Sabine and others. Per square foot, they range from 1.0 for an open window, 0.5 for hair-felt one inch thick, to about 0.01 for plaster or glass. Each isolated member of an audience is equivalent in absorbing power to about $4\frac{1}{2}$ square feet of open window. In the majority of cases the audience constitutes the most absorbent feature in a hall, so that the reverberation period is markedly responsive to the size of the audience.

SOUND-PROOFING.

The question of sound-proofing is often of great practical importance. As regards the transmission of air-borne sounds, they are best arrested by having the walls sufficiently massive and rigid.

In the case of structure-borne sounds, it is necessary for effective insulation to interrupt the continuity of the structure. For example, a sound-proof room may well be constructed like an inner box which is floated on insulators on the structural floor, and everywhere insulated from the structural walls and ceiling.

To conclude what is only a partial survey of the subject, it is evident that neglect of the established principles may lead to defective acoustic conditions which may prove to be incurable after a building is erected. Preventive treatment is preferable to curative, and architects should be prepared to allow acoustic requirements some share in influencing their designs.

Lister and Physiology.¹

By Sir C. S. SHERRINGTON, O.M., G.B.E., F.R.S.

IT is indeed fitting that we should recall on this commemorative occasion the contributions made by Lister to physiology. His very earliest scientific papers were all physiological. He may be said to have entered by way of physiology his surgical researches which were to achieve so much. His first paper was entitled "The Contractile Tissue of the Iris." It was work done by the microscope, which he used for the study of function rather than of form alone. It appeared in 1853, in the first number of the first volume of the now well-known *Quarterly Journal of Microscopical Science*. Lister was then twenty-five years of age. That the microscope should be his instrument for his maiden voyage of discovery was but natural in the son of his father, Joseph Jackson Lister, that remarkable man, who leaving school early for the business he conducted so successfully, yet found time to cultivate optics to such purpose as to devise and give to the world the achromatic microscope. Lister's earliest paper, this on the iris, supplied the first full and correct description of the radiating muscle dilating the pupil of the eye. It thus made a lasting mark upon its subject.

Lister's second paper, of a few months later, dealt likewise with involuntary muscle; this time in the skin, where had been recently discovered the arrector muscles of the hairs; a discovery which Lister confirmed and in several respects extended.

We may be struck by the remoteness of these Lister's first themes both from surgery and indeed from actual practice—they are frankly academic. I think we have to picture him a young man to whom the thing that really mattered was to engage at once upon research, caring less what in particular the research might be; a young man so ardently curious about Nature, especially animate Nature, that he turned enthusiastically to the problem that came first to hand. These papers in the simplicity of their text seem to reflect the Quaker upbringing of Lister's home. There is already that sobriety of expression which, character-

istic of Lister all his life, made yet the more impressive his own self-restrained statements of his great results later on. No man in his career had more excuse for, more justification for, hyperbole of phrase than had Lister, and no man ever indulged in hyperbole less than did he. It is therefore of significance when the young author allows himself an expansive adjective, as when he writes "the grand discovery of plain muscle-cells," "the beautiful muscle of the iris." We feel these expressions to be, from him, not mere phrases. An abiding interest of these youthful papers is their revelation of attributes in Lister's, so to say, original nature. Any reader of them must be struck by his power of penetrative and faithful observation, his patient enthusiasm, a restless testing of authority by observed fact, and an unhesitating self-submission to wherever the truth might lead.

His third paper, still physiological and on the same theme, smooth muscle, followed some four years later. The cellular nature of that tissue had been denied; Lister returned to its further proof. He furnished it overwhelmingly. Forty years afterwards the then foremost authority on this tissue wrote of this paper of Lister's as being still not only abreast but in several respects ahead of other subsequent papers on its subject.

This work proved, however, to be Lister's farewell contribution to that particular theme. To him by then much had happened and was happening to compel his main interest elsewhere. His scientific enthusiasm had indeed definitely orientated itself towards a chosen quest in the great field of the unknown. His spirit of inquiry had found a direction of overpowering interest to it. In his own words, written to his father, he had fallen in love with surgery; and with that widely detailed and highly technical art and calling prospectively spread before him, the genius within him impelled him to study not so much this or that particular skill or difficulty, but the fundamental and all-pervading process of inflammation itself as being for him the one prime and central problem for investigation.

¹ Discourse delivered in the Robert Barnes Hall of the Royal Society of Medicine on April 6.

