 1 gr.; whole starch, 50 grs.; soda bicarbonate, 2 grs.; water, 500 grs.
3. Ptyalin, 1 gr.; whole starch, 50 grs.; hydrochloric acid, *P.B.*, 2 grs.; water 500 grs.

These mixtures were frequently agitated to promote action or solution, but the greater portion of the starch-granules remained intact. When some of these were examined by a microscopic power of three hundred diameters, the cellulose appeared somewhat shrivelled, but it still protected the granule cell-contents from the fermenting agent. The three fluids were separately filtered, and tested with the alkaline copper test, and small quantities of sugar were detected—perhaps derived from some prurptured granules, or from exosmosis of granulose. These results were checked with the following solutions, kept at exactly the same temperature for the same time.

1. Ptyalin, 1 gr.; water, 500 grs.
2. Starch, 50 grs.; water, 500 grs.

We are therefore able to confirm Dr. Roberts's assertion of the indigestibility of uncooked starch; and it may be taken as an established fact, that the value of a farinaceous food depends greatly, if not exclusively, on the extent to which its starch-granules are broken, and their contents permitted to come into contact with digestive ferments.

A second series of experiments was commenced as follows.

1. Ptyalin, 1 grain; dilute lactic acid, 2 ℥; water, 500 grs.
2. Ptyalin, 1 grain; soda bicarbonate, 2 grs.; water, 500 grs.
3. Ptyalin, 1 grain; — water, 500 grs.

* Concluded from page 475.

These solutions were again kept at a temperature of 98° Fahr., and into each was dropped from time to time gelatinised starch (one in ten), as often as a drop of the mixture, removed on the end of a glass rod, failed to give the blue reaction with iodine. After one hour, the following results were obtained.

- 1 had transformed 870 grs. of starch with acid reaction.
- 2 had transformed 610 grs. of starch with feeble acid reaction.
- 3 had transformed 716 grs. of starch with acid reaction.

The necessity for disruption of the starch-cellulose prior to ingestion of starchy food cannot therefore be overestimated; but it is suggestive and curious to observe that the salivary digestion was most rapid when the reaction of the fluid menstruum was feebly acid, least rapid when alkali was present, but that even the alkaline digestion (so to say) of experiment No. 2 generated acid of some kind.

It seems to follow from these experiments that the power of ptyalin may be checked or increased, as well as rendered inactive or inert; and that the blame of inactivity must rest on the nature and condition of the food presented to the salivary secretion, rather than on the saliva itself.

Diastase or vegetable ptyalin exhibits properties remarkably like animal ptyalin. They may possibly be absolutely identical bodies [or having relations to one another similar to those borne by gluten and animal albumen. F. A. L.]. Neither ptyalin nor diastase has yet been obtained sufficiently pure to establish their identity or even isomerism; yet diastase, in the form of malt-extract, may be fairly used as a solvent of starch, with this proviso: that (like ptyalin) it also requires the starch-granules to be broken up, or their solvency and its digesting power is very small and comparatively worthless.

Fifty grains of malt-extract were substituted for the one grain of ptyalin, and the behaviour with cooked and uncooked starch was found to be qualitatively similar in activity and inertness.

A third series of experiments was undertaken to determine the compatibility or incompatibility of the ferments of the saliva and the gastric juice. For this purpose, the following processes were adopted. Two ounces of pure dried starch were gelatinised with twelve ounces of boiling distilled water, and divided into six equal portions (like solid translucent jellies at 100° Fahr.), and they were treated as follows.

To jelly 1	was added diastase, 1 gr.; pepsin, 1 gr.
" 2	" diastase, 1 gr.; pepsin, 1 gr.; lactic acid dil., 5 ℥.
" 3	" diastase, 1 gr.; pepsin, 1 gr.; hydrochloric acid, 3 ℥.
" 4	" pepsin only, 1 gr. [<i>P.B.</i> , 3 ℥.]
" 5	" hydrochloric acid, <i>P.B.</i> , 3 ℥ only.
" 6	was kept without addition, for comparison.

These mixtures were kept at a temperature of 98° Fahr. for four hours, the time prescribed for the pepsin action on albumen by the *Pharmacopœia*. A considerably shorter time was sufficient for this determination, as the jellies 1, 2, and 3 quickly liquefied, in consequence of the conversion of the starch, but Nos. 4, 5, and 6 remained sound and gelatinous. Ten volumes of a weaker starch-paste (6 per cent.), when treated with one volume of a three per cent. watery solution of diastase, liquefied in ten minutes, and was easily filtered.

