

salts, and the ammonia with which they are combined appears to be the representative of so much nitrogenous waste, which, instead of being converted into urea in the liver, has combined with the acid, and been excreted as ammonia. This indicates that acids act upon the liver, although, as I have just said, we do not yet understand their precise mode of action. Clinically, however, we find that nitrohydrochloric acid is exceedingly useful in persons who are troubled by eructations of sulphuretted hydrogen; and it not only removes the taste of rotten eggs which is so disagreeable, but lessens the depression of spirits which frequently accompanies this form of dyspepsia. It is also useful in oxaluria and depression of spirits, even when no disagreeable eructations are present. Ammonia also has a powerful action on the liver, and chloride of ammonium has been strongly recommended in hepatic disease. It is only within the last year or so that we have learned anything definite about the action of ammonia on the liver; but it has now been shown that ammoniacal salts increase the formation of glycogen. Our knowledge of alteratives, at present, consists only of a few isolated facts, but, before long, we may hope to have a more perfect understanding of their mode of action, and, consequently, be able to apply them more successfully in disease.

Another class of remedies which are also useful in indigestion is diuretics. Although these have no very direct action on the intestinal canal itself, they not only alter tissue-change in the body, but affect the nervous system, through which the digestive processes are co-ordinated. In some cases of gouty dyspepsia, large quantities of hot water are exceedingly useful, both by relieving the dyspepsia itself and by getting rid of any urinary irritation. The diuretic action may be increased by the addition of alkaline salts; and effervescent citrate or tartrate of potash is useful both as a diuretic and as a local sedative to the stomach in neurotic or gouty gastralgia.

By the frequent use of water as a diluent, either alone or with salines, the consequences of indigestion in regard to the lungs, heart, and head, may be often averted or remedied. Asthma occurring in gouty subjects is, perhaps, best treated by a mixture of bromide and iodide of potassium; and the addition of a little arsenic is said to increase its effect. In cases of intermittent pulse, bromide of potassium is frequently very useful, though one of the best remedies for it is one which, I believe, was prescribed by the late Dr. Warburton Begbie, consisting of two grains of powdered rhubarb, ten of sub-nitrate of bismuth, one and a half of nux vomica, and three of compound cinnamon-powder. This should be taken before meals; and, if there be much acidity, ten grains of bicarbonate of soda, or of magnesia, may be added to it. It may be given either in water, or, what is perhaps more pleasant, wrapped in a wafer and swallowed along with a little water. Giddiness, as I have said, frequently takes the place of headache in persons of middle age suffering from biliousness, and both headache and giddiness are frequently connected with disorders of vision. The most common causes of headache, indeed, are decayed teeth and inequalities of vision. Where the teeth are decayed, rinsing the mouth out with a lotion of bicarbonate of soda, or applying a little caucine to the exposed pulp, will relieve the headache, and especially if combined with the use of a saline purgative. In many so-called bilious headaches, the eyes, as I have mentioned, are very tense, and tender on pressure. Such headaches are not unfrequently relieved by the use of small doses of salicylate of soda, half a grain in an ounce of water being taken every quarter of an hour or half an hour. How this acts, it is impossible at present to say; for, though it possibly acts on the eyes themselves, its utility may also be due to its action upon the hepatic secretion. Inequality of the visual power in the two eyes is an exceedingly common cause of headache; and I have sometimes found that a sick headache may be arrested, even after the well known zigzags have become visible, by putting on a pair of spectacles which will equalise the eyes; or, perhaps even better, it will overcompensate the weak eye, and throw the strain upon the other.

