PREVENTIVE TREATMENT IN INFLUENZA.

A BRITISH MEDICAL ASSOCIATION LECTURE GIVEN TO
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QUESTIONS of preventive medicine are very much to the fore just now, and the country has been stimulated to all kinds of expectations by the formation of a Ministry of Health, by the appointment of a consultative council, and by the wide circulation and advertisement of attractive memoranda upon the need for further measures of a preventive kind in regard to national health. In connexion with preventive treatment the difficult problem of influenza takes a prominent place, partly from the memory of the recent epidemic, with its heavy mortality and still heavier resulting disability, partly from fear of the next epidemic, whenever this may chance to come. What preventive measures can we adopt to ward off the disease or to check its spread and its severity if it appears?

The question falls for consideration under four headings: (1) The prevention of epidemics. (2) Prophylaxis as it concerns the community. (3) Prophylaxis as it concerns the individual; and (4) The control of the epidemic when it arrives.

I. PREVENTION OF EPIDEMICS.

I have scarcely anything to say on this point. The science of epidemiology is even less exact than medicine itself. Some say it is not a true science at all, but only a hybrid science, a combination of bacteriology, statistics, and history. Others say that, given proper study and research, it is capable of great expansion of knowledge, the value of which is at present lost to us. Be this as it may, we are to-day so much in the dark concerning the factors which determine epidemics of disease, and especially the factors which determine epidemics of influenza, that this branch of medicine is almost barren of results of a practical kind. What are the causes of the enhancement of the virulence of pathogenic micro-organisms? What are the causes of a rise or of a fall in susceptibility to infection? On these matters we have next to no knowledge, and without it we can scarcely hope to put up a barrage against an epidemic wave of incidence of influenza.

II. PROPHYLAXIS IN REGARD TO THE COMMUNITY.

What can be done to lower the susceptibility of the nation to infection by the influenza virus?

It is usually held that the maintenance of a high standard of general health in the country is a safeguard against an epidemic of disease appearing amongst us and against its making headway if it should appear. During the last epidemic of influenza a good deal was said as to the possible influence of war conditions upon the incidence of the disease. Some went so far as to suppose that the epidemic owed its existence largely to these conditions, and that it was of the nature of a pestilence which came in the wake of the war.

But there is little or no evidence in support of any such supposition. On the contrary, there are several facts that together make a strong case against this view. If the food restrictions, the nerve strain, the fuel shortage, the exposure and the fatigue consequent upon the war, exercised so debilitating an effect upon the health of the community that there resulted a rise in the susceptibility to infection, then we should expect a rise to have occurred in the incidence of sickness generally during the few months prior to the influenza outbreak. But there was no such rise.¹ Then, again, the maximum morbidity, and the maximum mortality, fell, as we all know, upon young adults and adults, the very class best able to stand these adverse conditions, and not upon children and the elderly, the two classes known to suffer most from them. Moreover, by March of this year food had improved considerably, both in quality and in quantity, and fuel was

not so scarce nor so necessary, and yet there appeared the second big wave of the epidemic.

Two other interesting facts may be recalled in connexion with the point I am discussing. One of the centres from which the epidemic originally spread was Spain, a neutral country, where adverse economic conditions certainly did not obtain more than elsewhere. In Switzerland, where food and fuel were not so scarce, the mortality from the disease was higher than in Germany, where they were much scarcer.² Lastly, no adverse economic conditions preceded the 1889-91 epidemic in this country.

I do not, therefore, think it can be held that, even if we succeed in converting a country of C3 citizens into one the great majority of whose members would pass the medical boards as A1 individuals, we should thereby protect ourselves against influenza and its ravages. Some micro-organisms are prone to attack and to infect persons of low general resistance: tubercle and the more chronic pyogenic infections are examples of this. But in another group of micro-organisms infection depends much more upon the virulence of their elements than upon the resistance of the host; the influenza virus certainly belongs to this group. As a barrier against the first class of micro-organisms there is no doubt that to keep the general standard of health at a high level is the best form of prevention: to provide air, light, exercise, rest and good food—in short, so to arrange matters that this country, in the words of the Premier, is made “a place for heroes to live in,” constitutes the best defence against attack. But for defence against infecting agents of the latter class we seem to need a much more specific means of prevention.

III. PROPHYLAXIS IN REGARD TO THE INDIVIDUAL.

What can the individual do, or what can be done to and for him, in this matter?