The deductions from this series of experiments are that diastase, and presumably ptyalin, *will act* in the presence of pepsin; that diastase still acts even when the pepsin is feebly acidulated; and, therefore, that the combination of pepsin and diastase (in such compound preparations of digestive ferments as "peptodyn", for instance) *does not neutralise or destroy* the action on starchy food.*

To establish this proposition as a scientific fact, a small starch pudding was made, and a watery mixture (one-tenth volume) of "peptodyn" was added to it. In a few minutes, the whole was liquefied, and the filtrate reduced the copper-test for glucose, etc.

Before passing from the amylotic digestion, we must notice the process of Cohnheim for the preparation of ptyalin from saliva, given in *Watts's Dictionary*, vol. v, pp. 175-6. "If saliva be treated first with dilute phosphoric acid, and then with lime-water, the bulky precipitate of phosphate of calcium carries down with it the greater portion of the ferment together with the albumen. If the separated deposit be agitated with distilled water, it gives up the ferment, but not the albumen, and hence, by filtration, a clear liquid can be obtained, acting powerfully upon starch. From this the ferment may be precipitated by alcohol, forming, when carefully dried, an amorphous mass mixed with phosphates." We have repeated Cohnheim's experiments upon a small scale, and found that the ferment was not destroyed by the action of dilute phosphoric acid for some considerable time, provided the mixture was kept cool. We also noticed that phosphates exist naturally in normal saliva, as well as in association with the other digestive ferments, and most

* Further on, the necessity for the administration of bicarbonate of soda with a dose of pancreatine, to guard the latter from destruction in its passage through the stomach, is similarly disproved. F. A. L.

likely act as powerful auxiliaries to digestion. We have found alkalies affect diastase injuriously, and a markedly alkaline malt-extract we found quite free from starch-converting properties. We cannot do better than conclude these experiments and remarks upon ptyalic digestion by calling attention to a paper read before the Chemical Society by Mr. W. H. Watson; the conclusions drawn by him from his tabulated experiments being given as follows. "1. By the addition of the small amount of hydrochloric acid, the action of the saliva is decidedly increased. 2. The retarding influence of the alcohol (added) is not lessened by the presence of the acid. Hence it follows that the saliva will be more active upon farinaceous foods when mixed with the acid juice of the stomach than it would otherwise be." (*Journ. Chem. Soc.*, August 1879, page 543.)

As regards the second digestive agent—the pepsin of the gastric juice—there is no room for doubt that this albuminoid acts in acidulous solution or as an acidulous salt; but there is a great difference between free and combined acid. Even when the specific acid is known, Bidder and Schmidt found more hydrochloric acid than was necessary to neutralise the inorganic bases of the gastric juice; but they did not calculate the organic bases, albuminoids, and even ammonia—the results of the oxidation of the zymogen and also of the transformed food. Pepsin acts in an excess of hydrochloric acid in watery solution (as in the official test for pepsin); but it does not follow that so simple a process in the testing-flask exactly represents the peptic digestion of the stomach. In fact, we know that gastric digestion is preceded by a certain amount of salivary digestion, and the substances and products of this must modify gastric digestion, especially if we admit without reservation the theory that the salivary digestion is neutralised and destroyed by the gastric juice; for then the gastric digestion itself would be weakened by neutralisation of the saliva, and the more perfect the mastication, the worse it should be for the gastric juice.

Combined hydrochloric acid unquestionably exists in the gastric juice, but we are not certain that the acid is also the same. Lehmann asserted that he found lactic acid in the gastric juice. Bernard and Barreswill denied that normal gastric juice contained free hydrochloric acid, on the ground that they could not recover it by distillation, but another acid, which failed to precipitate argentic nitrate; and von Grünwaldt confirmed these results, and attributed the acidity of the gastric juice to lactic and butyric acids generated by the stomach, or developed from the food. At the same time, Schmidt, and more recently Richet, assert the presence of free hydrochloric acid; Schmidt, however, thinking the ferment to be a conjugated acid, for which he coins the name peptohydrochloric acid (see Kühne's *Lehrbuch*).

Among the results of the action of pepsin and acids upon albuminoids are the formation of leucin and tyrosin—substances possessing basylous characters, and capable of combination with hydrochloric acid. After numerous experiments upon the fresh stomach of the pig, and also upon the glycerine extract prepared by the process of von Wittich, we have invariably found leucin and tyrosin present in solution in the acidulous gastric juice, and consequently modifying the action of the acids upon the one hand, and the ferments upon the other. As an example of modified albumen, it is possible to combine egg-albumen with hydrochloric acid; and, when the salts are removed by dialysis, the distinctly acid hydrochlorate of ovalbumen is not only soluble, but remains uncoagulated by a heat of 246° Fahr.