In speaking of the disorders of digestion, I have left to the last one of the most important methods, and one which sometimes gives results little short of miraculous. This method was first introduced to the profession in America and England by Dr. Weir Mitchell, in his book on *Fat and Blood, and How to Make Them*, but in this country it obtained little notice, until it was taken up by Dr. William Playfair. It consists essentially in passive exercises and abundant feeding. We all know how active exercise increases the appetite. Tissue-change goes on more rapidly in the organs, waste is more abundantly excreted, and more food is eagerly sought for. But there are many feeble flabby persons who cannot take exercise, or if they can, will not. Moreover, there are others who are quite willing to exercise the voluntary muscles of the limbs, but cannot exercise the

involuntary muscles of their internal organs. Now, treatment by massage helps both of these. It increases the nutrition, both of the voluntary muscles and of the internal organs; and under its use patients, apparently hopelessly incurable, completely recover. Dr. Playfair has had, moreover, success with cases of hysterical women; but I have been most struck with the success of the treatment in the case of a man in whom all medical treatment had proved useless. This patient, whom I first saw about two years and a half ago, in consultation with Dr. Image, of Bury St. Edmunds, was a very tall powerfully built man, who had been accustomed to outdoor life, and much active exercise. He had at one time suffered from asthma, but this had left him, and he became liable to attacks of pain and vomiting. I was inclined to look upon the case as one of neurotic dyspepsia, but other physicians, who had been consulted, both in this country and on the continent, regarded it as tubercular peritonitis. For two years he continued to become more and more emaciated, until at length he was reduced to the appearance of a living skeleton. Only once in my life do I remember seeing a man so thin, and that was a person who was exhibited in a show. Dr. Playfair was at first doubtful about undertaking the case; but as Dr. Image and I were anxious that he should do so, he kindly agreed, and in the course of eight weeks our patient was a different man. Under the use of massage and forced feeding, his muscles enlarged, until now he might perfectly well join a Highland regiment, and wear a kilt, without being ashamed. His muscles, which had almost entirely disappeared, have not only become of a normal size, but they are as hard as pieces of wood; and from being a simple skeleton, he is now a well developed man.

From the hasty sketch that I have given of the disorders of digestion, their consequences and treatment, in these lectures, it will, I think, appear that, although our knowledge of the subject is still very imperfect, a large number of observations have been accumulated, which we may hope will, before long, enable us to understand the pathology more fully, and treat these disorders more perfectly.

## AN ADDRESS ON MEDICAL REFORM.

*Delivered at the Annual Meeting of the Dublin Branch.*

By LOMBE ATTHILL, M.D., F.K.Q.C.P.,

Ex-Master of the Rotunda Hospital; President of the Branch.

DR. ATTHILL, having thanked the members of the Branch for the honour done him in electing him President for the ensuing year, and having referred to the flourishing condition of the Association in Ireland, and specially of the Dublin Branch, proceeded to say:

Just two years ago, this hall was the scene of an animated discussion on the subject of medical reform; and, after a debate which extended over three days, the Branch, by a large majority, decided in favour of an amendment moved by me, to the effect "that the policy of the parent Association in reference to medical reform should, in principle, be supported by this Branch." I regret to say that as yet nothing definite has in this matter been accomplished; the difficult question of medical reform remains as unsettled as ever.

During the past year, a Bill was wellnigh carried through both Houses of Parliament, which, reformer as I am, I must still declare to have been ill digested, unfair to most, if not all, of the medical corporations in the United Kingdom, and defective in some points of vital importance; and I most heartily rejoice that that Bill did not pass into law. If we are to have legislation for the medical profession—and it is much needed—you will, I think, agree with me, that it should be based on two great principles; namely, first of all, to secure the maximum amount of good to the general public, and next, to inflict the minimum amount of injury on the medical corporations, which have, during a long lapse of time, done much good work, and which still, with only one or two exceptions, fulfil their duties honourably, efficiently, and for the public good.