To keep himself fit is, on general grounds, a sound piece of advice, but this does not really touch the root of the matter, any more than keeping the whole community fit is likely to ward off an epidemic. If the individual is fit, no doubt that helps him if he gets infected, but there are no facts justifying the assertion that if he is fit he thereby avoids infection. Influenza attacks the weakly and the strong, as the rain falls upon the evil and upon the good. Indeed, since to be weakly carries with it some protection against normal routine and the conditions of life leading to contact with infected persons, the robust individual is often more open to infection than his weakly brother. No doubt this factor came into play in connexion with the age-morbidity and the age-mortality of the disease as seen in the last epidemic, when the war intensified this disproportionate exposure to infection between the able-bodied and the weak. In the face of considerations like these it is difficult to see what else than some method of specific immunization can really solve the problem.

This brings us at once to the biggest gap of all in our knowledge of the disease: we are still without any certainty as to the essential causative agent in influenza. That it is a single agent, even, is not clear, though the argument is strongly presumptive in favour of the view that it is. But whether this agent is Pfeiffer's bacillus, or some other microbe as yet not isolated—possibly a member of the “ultra-microscopic” group—we cannot say. We are even farther away from exact knowledge on the point than we thought we were eighteen months ago. We entered upon the epidemic with more confidence that we knew the causative agent than we had when we emerged from it. This was partly because the clinical picture of the disease made us doubtful, and partly because bacteriological evidence failed of complete demonstration, and this with abundant material to work upon and greatly improved technique since the epidemic of thirty years ago. The most carefully devised and thoroughly undertaken experiments with Pfeiffer's bacillus have failed to produce the disease in human beings, even when the bacilli have been quite freshly isolated and sprayed in enormous quantities into the nose, eyes, and throats of volunteers. Virus taken directly from influenza patients, sprayed in similar fashion, has failed also. Nor has it been possible to get healthy individuals to filter off Pfeiffer's bacillus from influenza patients placed in close contact with them, coughing and breathing freely within two inches of the

mouths of the volunteers.³ Negative results teach us nothing of positive value, it is true, but, in view of such experiments as these, and many more facts throwing doubt upon the claims made for this microbe, it seems clear that we must consider the nature of the exact causative agent as not yet established.

Of the secondary invading micro-organisms we know a great deal, and this knowledge is of considerable value, but until we are clear as to the cause of the primary infection we are not likely to advance very far on the lines of specific immunization. It does not, however, follow that we must necessarily wait for this knowledge; the earliest of all our methods of immunization against infectious diseases—I refer, of course, to small-pox—warns us against this; for even now we do not know the essential nature of the small-pox virus. And yet, as the result of vaccination, small-pox has become, in this country, a curiosity rather than a dread.

The gist of it all is that we require more and more work done upon the etiology of influenza and more and more investigation into the essential cause. The onus in this matter does not lie with the practitioner, but with the responsible Government of the country. I do not mean that we practitioners need not keep alert and observant—we must not forget that Jenner was a practitioner—for such an attitude is of the utmost importance; by preserving it we may give a valuable lead to the laboratory worker and to the research organizer in the field. But it is essential that the stimulus given to medical research by the exigencies of the war should not die down in this country, as seems not unlikely to happen. There is stigma enough in the reflection that it required a world war, and a bitter struggle for our very existence, to drive us into a belated investigation of the causes of disease and the means of preventing and of curing them. There will be national disgrace if peace finds us sinking again into somnolence or, what is much the same, into bureaucratic self-satisfaction. Let economy be practised by all means, and let the Government preach retrenchment, but money spent upon the national health is the soundest investment the country has ever made, and to sell out this particular stock is the height of folly.