Not only do phosphates appear inseparable from active pepsin, but they cling with similar tenacity to ptyalin and pancreatin, as well as the biliary and intestinal juices—in fact, working as constituents in all digestion.

An energetic peptic action can be obtained by either of the following formulæ, in watery solution.

Pepsin, leucin hydrochlorate, sodium chloride.

Pepsin, leucin hydrochlorate, calcium lactophosphate.

Pepsin, leucin, tyrosin, sodium chloride, calcium lactophosphate.

Pepsin, lactophosphate of calcium.

By the following formulæ, we have obtained the starch-converting power of diastase and pancreatin in the presence of pepsin.

Pepsin, diastase, leucin hydrochlorate.

Pepsin, diastase, calcium lactophosphate.

Pepsin, pancreatin, leucin hydrochlorate.

Pepsin, pancreatin, calcium lactophosphate.

As the best neutral extractive and simple preservative of pepsin or pancreatin known at present seems to be glycerine, we extracted separately fresh stomachs and pancreas of the pig with this fluid, without the intervention of either acids or alkalies, and both fluids were tested and found very active.*

One drachm of pepsin glycerole dissolved one hundred grains of albumen, in three hours, at 98° Fahr.

One drachm of pancreatic glycerole emulsified one ounce of lard and two ounces of water.

One drachm of pancreatic glycerole converted one ounce of solid starch-paste into dextrin and sugar.

One drachm of pepsin and pancreatic glycerole together dissolved albumen and converted starch-paste.

One drachm of each together, again, after solution of albumen emulsified one ounce of lard and two ounces of water.

One drachm of each together dissolved equal parts of lean and fat beef, one ounce, in four hours.

The appearance of the latter fluid resembled a weak milk or chyle, possessed an acidulous reaction, and contained lactic acid.

These results are confirmed by the observations of Dufresne, who found that pancreatin could remain inert in pure gastric juice for two hours, and, after commixture with the mixed gastric juice and neutralisation (with alkaline bile?), would convert seven times its weight of starch into sugar. Pancreatin, therefore, does not undergo any alteration in chyme, and recovers all its activity in the duodenum; and one *gramme* of this substance can digest simultaneously thirty-eight *grammes* of albumen, seventy-five *grammes* of starch, and eleven *grammes* of lard.

From the similarity in mode of action between the salivary and pancreatic glands, it is not to be supposed that they are antagonistic. Some observers have even gone so far as to assert that the saliva recovers its activity after passing the pylorus; but whether such is the case we do not know, our experiments having been directed to show the compatibility of pepsin with the salivary and pancreatic ferments.

We have in part anticipated some of our results as to pancreatic digestion. We are ready to admit that the pancreatic secretion is sometimes either neutral or very feebly alkaline; but we have *most frequently found it acid*, even before the pancreas had entirely lost its natural heat. This acidity of the juice does not interfere with the emulsification of fat; but, on the other hand, it emulsifies fat more quickly and completely, and the resulting emulsion can be more easily (and for a longer period) preserved.

As with the other processes of digestion, this one has also its limits; and when the pancreatic ferment has done its peptonising work, or has become widely diffused through viscid aliment, it refuses to digest more, and nature wisely passes it forwards into the intestinal tract. We have found it one of the most imperative necessities in the manufacture of a pancreatic emulsion that shall keep good for any length of time, to obtain the maximum digestive power of the pancreatic juice on the fat employed; for if an excess of juice (with powers unexpended on fat-molecules) were allowed to remain over, intermingled with the emulsified fat, the emulsion would rapidly deteriorate, and become offensive. We are, therefore, not surprised that a pancreatic emulsion refuses to convert starch into dextrin and sugar, for the emulsion is really a peptone or food; and just as we do not expect a pepsin, after it has exhausted itself by dissolving albumen, to resume its powers and dissolve another hard-boiled egg, so we do not think it fair to expect fatty peptone (only suitable as it is fully ready for assimilation) to be transformed into a digestive agent, and perform the work of amylolytic digestion.