I will ask you to consider what the object to be gained by any medical legislation should be. Is it not primarily that notoriously incompetent men be excluded from the profession? Not that, by their exclusion, we, who have obtained admission, may be bettered, but that the public, and especially the poor, should be protected from the injuries which are, under the present system, inflicted on them;

for, under the present system, the law declares the holders of all registrable qualifications to be on a par, equally eligible for public appointments, and therefore equally entitled to public confidence; but it is notorious that at least one or two of the licensing bodies are so lax in their requirements, that men rejected as being dangerously ignorant by one set of examiners pass the examination at another place, a few days subsequently, and return legally qualified practitioners. Many of these dangerously ignorant men obtain public appointments by the force of interest, and to them the lives of thousands of the poor are entrusted. A monstrous injustice is thus inflicted on men of superior fitness, and a far more monstrous wrong on the public, and specially on the poor, who have no means of securing better advice. The first step, then, in any medical legislation should, without doubt, be the rendering the examinations of every one of the licensing bodies as efficient, and as nearly equally so, as possible. By equal, I mean that the curriculum of education should be the same, the mode and standard of examination identical, and the fee, if possible, equal in amount in all cases.

The Bill of 1834 would not have effected this. The regulations for the examinations to be held in each of the divisions of the United Kingdom were to be drawn up by the local boards elected by the licensing bodies in England, Scotland, and Ireland respectively; and there was not alone no guarantee for equality of curriculum and examination, but an almost absolute certainty that they would vary in each case. The old evils would therefore have remained, though doubtless in a modified form.

Then, while thus failing in the fundamental principle of protecting the public, by preventing inefficient and ignorant men from being placed on the Register, and possibly being elected to positions of responsibility, the Bill seemed to me to inflict the maximum amount of injury on the licensing bodies. It is obvious that the prestige of the medical corporations, and in some degree of the universities, would be lessened by the establishment of any boards, such as those proposed by the Bill—that is an unavoidable effect of any such proposal; but the injury would have been lessened, had the surplus funds which might have remained after paying the expenses of examinations, etc., been handed over to the medical corporations, in proportion to the average number of candidates admitted by each, during, say, the previous five years; while, again, the just claims of the medical corporations were sacrificed to the demands of the universities for a preponderating influence on the divisional boards, to which, certainly, they are not entitled.

With these glaring defects in the Bill, it is not surprising that the Government encountered such opposition as to compel them to abandon it, and thus the hope of an equitable settlement of the question was indefinitely postponed, and most sincerely do I hope that no such Bill will ever become law.

I could easily criticise, at length, the details of this Bill, and of those which during the last few years have been introduced into Parliament, but it would be a tedious and uninteresting task. Let me, however, express my regret that the one introduced by Lord Ripon in 1870 was not accepted by the medical corporations; for I am convinced that, had they co-operated with him, and, while accepting the principle embodied in it had confined their efforts to amending some of its details, an Act would have been passed which, while giving sufficient protection to the public, would have been infinitely more favourable to the corporations than any Bill which is likely to be hereafter introduced by Government.

The main feature of that Bill was the establishing a compulsory conjoint examination, to be conducted by the licensing bodies in each division of the kingdom, the rights of the various universities and medical corporations being interfered with in the least possible way. I believe I am safe in saying that last year each and all of the licensing bodies, at least in this country, would gladly have accepted such a Bill, could they have had it substituted for the one we all joined in opposing.

But we should learn a lesson from the past. Hitherto, as each Bill has been withdrawn, the medical corporations relapsed into a state of apathy, not to arouse themselves till another Bill was introduced which threatened to injure them, or, as last year's one did, to extinguish them. It is quite useless to suppose that because that Bill, like its predecessors, failed to become law, we are safe from legislative interference in the future. A reprieve has been granted; but of this be sure, that the defects of the existing system, under which twenty licensing bodies compete against each other, are too glaring to be left for long alone. We, if we be wise, will take advantage of the lull, and try if we cannot meet the next attempt at medical legislation more united than before, or, what would be still better, originate a Bill ourselves. Is it impossible that the leading medical corporations