Thenceforward Lister's physiological researches were merely side offshoots from that pathological study engaging his main thought; thus his paper on the nervous control of arteries, distinguishing between the immediately local and the more distant effects of a stimulus, and especially of an irritant stimulus upon the blood-vessels. The local effect, he concluded, was independent of the nervous system, but with a surrounding zone of effect mediated by nerve, a finding closely suggestive of present-day views. Another paper was that on the pigment cells of the frog's skin, the cells on which the animal's well-known colour changes depend. Lister concluded the shift of pigment to be an active shift of the pigment grains within the cells themselves, and the way in which he consolidated and marshalled his evidence for that proof is a striking example of his thoroughness as an investigator. There is little doubt that from detailed study of these pigment cells Lister gained much of that vivid and intimate conception of cell-life struggling against irritant agents which informed and directed his surgical strategy afterwards.

Another of his physiological investigations concerned the inhibitory nature of certain visceral nerves. He wrote: "I have been led to make an experimental inquiry into this so-called inhibitory agency because it appears to me to have an intimate bearing upon the question how inflammation is developed through the medium of the nervous system at a distance from an irritated part." His main conclusion was that inhibition resulted from more energetic action of those same nerves which, when working mildly, are excitatory. Then, and still more closely related to his pathological inquiries, followed two 'papers on clotting of blood, confirmatory, as he himself remarks, of his conclusions arrived at about inflammation.

These papers and the year 1862 conclude practically the tale of Lister's researches devoted directly to physiology. Perhaps their main interest now is their revelation of their author in his earlier research career. Conspicuous in them is capacity for noting detail and the rarer power of sifting out from it the broader meanings. Another of their qualities is the conscientious pains to observe for himself phenomena which many would be content to take on trust from the excellent descriptions already given by others. Lister as an observer was satisfied by nothing less than seeing for himself, and his eye never staled. There was also genius. What but genius could have whispered to him to make a frontal attack upon what then seemed the inevitable and universal process of suppurative inflammation itself. Surely in his choice of that problem there was genius, the humility of genius to set itself to begin at the very beginning, the daring of genius, to set itself to rebuild from the foundation. A further quality is the scientific courage which knows no fear except to lose the truth. Moreover, even at this stage, though he might appear engaged on diverse problems, he was in fact centred upon one, of which

from his point of view the several were but several aspects.

Thus from these early papers we see that in reality, almost from the outset of his career, he had not only found but had also flung himself upon what was to be his life-work and his life's problem—a problem we may imperfectly subsume under the one broad term 'inflammation.' That was the study which he was to follow to a practical solution so magnificently, and in so doing display what these earlier papers had less opportunity for showing, the splendid power of establishing and systematically pursuing to its consequences a great generalisation. Hence from these earlier researches we can see spring that triumphant career of experimentation and observation, in the laboratory and the ward, which, with a really surprising speed of mastery, winged surgery for that which she is to-day, a far-flighted angel of healing the civilised world over.

These papers, valuable though they are, whose features we have been examining, do not exhaust—far from it—the gift made by Lister to physiology. In addition to and beyond them he enriched it with the contribution of enhanced means towards its own most cherished aims. He put into the hands of physiology for all time a superlative refinement of its method and made possible observations otherwise impossible. Sir Berkeley Moynihan has recently eloquently insisted on the importance of surgery as a means to discovery. In physiology, how could Pavloff have achieved his epoch-opening study of the digestive processes except by leaning upon Lister's surgical principles? Was it not by means of Lister's surgical principles that Ferrier initiated his study of localisation of cerebral function? How could the physiologists of Toronto less than four years ago have bestowed upon diabetic sufferers that merciful remedy insulin, had it not been for the legacy of operative principle and science bequeathed to them and to the whole world by Lister?

Lister's own words leave us in no doubt as to the source of rejoicing it was to him that among benefits accruing from his work was this of an enlarged scope and power for physiology and experimental medicine. He dwelt, both in public and in private, upon the need and importance of such experimentation for the progress of knowledge necessary to civilisation. He rejoiced that he had contributed to man's power in that way. Indeed, the experimentalist owes to Lister an instrument of research the beneficent future of which the boldest imagination may well halt to set limit to.

Of the gifts from Lister to humanity, one which the experimentalist is ever mindful of with especial gratitude is that, while helping man to mastery over disease alike for animal and man, he contributed to free that necessary experimentation from the infliction of pain. Man, sacrificing animal life as he does to satisfy the material needs of human kind, has the right to regard the intellectual and moral impulse driving him to mitigate and dominate disease, as justified in its resort to animal experimentation. He feels the more fully justified in doing so, and takes that step

with a clear conscience, because largely owing to Lister it can be taken without inflicting pain or suppuration.