Podolinsky, following up the researches of Heidenhain, found that the albumen-dissolving ferment of the pancreas does not exist in the gland, but appears first in the secretion. It can, however, be rapidly formed in the gland after death, and this conversion takes place—firstly, on exposing the organ to atmospheric influences, secondly, on diluting the glycerine extract of the fresh gland with water, and thirdly, on treating the gland with acids. The results of the experiments show that the active ferment is formed from zymogen by oxidation (Pflüger's *Archiv*, 1876). These results were confirmed almost immediately by Kühne's remarkable research on trypsin (*Verhandlungen der Naturhistorische Verein zu Heidelberg*); and the results of our extended operations on large quantities of fresh pancreas have proved to us most conclusively that, concurrently with the formation of the active pancreatic ferments, sarcolactic acid is also formed; and the natural deduction from this circumstance is, that the acidulous reaction, at least of this substance, is favourable, if not really essential, to true pancreatic digestion.

The peptones obtained from albumen or fibrin by means of pepsin or pancreatin have acid reactions, and contain, amongst other matters, leucin, tyrosin, and glutamic acid both free and associated with hydrochloric acid.

A series of experiments on the intestinal juice is in progress, and

* The thought suggests itself: Do not the quality and quantity of ferment secreted by, and obtainable from, fresh stomachs and glands vary greatly? May not

a great deal depend upon the length of fasting to which the animal has been subjected before death? Is this point at all attended to by the suppliers of the materials?—F. A. L.

promises interesting results. At the present time, our experiments seem to show that this juice will not emulsify fat. It acts more slowly upon albuminoids than the gastric juice, but very rapidly converts starch-paste. We hope to be able to separate the peculiar ferment more completely from the tissues, and then to study its reactions more thoroughly.

DISLOCATION OF THE WRIST.

By FRANCIS G. HAMILTON, M.R.C.S. Eng.,
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A CASE of dislocation of the wrist having been reported in the JOURNAL for March 13th, by Mr. R. Anderson, induces me to send the following notes of a similar case. At the time when it occurred, I was Senior House-Surgeon to the Royal Free Hospital, and the notes are reproduced from those then taken.

W. M., aged between 14 and 15, was brought to the Royal Free Hospital on August 12th, 1876, at 6 P.M. The boy, when playing on a railway viaduct, had been chased by an official of the line, and had fallen from the viaduct, a distance of sixteen feet, striking his left side, and doubling his left wrist under him. On examination, a distinct semicircular projection was visible on the extensor aspect of the left fore-arm, about an inch and a half above the normal position of the wrist-joint, the convexity pointing upwards. There was another similar projection on the flexor aspect, in the normal position of the wrist-joint, with the concavity downwards. The fingers were semiflexed and flaccid. Both styloid processes could be plainly felt, immovable, and in the right position, as proved by comparing the two fore-arms, and by following down the subcutaneous lines of the ulna and radius. The convexity of the carpal articular surface and the concavity of the radio-ulnar could be distinctly felt, the hand itself being slightly drawn to the ulnar side. The diagnosis of dislocation of the carpus on to the extensor surface of the forearm was indubitable.

Reduction was effected without any difficulty by simple extension; it was sudden, and the deformity was at once removed, and did not return in any degree when extension was removed, and the movements of the joint could be then all elicited with but slight pain. The hand and forearm were placed on a straight splint, reaching from the elbow to the metacarpo-phalangeal joints on the flexor surface.

Twelve days later, the splint was removed, and the joint was found rather abnormally lax, and slightly swollen over the flexor tendons. The patient could supinate and pronate the forearm freely, and could also lift a light chair with the affected hand without pain. He said that, since the reduction, he had experienced no pain, and he had slept well.

A similar case of dislocation of the wrist backwards was reported by Mr. Alder Smith in the JOURNAL for June 24th, 1876.

Mr. Holmes states, in his *Surgery*, that "dislocation of the wrist occurs almost always backwards", and that "dislocation in the other direction (*i.e.*, with the hand in front of the forearm) hardly ever occurs as a traumatic lesion". There is, however, a good illustration of a traumatic forward dislocation in Erichsen's *Surgery*, taken from a case of a case of Mr. Cadge of Norwich.

Dr. Frank H. Hamilton, in his classical work on *Fractures and Dislocations*, relates a case of backward dislocation which he himself saw in an old man aged 75. He also quotes another case, that of a lad about thirteen years old, who dislocated both wrists by being thrown from a horse, one wrist being dislocated backwards, and the other forwards.

The accident certainly but very seldom comes under the observation of surgeons; but Hamilton states, on the authority of Professor F. L. Parker of South Carolina, that there are thirty-three cases of wrist-dislocation on record, and of this number only ten were forwards, and the remaining twenty-three backwards; but he declares that only five of the backward, and two of the forward, dislocations are free from all objection. The cases reported by Mr. Alder Smith, Mr. R. Anderson, and myself agree in the following particulars. The patients were all aged about fifteen years, the diagnosis and the reductions were very easy, and the dislocations were all the result of great violence.