of the kingdom can ever be so far brought into union, as to be able to formulate certain points which, while removing the grave defects which at present exist, would save these old and valuable corporations from destruction? I cannot conceive a greater injury, alike to the public and the profession, than the destruction of the influence which the Colleges of Physicians and Surgeons exercise over their members and licentiates in each of the divisions of the kingdom. I am not now alluding to the educational aspect of the question, but to the good they do by binding their licentiates together, and by the fact that they form, as it were, courts of censors, which constantly exercise a salutary supervision over them. It will be a bad day, alike for the public and for the profession, when this influence ceases to be felt. This is one of the grounds on which I base my objection to the proposal that the universities should have a preponderating influence over the corporations on the divisional boards. The graduates in medicine of any of the universities form only a moiety, sometimes only a small moiety, of all their graduates: once these have obtained their degrees, they are free from all control or supervision on the part of their Alma Mater, which, however they may respect, they cannot fear, and to whose censure, were it ever expressed, they would be perfectly indifferent.

The cry for medical reform has come from the ranks of the profession and not from the public, who seem indifferent about the matter; but, in my opinion, the medical corporations are in fault in not taking the initiative, and guiding the movement instead of being driven by it. Unfortunately for the profession and for themselves, they are too conservative; and I greatly fear that, in the near future, unless they bestir themselves, and assume their proper positions as the guiding hands in the movement, they will be virtually extinguished, as nearly happened last year. There is yet time to avert such a catastrophe; let us hope that they will not, by their inflexibility and obstinacy, allow destruction to overtake our time-honoured institutions.

In this division of the United Kingdom, an obvious step of great importance should be promptly taken. A conjoint examination should be held by the Colleges of Physicians and Surgeons of Ireland. More than twenty years have elapsed since I first advocated this step in my place as a Fellow of the College of Physicians. Attempt after attempt has been made since then by the advocates of this reform in both colleges, as yet without success. For a long time, the College of Surgeons could not be brought to agree to a reasonable compromise; last year, however, the matter looked promising; and now, as it appears to me, but one or two points of very minor importance remain to be settled. I trust this may yet be effected, and that an arrangement, so obviously desirable, may be speedily carried out. I have already indirectly blamed the Council of the College of Surgeons for formerly obstructing the proposal for a conjoint examination. I fear I must add, as a matter of justice to them, that my own college, within whose walls we this day are assembled, is now hardly free from blame.

But though I earnestly advocate a conjoint examination, it must not be supposed that I consider it more than a step—doubtless a very important one—towards medical reform; that, in my mind, should include a compulsory conjoint examination for each of the three divisions of the kingdom, with the same curriculum of education for all students, and the presence of one or more assessors at each examination, who should, of course, take part in it; their presence would do much to keep up an equality of the standard of examination in each division of the kingdom, while their number would be too few to give a stereotyped form, the danger of which would be lessened still further by arranging that the same men should not hold office for a lengthened period. Some such Bill, if supported by the medical corporations, would probably pass; but what hope have we of the twenty licensing bodies joining to promote such a scheme when we see that two colleges in the same city, in no way in rivalry with each other, cannot agree on the terms for holding a conjoint examination? Indeed, one is almost forced to think that the old Latin proverb, "Quos Deus vult perdere prius dementat," is applicable to our medical corporations.

If the proposal, formulated in Lord Ripon's Bill, for a conjoint examination, be rejected in consequence of the impossibility of getting the twenty licensing bodies to agree, there is an alternative plan, one which, in my opinion, has many advantages, and which they might, and certainly ought, to join in promoting. I allude to the system which exists in Germany, where a person, desiring to practise medicine, must pass an examination conducted by the Government, in addition to the university examination. There, the student first passes his university examination, and obtains his degree, but he is ineligible for any public appointment; indeed, I believe, is not allowed to prac-