Thus it is that through years to come, after, indeed, it may be the actual papers contributed to physiology by him have become matter chiefly for the historian and the antiquarian, Lister will still receive unfailingly his meed of commemoration from the physiologist and experimentalist, and in a manner which to himself would of all ritual and

offering have been the most congenial—namely, in their daily observance and trust of methods which he discovered and inculcated, and in the practice of them for the alleviation and prevention of disease. It is therefore with peculiar gratitude that physiology brings its tribute of admiration and veneration to the memory of one great in character as in achievement, and great even among the greatest of the benefactors of mankind, Joseph Lister.

Obituary.

PROF. IRA REMSEN.

SOON, few chemists will be left who have passed the age limit. Already, during this year, three of my oldest friends, all distinguished chemists, have ceased to be. Hermann Wickelhaus, who was my fellow-student at the Royal College of Chemistry, Oxford Street, under Frankland in 1866; Carl Graebe, who was *privat docent* and worked at a bench close to mine in the old laboratory in Leipzig in 1868; Ira Remsen, the American, who went to Germany when I did, whom I did not meet, however, until after the Johns Hopkins University was established. The first was concerned with Darmstaedter, in 1869, in introducing the soda-melt into the naphthol industry; the second stands for quinone and artificial alizarin; the third for saccharin: all very notable connexions.

The story of Ira Remsen's career has been well told by Dr. B. Harrow in "Eminent Chemists of our Time" (T. Fisher Unwin, 1921). He was of Dutch parentage. The elegance of his name was matched by the elegance of his person: he was always a man of gracious presence and owed much of his success and influence to his attractive personality. Five years' serious study in Germany made him both a real chemist and a modest man—with a sense of proportion not always to be found to-day in the chemist, particularly in his own country. His career before going abroad is of interest, as showing how miserable were the opportunities of students in his youth. His father made him take up medicine and apprenticed him to a medical man, who was teacher of chemistry in the Homeopathic Medical College, New York, whose teaching consisted in giving him a book and telling him to read. A casual experiment which he made (with generally destructive results) to ascertain what was meant by "Nitric Acid acts on Copper" seems to have infused him at this time with a special interest in chemistry.

However, Remsen graduated in 1867, at twenty-one, as doctor of medicine, submitting a thesis on the fatty degeneration of the liver—of which he was profoundly ignorant. He then insisted on going abroad to study the subject for which he had a liking. He first worked, during a year, in Munich with Volhard, then two years in Göttingen with Fittig, taking his Ph.D. in 1870. He spent the next two years at Tübingen as assistant to Fittig. He was, therefore, under the best of influences in Germany.

Remsen found no immediate opening on his return but eventually became professor of physics and chemistry at Williams College—without a laboratory. We are told, that when he preferred a mild request for one, the president's answer was: "You will please keep in mind that this is a college and not a technical school. The students who come here are not to be trained as chemists or geologists or physicists. They are to be taught the great fundamental truths of all sciences. The object aimed at is culture, not practical knowledge." With which immortal discourse the great man dismissed the subject, says Remsen's biographer, as though the view expressed were a mistaken one. I am inclined to think that Remsen, to-day, would perhaps be inclined himself to give a similar answer, though without advocating 'no laboratory.' An I be not mistaken, the advice thus given by the president of Williams fifty years ago is much needed throughout the university world to-day, especially in the U.S.A. culture—knowledge of the great fundamental truths—is what is now most wanted among us: students get it nowhere.

At thirty, Remsen became professor of chemistry at the Johns Hopkins post-graduate university established, in Baltimore, in 1876. Ultimately, he was president of the University. He is to be credited with two great achievements: in 1879, together with Fahlberg, he discovered saccharin; he also started the *American Chemical Journal*, which he carried on until 1914, when it was merged in the *Journal of the American Chemical Society*. Saccharin is now an excisable article in our free-trade country. There are three factories making it. For the year ending Mar. 31, 1926, the total duty collected was £83,118, of which the Customs duty on imported saccharin amounted only to £567. The rates of duty for sugar and saccharin respectively are 11s. 8d. per cwt. and 3s. 9d. per ounce. This is approximately as 1:550, the ratio of the assumed sweetening powers of sugar and saccharin.

The retention of benzoic acid as a permitted preservative in food is due to a Board appointed by President Roosevelt, in 1909, of which Remsen was chairman. He and other members tested its action upon themselves—and lived through the trials. The public generally here has lived through trials upon itself with far larger amounts of boric acid, which is disallowed—although no *scientific* proof of its harmfulness has yet been given. Maybe, the presence of preservatives in food is entirely