LOCH KATRINE WATER.—The monthly report of the quality of Loch Katrine water, prepared by Professor E. J. Mills of Anderson's College, has been issued. The results are returned in parts per 100,000: Total solid impurity, 2.90; organic carbon, 0.158; organic nitrogen, 0.017; ammonia, 0.000; nitric hydrogen, 0.008; total combined nitrogen, 0.025; chlorine, 0.63; hardness, 1.15. The water when sampled was light brown in colour, and contained little suspended matter.

CLINICAL MEMORANDA.

NOTES ON THREE CASES OF PARACENTESIS THORACIS.

THE first case I ever saw occurred when I was assistant-surgeon to the Newcastle Dispensary some years ago. A man, aged 48, had been suffering from chronic pleurisy of the right side, gradually followed by effusion of fluid therein. At a consultation of two physicians and myself, an operation was deemed necessary, as the only means left of affording the poor man any relief or chance of life. Accordingly, paracentesis thoracis was performed by introducing a fine trocar and cannula into the chest, between the fifth and sixth ribs, at the insertion of the serratus magnus muscle, and about one pint of straw-coloured fluid was carefully drawn off; that quantity being thought quite sufficient to remove at one time. After the lapse of a few days, the man died. At the *post mortem* examination, more than a gallon of fluid was found in the chest. The lung was compressed into a very small space against the vertebral column.

The second case happened in a strong and active woman aged 33, a person engaged behind the counter in a cocoa-room. She was attacked by acute pleurisy of the right side, followed by effusion of serum. Blisters, iodine (internally and externally), diuretics, and all sorts of drugs were used, but were of no avail. At the end of eight weeks, she was too ill to be moved out of bed. Assisted by my friend Mr. Angus, I removed, by means of Potain's aspirator, eighty ounces of clear straw-coloured fluid; this was all we could get through the needle. This patient recovered without a single bad symptom, except a rather protracted convalescence.

The third case was in a young and strong railway porter, aged 27, suffering from pleurisy, followed by effusion. I assisted my friend Dr. W. T. Wilson, of this town, to perform the operation by means of the aspirator, and we removed at one time one hundred and forty ounces of serum. The chest was not completely emptied; but a severe fit of coughing seizing the patient, we removed the needle for fear of injuring the lung tissue. This patient also completely recovered.

REMARKS.—Niemeyer recommends an early interference in such cases, whilst Tanner speaks very doubtfully of the operation at all. In the two last cases, much valuable time was lost by trying various medicaments, which were of no avail; and the result was to reduce the patients' strength, and render the convalescence more protracted. There is now little doubt that, as soon as the chest is detected to be full of fluid, an early paracentesis by means of the aspirator gives the patient the best and quickest chance of recovery. If carefully done, there is little danger attached to the operation. Preserving the patient's strength, shortening the period of confinement in bed, and preventing the permanent collapse of the lung, are the results which are to be obtained by an early and complete aspiration of the pleural cavity.

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SURGICAL MEMORANDA.

REMOVAL OF A FOREIGN BODY FROM THE ORBITAL CAVITY.

T. H. F., A SEAMAN, aged 28, came to me a few days ago with the following history. Three weeks since, when with his ship off Greenock, he went ashore, being somewhat the worse for drink at the time, to look for a shipmate. As he was gazing into the window of a factory, a workman thrust something into his eye. At first, he thought it had been merely his finger. Feeling pain in the eye, he applied to a medical man, who ordered him poultices and a wash of nitrate of silver. At times he felt a dull aching, which gradually became worse. A week later, on looking in the glass, he could see something in the eye, and pulled out a piece of pipe-stem broken in halves down the centre, which, from his description, would appear to be rather over one-third of an inch in length. He could see with the eye; but, still feeling pain, he was anxious to have something further done, and applied for advice at a hospital, but was told there was nothing the matter with the eye.

On examination, there was seen to be much chemosis, the conjunctiva—chiefly over the lower part of the globe—being swollen into thick projecting folds; and, on depressing the lower lid, a prominence of the membrane was observed, situated near the inner canthus, but covered by the lid when *in situ*. A hard body could be felt under this conjunctival swelling. The eye itself was forced somewhat backwards and upwards, but, as far as could be seen, was itself uninjured. A speculum was introduced to keep the lids well apart; and, on snipping through