tise till he passes the Government examination also. This system is, as you are well aware, already in force in this country, so far as the army and navy medical services are concerned; and, I would ask you, why should it stop there? The State must have satisfied itself that the degrees and diplomas in medicine and surgery, granted by the various universities and colleges, are not always satisfactory proofs that the holders of them are competent men; otherwise, it would never have gone to the trouble and expense of holding special examinations to test the efficiency of candidates who wished to enter into the medical departments of the army and navy. Why should not the State take equal care of, and show equal anxiety about, the health of the civil population? It is impossible for the Government to escape from the horns of the dilemma on which they are fixed, for they must either admit that the examinations to which candidates for the army and navy medical services must submit, are vexatious and unnecessary, or that while they take care to exclude incompetent and ignorant men from having the charge of soldiers and sailors, they are indifferent to the injury to which the sick poor in our hospitals, workhouses, poor-law unions, and gaols are being constantly exposed, from the possibly frequent, and certainly occasional, election of incompetent men.

The German system has much to recommend it. It would leave the universities and medical corporations as free as ever. Indeed, I believe it would tend to improve their examinations, and to raise the standard of education, for the disgrace which would attach to having their graduates or licentiates rejected by the Government Board would render them careful not to pass incompetent men.

The only objections which can validly be urged against this system are: that it would entail additional expense on the candidate, and in some degree protract his term of study.

But neither of these objections is of real weight; the cost of the State examination should not exceed a sum sufficient to cover its actual expense; the certificate, if given at all, should be issued free of charge; but the mere placing the name of the successful candidate on the *Medical Register* would suffice all purposes, and, indeed, would, I think, be the better course. As to the objection that the period of study would be lengthened, this could only be to the extent of the interval which must necessarily elapse between the date of his obtaining his degree or diploma and that at which he could present himself before the Government Board. This need only be a brief one; but, even were it longer, the protracting of the period of study would, in my opinion, be a positive gain, in the great majority of cases, to the individual; for the period allotted to study is far too short. I ask any one of you, is it possible that any young man can attain in about three years, as he is at present supposed to do, a competent knowledge of medicine, surgery, midwifery, and materia medica, not to mention anatomy, chemistry, botany, physiology, pathology, etc., such as to render him a fit person to whom the lives of his fellow men may safely be entrusted? And would not an enforced lengthening of the period of study be a positive advantage to him, no less than to that of the sick poor who may come under his care?

The question is frequently asked by those of the public who think at all about medical reform, How does it happen that the medical corporations have not taken any steps to lessen the abuses which they admit exist under the present system? There can be but one answer; the medical corporations fear that legislation will interfere with their privileges, and therefore will not make any move. The cry for medical reform comes from the profession at large, who are naturally more anxious for direct representation on the Medical Council, and for the granting increased powers to it, than for the welfare of the corporations. This state of things leads me back to the point I have already endeavoured to impress on you; namely, that if the medical corporations are to be saved from virtual extinction, they must come forward themselves, and take the initiative in formulating a Bill and guide the movement. Medical reform may be delayed for a time, but come sooner or later it must. We are about to enter on a new political era; a Parliament far more democratic than any previous one will soon be elected. Democracies are always arbitrary; they have but scant respect for old and time-honoured institutions; and I fear, in a very few years, the medical corporations, if they be not wise, will virtually cease to exist.

Three years ago, my friend Dr. G. H. Kidd, who then filled the chair which I now occupy, delivered a very able address on the subject of medical reform, the tendency of which was to deprecate any change in the existing state of things; and, towards the conclusion of it, he argued in favour of an unlimited and unfettered competition between licensing bodies; and instanced, as an example of the good to be effected under such a system, the condition of the medical profession in America, where degrees or licences are obtainable, with very little difficulty, from an almost unlimited number of bodies. At the

time, I was somewhat surprised at the state of the profession in America being held up as an example to be imitated; for, though well aware that men of the greatest mental culture and of the highest attainments adorn its ranks, I have over and over again heard well informed Americans lament the deplorably low standard of education which exists among a very large number of the practitioners throughout the States. But mark what is going on there now. Why, medical reform is not alone demanded, but it is becoming a burning question, the tendency of opinion being in favour of the adoption of the system in force in Germany, the very alternative to which I have just now been alluding; indeed, a Bill has been prepared, and has, I believe, ere this been introduced into the Legislature of Pennsylvania, which, if passed, will establish the German system in that State.