In the present state of our knowledge the available materials for preventive inoculation "against influenza" are not very convincing in regard to their specific value. And yet, when I am asked my advice on the matter, I generally favour the use of a prophylactic vaccine, not because I think it is a specific preventive—like typhoid vaccine in typhoid fever, for example—but because there is some reason for considering that a certain degree of protection is conferred against serious grades of catarrh and secondary infections, and because the more of such experiments there are carried out with care and with proper records the better for the advance of our knowledge. Preventive inoculation of single individuals, whatever results, teaches us little or nothing, but similar treatment of collections of individuals in schools, in other institutions, in the navy and in the army, may teach us a great deal. In this matter the Ministry of Health should provide ways and means—for this also is research, and of a very valuable kind. Large stocks of vaccine, of known and approved content, should be at the disposal of the medical officers of health, who should co-operate with medical officers in charge of various institutions and should be responsible for collating the results. "More work for the medical officers of health," it will be said. Certainly; I should like to see medical officers of health so busy with work of this and similar kinds that they had no time for private practice at all. They should invariably be whole-time men, and they should be paid salaries consistent with their training, their expert knowledge, and the great responsibility attaching to their office. At present some medical officers of health are paid about a third the salary which a town council pays its clerk, who has a staff to do his work, is pensioned when he retires, and has in many instances received no special nor expensive education to qualify him for his post. Until national health comes to be considered of as much value as paving the streets and running the tramways these anomalies will continue to exist. The health of the country never has been regarded as an asset of much value, and for this reason the money invested in it has never been adequate to its real needs.

IV. WHAT CAN BE DONE TO CONTROL THE EPIDEMIC WHEN IT HAS ARRIVED?

I will take the question of public control first. Isolation of the patient, promptly and thoroughly undertaken, is, of course, the essential thing. Here we have a branch of preventive medicine which can be exploited straightway, without waiting for the results of research into causes. During the war it was not practicable to carry out even the first principles of isolation. Hospitals were already full of wounded and sick soldiers; movements to and fro of large bodies of men were inevitable; transports arrived with men in all stages of the disease and of convalescence; more and more virulent strains of the virus were being continually imported; doctors and nurses were very scarce, and those that were available were grossly overworked. The conditions for spread of the epidemic were, in fact, very good, and for its control very bad.

No doubt grievous blunders occurred, and much thoroughly bad organization took place here and there; most of us could write about these things if we wished to emulate certain admirals and generals. We are either too discreet or too busy to do so, and since the sailors have forfeited their right to the title, we might claim it for ourselves, and be designated "the silent profession." We may reasonably hope that these handicaps imposed by the war will not be repeated for some time. But we need positive aids, in addition to a guarantee against negative handicaps.

1. Quarantine at the ports, we presume, has already returned to its efficient pre-war state.

2. Early diagnosis and notification, however difficult the problem raised, are matters in which we can all give important help whilst in the daily pursuit of our own practice. The careful observation and recording of the sporadic cases, which may link up the epidemics in a manner not yet made clear, must be a valuable aid to the student of the epidemiological factors.

3. But I have no doubt that the greatest of all our checks to the spread of an epidemic would be a proper system of hospitalization, adequate to the peculiar features presented by the disease. It is hoped that one of the earliest pieces of work undertaken by the new Ministry of Health will be in this direction. A thorough scheme should at once be drafted, by which several large hospital units are established up and down the country for prompt mobilization in times of epidemic emergency. Each unit should have its base, consisting of a well-chosen set of buildings—a fever hospital, a large block of schools, or an infirmary—its staff of doctors, bacteriologists and nurses, its laboratory, and its dispensary. In this matter the lessons of the war should be utilized for the exigencies of peace. And a great deal of useful experience in regard to base hospitals is already fresh in mind, and in potential organization. It would be possible to mobilize these units one by one as required by the incidence of the disease, and have them running smoothly with a few days of their requirement. The staff would be a whole-time staff during the active service of the unit, and demobilization would take place so soon as the epidemic subsided. The expenses of these hospital units would be covered by a special grant made to the Ministry for the purpose. Some of the units might be incorporated with the present large general hospitals, which would set aside a number of wards for the cases and allot them temporarily to a certain number of the staff and of the nurses for treatment. Some of the units might have their base in "special" hospitals, whose usual cases could for the time be pooled with others in "special" hospitals of the same kind. Transport arrangements could be systematically undertaken by the St. John Ambulance.

The efficiency and the success of such a method of public control of an epidemic would turn almost entirely upon the thoroughness with which the schemes were organized beforehand. The analogy between warfare and medicine is hackneyed, but it is very apt. Just as we were caught almost wholly unprepared by Germany when war broke out in August, 1914, so we were caught almost wholly unprepared when the epidemic of 1918 came upon us. Why not learn the lesson and start at once an organized system of defence and of offence against the next outbreak, be it influenza, or cerebro-spinal fever, or whatever it be? Mobility was shown during the war to be the most valuable feature that an army could possess—the

power of rapid concentration upon an objective. This is so in preventive medicine; I believe it to be so in curative medicine also—promptness in collecting all available therapeutic means and bringing them quickly into action. But in order to get this mobility in times of stress in public health the whole territorial scheme, as it were, must be already in potential, and available for calling up at the shortest notice.