The fact is, that the system at present in force here is a relic of the past, when the difficulties of travelling were so great that numerous centres, not alone for medical education, but also for the purposes of examination, were absolutely necessary; but now that the telegraph and railroad have all but annihilated time and space, some modification of it becomes absolutely necessary to prevent the incompetent student, when rejected at one place, from passing on to another where the examination is easier, and thus obtaining a qualification, which, though manifestly inferior, is by the law placed on a par with that obtained by the carefully trained and highly educated man.

To one other matter connected with medical reform I shall briefly refer. I allude to the constitution and functions of the Medical Council. That there should be representatives of the Crown and of the corporations on the Council is just and obvious, but that there should be none other I consider most unjust; and, therefore, I believe that the claim for the direct representation of the profession on the Council must be admitted, and that it must form a part of any scheme for medical reform which may be submitted to Parliament. Indeed, I believe that had this been done, and had powers been given to the Medical Council to enforce its "recommendations" as to curriculum of education and examination, much good would have been effected; but, as matters stand at present, the functions of the Council are rendered abortive, and, indeed, save for the issuing of the *British Pharmacopœia*, it has effected well nigh nothing; for I look upon the registration of medical practitioners as being of very doubtful advantage, seeing that it has virtually done little more than place the highest medical degree or licence on a par with the lowest.

An example of the inutility of the Medical Council, as at present constituted, is afforded by the fact that their "Recommendations" are practically disregarded by the licensing bodies. Thus, in their existing "Recommendations," they require "that the age of twenty-one years shall be the earliest age at which a candidate shall obtain a licence to practise, and the age shall in all cases be duly certified." One would suppose that this recommendation, so obviously right and proper, would have met with a ready acceptance; but, in point of fact, it is only enforced by a few of the licensing bodies. It was for some time enforced by the King and Queen's College of Physicians; but they were obliged to cease doing so, as it was proved that candidates to whom permission to be examined was refused by the College on this ground, were permitted to present themselves without question elsewhere. A stronger proof of the necessity of putting an end to the competition which exists among the licensing bodies than this, can hardly be brought forward, while it illustrates the utter inutility of the Medical Council to effect good, or to initiate any improvement in medical education.

I have dwelt at some length on the subject of medical reform, and of what should be the tendency of medical legislation, because I am satisfied that, though, from the pressure of great political events, there is at present a lull, the subject will ere long come again to the front; and I would fain hope that, when the question again arises, wise counsels and more unity of purpose may be found among our medical corporations; and the more the subject is calmly discussed, the greater the hope that such may be the case.

But, though wise legislation is to be desired, it by itself can do but little to elevate the profession. The most it can effect is to raise the general standard of education, and to exclude from the *Register* half-educated and ignorant men; but no Act of Parliament, nor compulsory standard of education, can give lustre to our profession, nor will it ever add one name to the long roll of illustrious men who have ennobled the science of medicine. To effect that, careful training during the period allotted to study, and subsequent self-culture, are needed. The want of careful training is the great defect of the present day. This was well put by Professor Hamilton, in his address delivered in this hall last year. "Under the apprentice-system," he says, "we had training with very little teaching; under the lecture-system, we had much teaching, with little or no training." All this,

I heartily endorse. The worst feature of the present system is, that it produces men, so imperfectly educated in a vast number of subjects, and at so high a pressure, that the majority seem incapable of pursuing a steady system of self-culture, after they have obtained their degrees or diplomas; and, without this, hope there is none of their becoming efficient practitioners. Without self-culture, and the thoughtful investigation of the clinical facts which come under the observation of the young physician, advance in the true knowledge of his profession is hopeless; and medical reform, be it ever so carefully planned, will, when obtained, be but a barren victory.