I suggest that one or two, or more if needs be, of these establishments that I have outlined should remain in commission between the epidemics, so as to be available for special study and treatment of sporadic cases. They could be staffed by men who—recently demobilized but perhaps looking for suitable work under the Ministry—have had recent and quite exceptional experience in the influenza epidemic. In the matter of research we hear that the highly expert men working during the war and immediately following it under the auspices of the Medical Research Committee are being disbanded. This cannot be for lack of subjects requiring research; is it for purposes of economy? Is it credible that the nation desires the Government to save a few thousands of pounds in this direction?

Efficient isolation of the infected patient is not the only benefit that would accrue from such a scheme of hospitalization. Segregation of the cases might also be attempted, either on clinical or bacteriological lines, or on both. In a large hospital of several wards an effort along this line might lead to results quite unanticipated. A little was attempted in this way by the American Medical Service in France during the war.⁴ Our enterprising allies separated groups of cases according to the dominant micro-organism found in the sputa on admission; this can quite often be done rapidly by examination of stained films. "Pfeiffer cases" might be put into one ward, "pneumococcus cases" into another, and "streptococcus cases" into a third. It will readily be seen what large possibilities there are in work like this, but also how impracticable it is to attempt it unless efficient hospital methods are organized before an epidemic arrives.

Evidence has recently been brought forward suggesting that a practical method of control in the future may depend upon rendering the room atmosphere bactericidal by certain fumes, such as NO_2 and SO_2 gases.⁵ These gases appear to be inimical to the influenza virus, or to the bacteria which invade the mucosa of the influenza patient and lead to secondary infections, adding greatly to the mortality of the disease. By the employment of gases in this way, rather than steam or chemicalized aqueous vapour, a much greater number of patients could be treated together. But such treatment would, again, demand proper methods of hospitalization.

Lastly, consider the great value of such a scheme of isolation and segregation hospitals in the scientific trial of vaccines or other form of immune therapy. At present we have a huge mass of individual experiences to guide us, or rather to confuse us, and as yet scarcely any scientific data. This is, of course, largely due to the handicaps under which observers were working during the last epidemic. Until the claims of various enthusiastic immunizers are subjected to rigid controls we cannot even express a considered judgement on the subject of inoculation treatment of influenza. Impressions we may have, and there are always common-sense and general principles to guide us through the babel of advice, but a sound position on the matter cannot be established until the work is done with proper observation and control by unprejudiced men.

It must strike the intelligent part of the public as a glaring confession of our ignorance on the matter that some of us are wildly enthusiastic, some are coldly temperate, and some of us entirely negligent, when the question of inoculation treatment is mooted. The very formulae recommended differ enormously, both in the nature of the ingredients, in their proportionate composition, and in the dosage advocated. Indeed, these things are even more variable in the formulae proposed for treatment than they are in the formulae proposed for prophylaxis. The matter is not rendered more simple, but a great deal less so, by the enterprise of the wholesale chemists, from whom no more pure science must be expected than is necessary to convince the practitioner that the remedy so alluringly offered is not a quack one.

It may very well be that both the success and the failure of vaccines in the treatment of influenza are due to the great differences known to exist in the infecting flora in different cases. The ideal vaccine—if vaccine be the type of specific remedy we shall ultimately rely upon—must of necessity be autogenous in these cases of mixed infection; but an autogenous vaccine for each patient is quite impracticable during an epidemic of a fulminating disease. "Group" vaccines would, however, be quite practicable, but to use them properly would require segregation of the cases along the lines already suggested, in fact would demand, once more, an adequate scheme of hospitalization.

Some other suggestions for control of an epidemic may be briefly mentioned, such as the closing of places of public amusement and of worship, the disinfection of railway-carriages and other public vehicles, and the wearing of masks. In these things all the advantage does not lie entirely on the side of the precaution. The more interruption that is attempted in the normal routine of public life, the more fear is engendered, and to engender fear is to breed panic. Forbidding public amusements, as has been pointed out, may drive a good many people into worse atmospheres in their own homes. Moreover, there is a limit to what is economically practicable in these things.