### ON THE SOURCES AND THE EXCRETION OF CARBONIC ACID IN THE ECONOMY.

Read at the Section of Anatomy and Physiology at the Annual Meeting of the British Medical Association, in Belfast.

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NOT many years ago, it was a general belief among physiologists that the generation of carbonic acid occurred chiefly in the lungs, owing to the direct oxidation of part of the carbon contained in the blood; and, accordingly, the lungs were regarded as the chief, if not the sole, centre for the production of the animal heat. Respiration, in fact, was described as a combustion-process occurring in the lungs, a process with which the rest of the body was not in any way directly concerned, except, perhaps, in supplying to the blood some of its effete carbonaceous material to be burnt up in the course of respiratory oxidation. Chemical and physical investigations, however, have caused this view to be discarded. It has been found, for example, that the venous blood going to the lungs contains a large quantity of carbonic acid, and is absolutely warmer than the blood leaving the lungs, as has been proved in the case of the blood in the right and left sides of the heart respectively; the blood, moreover, which leaves the liver and other glands when in a state of activity, has been shown not only to possess a higher temperature, but also to be richer in carbonic acid than the blood entering these organs.

In short, the temperature of the blood, according to Claude Bernard's and Korner's observations, is highest in the liver, that of the blood in the hepatic vein being, on an average, 0.7° Cent. to 0.9° Cent. higher than that in the portal vein; and the next highest temperatures have been noted in the blood flowing respectively from the brain, the salivary glands, and the muscles, particularly when these parts are in an active condition. It is true that Heidenhain (*Physiologie*, von Dr. L. Hermann, Band v, theil 1, s. 274) has arrived at results differing somewhat from those of Bernard, for he finds that the blood of the liver has a temperature not exceeding that of the blood of the spleen, or of other abdominal viscera; yet there is no doubt about the temperature of the blood from the liver being high as compared with that of the blood from the lungs, muscles, etc.

What, no doubt, has greatly tended to direct so much attention to the importance of the tissues in respiration, has been the result of the investigations of the properties of protoplasm in the simplest forms of animal life. The primitive amœba has been shown to absorb oxygen, and give out carbonic acid; and the natural inference is, that all tissues containing protoplasm act after a somewhat similar fashion. The closest attention has, therefore, been directed of late to the minute chemical changes occurring at the tissues themselves; and, accordingly, we find Liebig, Matteucci, Valentin, and Hermann pursuing their investigations directly upon living muscles that had been removed from the animal body, and enclosed in tubes inverted over mercury; Ludwig and Schmidt analysing the blood before and after it had passed through the living and active muscles of the animal so as to detect its alterations; and Hammarsten investigating the gases of the lymph with the same object in view.

In the case of secreting glands, likewise, observations have been made upon their recent secretions, as well as upon the changes effected in the blood during its passage through them. The saliva, bile, urine, and the like normal fluids result directly from the action of the histological elements of the secreting tissues, and are, therefore, more immediately influenced thereby than can be the lymph or blood flowing through the same tissues; but by investigations on the secretions, as well as on the lymph and blood of the tissues, we obtain not only the quantity of the gases in the tissues, but likewise their tensions.

The importance, indeed, of these investigations into the gases of the secretions is very great; for, by their means, much light is thrown

upon the seats of the oxidation processes in the economy. By a very simple experiment an example of this oxidation, with the concurrent disappearance of oxygen, and the possible formation of carbonic acid, may be satisfactorily demonstrated. If we examine with a spectro-scope, in a dark room, the red coloured light that passes between two of the fingers held together in front of a good lamp, the spectrum of oxyhæmoglobin will show itself. If, however, we apply a ligature to the fingers close to the palm, in order to prevent the entrance of fresh arterial blood, and examine as before, instead of the two bands of oxyhæmoglobin, there will be seen, in the course of a few minutes, only the single band of reduced hæmoglobin.