I come lastly to the question of control of an epidemic as it is affected by treatment of the individual case, and my remarks will apply equally to the sporadic as to the epidemic case. The check to an epidemic does not depend only upon hospitalization of infected patients; it depends also upon efficient management of the individual case. Even with a number of hospital units, such as I have outlined, quickly established and thoroughly run, there must needs be during an epidemic many thousands of cases treated in their own homes. The existence, too, of large numbers of mild cases of short duration puts a very definite limit upon institutional treatment. I have laid it down as an axiom elsewhere that every case of influenza treated promptly, and treated thoroughly, is a contribution to preventive medicine. In the homes of the well-to-do there can be no excuse for the neglect of measures of known value in treatment, and especially for ample ventilation. And yet how frequently did we see the patient in a stuffy little room, the bed placed hard against a wall, much of the available air space occupied by furniture and bric-à-brac, other and much larger rooms being left unoccupied. And even in the houses of the poor we can do much by explaining the fundamental principles of aération of the sick-room, the control of body heat, and the choice of food. When I once wrote about the special bearing of these principles upon the treatment of influenza patients⁶ I was told that what was possible in large houses was not possible in small ones, and that in many instances the overworked doctor had time only to call for a few minutes, give a word of encouragement to the patient, and leave a prescription or some medicine. To which I would reply that if the work is so pressing that something has to be omitted, I should omit the medicine and open the window. The word of cheer I should on no account omit—it can be put in whilst the window is being opened—but I should remove the superfluous blankets and rugs under which the patient is stewing, explaining as I did so the why and wherefore to the anxious relative, who is often very willing to help if only she knows how.

In the treatment of the actual case I regard the most important thing by far to be a free current of fresh air. It has not only the most important therapeutic value for the patient, it is also of great value as a preventive against spread of the infection. Winds appear to "break up" an epidemic wave; a current of fresh air, it seems quite certain, is our most potent means of defence in the case of the individual patient. I believe that no small factor in the spread of the recent epidemic were the light restrictions in many areas, including London, for these entailed the closing of windows or, if not this, the use of heavy blinds and curtains which rendered open windows ineffective.

Of the various drugs recommended by the public and the press as preventives in time of epidemics there is little to say, except, perhaps, that the taking of them has a certain psychic value. I do not think either quinine or cinnamon internally, or eucalyptus as a vapour, maintained, during the more severe trials of 1918 and 1919,

the prestige gained for them in 1889. Of the nasal douche and gargle advocated in the Local Government Board memorandum I cannot speak more confidently than of drugs and lozenges. The trouble about all these local measures is that the very people who are most liable to infection are much too busy and too preoccupied to carry out a mucous membrane drill with any regularity.

CONCLUSION.

In conclusion, we must, I fear, confess to a very unsatisfactory position at present in regard to preventive measures in the treatment of influenza. But to know how little we know is an essential step in progress. The great need is organized research and organized hospitalization, and now is the time for these things to be carried out. Let us not cease to urge upon those responsible for the public health the importance of the problem and the great uncertainty of our present knowledge, reminding them that economy here is of the falsest, and that the country possesses no asset to be compared in value with the health of its citizens.

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NORMAL AND MORBID CONDITIONS OF THE TESTES FROM BIRTH TO OLD AGE IN ONE HUNDRED ASYLUM AND HOSPITAL CASES.

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CORRELATION OF BIOCHEMICAL AND MORPHOLOGICAL CONDITIONS OF SPERMATOGENESIS.

It has been shown that sections of the testis of a newborn child exhibit lipid granules in the interstitial cells, also lipochrome granules similar in appearance to lutein. Fine lipid granules are also seen in and between the embryonic epithelial cells of the seminiferous tubules. Sections of the testis of a four months infant show that the seminiferous tubes are about twice the size of those at birth; no lipid granules are seen in the interstitial tissue. The appearances of sections of the testis of a boy aged 11 show almost similar appearances to those at four months; the tubes are not much larger. A few of the tubules show cells with mitotic figures and cells of Sertoli can be seen, but they contain no lipid granules.

Not until puberty and active spermatogenesis has commenced are lipid granules found in the interstitial tissue. Usually large droplets of ruby-red-stained fat are seen aggregated together in this tissue. Fine orange-stained granules can be seen in abundance in the interstitial cells of Leydig, in the spermatogonia, and especially filling the cells of Sertoli. The large droplets are probably lipid, with a greater proportion of unsaturated fatty acid.

The fact that the lipid ceased to appear in the interstitial cells as soon as, and as long as, spermatogenic cell growth ceased and reappeared with active spermatogenic proliferation, may be regarded as very suggestive evidence of the phosphorylated lipid being connected with nuclear proliferation.

This conclusion, moreover, is supported by the fact that in advanced regressive atrophy the fine orange-stained lipid granules have almost entirely disappeared from the interstitial tissue.

The cells of Sertoli may in some cases of advanced atrophy still contain lipid. Only large ruby-red droplets of varying size are usually seen in the very atrophied tubules, which may be explained by a fatty degeneration of the cells.

THE CORRELATION OF BIOCHEMICAL PROCESSES WITH THE HISTOLOGICAL APPEARANCES.

1. In films of seminal fluid from the vesiculæ seminales and sections of the testis stained with a basic and acid dye, such as haematoxylin and eosin, Giemsa or Leishman stains, the following microchemical reactions are observed. The head of the normal spermatozoon, consisting of nucleinate, is stained blue by the basic dye. The tail, except the axial thread, stains pink—that is, the lipid which forms the main constituent of the tail is stained pink.

2. In frozen sections of formalin-hardened testes stained with scarlet dye and haematoxylin, and mounted in Farrant's solution to show the distribution of the lipid granules, the following appearances can be observed. The spermatids in the process of development into spermatozoa are stained posteriorly by the scarlet dye and anteriorly by the basic dye. The fine orange lipid granules are seen in the spermatogonia, spermatocytes, and especially in the cells of Sertoli. The lance-shaped heads of the spermatozoa stained blue are seen diving into the cells of Sertoli, where it may be presumed they behave like living organisms and feed upon the store of lipid in these "nurse" cells. In situations where sheaves of spermatozoa have attained further development and projected their tails into the lumen of the tube prior to escape as free organisms there is a paucity of fine orange granules observable in the Sertoli cells. Chemical investigations by Miescher and Kossel have shown that the tails consist almost entirely of lecithin and cholesterol with a small amount of protein. Lecithin represented by the formula—

may be looked upon as glycerophosphoric acid combined with choline, a base with the constitution of a tertiary amine, and with two molecules of fatty acids (Koch, 1902).

From the following considerations it appears probable that the phosphorus of the glycerophosphoric acid enters into the formation of the nuclein, a fatty acid being formed which combines with the lecithin continually taken up from the blood and lymph. The presence of the unsaturated fatty acid with the lecithin favours the oxidation processes necessary for the active metabolic processes connected with the cell proliferation (Thunberg, 1909, 1913; Warburg, 1913; and Warburg Myerhof, 1913).

The "iodine value" indicating the degree of desaturation of fatty acids of lecithins obtained from various organs shows a high figure for lecithin from testicles—117—as compared with 73 for lecithin from ox heart, 81 from liver, and 69 from thyroid (Cruickshank, 1914).

Miescher's experiments show that the tails of the spermatozoa consist largely of a phosphorylated fat and some cholesterol, therefore I examined frozen sections of the testicles for cholesterol by Liebermann's test.

The sections were taken out of water, floated on to a slide, a covering glass placed over the section and glacial acetic acid was attracted under the covering glass by the application of filter paper to the edge; a drop of sulphuric acid was next drawn under the covering glass.

The granules in the interstitial substance and in the circumference of the tubules became pink, and finally turned to green when examined with a magnification of 100. When the magnification was increased to 500 or 600 the fine granules in the spermatogenic cells, especially the Sertoli cells, were seen to be stained green, also the spermatids and heads of the spermatozoa, which leads me to believe that these active developing cellular organisms have a thin covering membrane containing cholesterol. Seeing that cholesterol is insoluble in cold alcohol, and yet this reagent dissolves out nearly all the substances stainable by the scarlet dye, it follows that the cholesterol, although it has exactly the same distribution as the lipid which is stained by this dye, must only represent a fraction of the lipid in which it is in combination.

We know that cholesterol with lecithin enters into the formation of cell membranes. There is good reason, therefore, to suppose that the abundance of lipid found in the