I. SOURCES OF CARBONIC ACID.—With these preliminary remarks, we may now discuss the possible sources of carbonic acid in the organism. Some of the better known of these we shall merely glance at in passing; others, however, which are less familiar, as well as of a more hypothetical character, we shall consider at greater length.

1. The chief source of carbonic acid in the organism, beyond all question, is *simple oxidation*, in which a more or less direct combination occurs between the absorbed oxygen and the carbon of the food and tissues. The fatty matter of the food which is not stored up or directly consumed by the tissues requiring it, is ultimately transformed into carbonic acid and water, just as the like destination awaits the stored up fat of adipose tissue when it comes to be oxidised in the system. The carbo-hydrates (starches and sugars) taken as food, give origin likewise, when oxidised, to carbonic acid and water, although it is difficult to say whether these terminal products are direct or indirect. Indeed, there may be intermediate products, as in the case of the sugars-aceton sometimes appearing in the urine in cases of diabetes and continued fever; or glycosates may first be formed in the blood, and afterwards undergo complete oxidation. That some of these carbo-hydrates are oxidised during muscular activity, thus effecting a large production of carbonic acid, is also a very reasonable hypothesis. The proteids, further, may give rise to carbonic acid as the result of oxidation; but it is more probable that a direct complete metamorphosis of this kind takes place only to a very slight extent. As to the two views held regarding the part played by the albumen of the food; whether a portion of it enters at once into the constitution of the tissues while the rest circulates for a time in the blood, forming there unstable and readily destructible combinations; or whether the whole of it becomes tissue-albumen before undergoing subsequent metabolism; it would seem, without entering on a critical discussion of their respective merits, that the latter is the more likely; for the great increase in the amount of urea excreted after food, a fact which appears to be in favour of the former hypothesis, may be readily explained on the very probable assumption that the leucin and tyrosin, formed at the expense of the albumen in the alimentary canal, are absorbed, and thus form the immediate source, together, possibly, with kreatin, of the bulk of the urea then discharged.

Mention may also be made of Bidder's and Schmidt's opinion, that the albumen of organs is regularly destroyed at the rate of about one per cent. of the total albumen of the body in the twenty-four hours; and that, in cases of death from starvation, when the glands and muscles have lost 50 per cent. of their albumen, some of it has been oxidised at the tissues, and some of it liquefied and transferred to other parts of the body, as the brain, etc., for their nourishment.

Reference may likewise, with advantage, be here made to the respiratory exchanges which occur when certain tissues, such as muscle, brain, and bone, are placed in an atmosphere of oxygen. We find, then, that 100 grammes of muscle absorb 50 c.c. of oxygen, and exhale 56 c.c. of carbonic acid; 100 grammes of brain absorb 45 c.c. of oxygen, and exhale 42 c.c. of carbonic acid; and 100 grammes of bone absorb 17 c.c. of oxygen, and exhale 8 c.c. of carbonic acid. The consumption of oxygen and the evolution of carbonic acid, it will thus be seen, are highest in the case of muscle.

As to the influences regulating this destruction of the organic materials of the body, Hoppe-Seyler states that they appear to be intimately connected with the activity of the histological elements of the organs; but whether they are of the nature of fermentation or otherwise, it would, for the present, be impossible to say.

2. The second source of carbonic acid in the system is the *decomposition of albumen by hydration or dehydration*. In a paper (*Journal of Anatomy and Physiology*, 1882, p. 298) "On the Gases of the Bile," which I published in 1882, I put forward an hypothesis as to the probable mode in which albumen might, by its decomposition at the liver, produce carbonic acid. I there assumed that a molecule of albumen might be supposed to combine with 50 molecules of water, and yield 8 molecules of urea, 7 of glycogen, 5 of carbonic acid, 7 of oxygen, and 1 of sulphuric acid. The oxygen would not, of course,