

CLASSICS IN INFECTIOUS DISEASES

On Continuous Molecular Changes, More Particularly in Their Relation to Epidemic Diseases

John Snow
(1813–1858)

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This essay is reprinted, with omissions, from the book by John Snow, *On Continuous Molecular Changes, More Particularly in Their Relation to Epidemic Diseases: Being the Oration Delivered at the 80th Anniversary of the Medical Society of London* (London, John Churchill, 1853).

[Editor's note: John Snow has become so well known for his epidemiologic investigations that it seems, at times, almost unnecessary to read his work. Those who have failed to read his investigations of the mode of spread of cholera have missed an insight into an indefatigable collector of data, who analyzed his findings with great skill and perception. Snow's vision and capacity for analytical thought are shown in this essay, which is even less read than his work on cholera. The essay, which was delivered in 1853 to the Medical Society of London, indicates the intellectual framework on which the discoveries of the decade or two later were to be built.]

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The Preface

The title to these pages may, perhaps, seem rather obscure, on account of the various senses in which the word *molecular* has at different times been employed. I do not, however, know any better term by which to express all that refers to the attraction which exists amongst the particles of matter at insensible distances.

The word *chemical* is restricted to expressing what relates to the composition of bodies, and does not include properties, such as solidity and fluidity, which are called physical; nor some of the processes that we call vital, such as the formation of fibres and cells. It is especially desirable to have a general term to include what is understood by the words physical, chemical, and vital, in order to avoid the dis-

putes respecting these two latter words . . . and the needless antagonism in which these words are sometimes placed towards each other.

All changes of composition whatever, whether occurring in a test-tube, or in the living brain, are properly included amongst chemical changes; and all that takes place in living structures has a right to be called vital, whether it differs from what occurs elsewhere or not. Thus, whilst the terms *chemical* and *vital* have each a separate signification, they have a certain ground in common, since changes of composition in living beings are at once both chemical and vital, and belong to both chemistry and physiology; just as fossil animals belong to both the mineral and animal kingdoms, and to the sciences of geology and zoology at the same time. To dispute whether the formation of urea or cholesterine is a chemical or vital process, is as useless as it would be to dispute whether a fossil ichthyosaurus is a mineral or an animal, and whether it belongs to geology or zoology.

I beg the reader to remember that the term *oration* proceeds from the laws of the Medical Society, and not from any claim of mine to be considered an orator. . . .

The Oration

The Medical Society of London [has] conferred on me the honour of electing me to deliver the oration for the present year. . . . It is my intention on the present occasion to make a few remarks on some of the chief phenomena of living beings. . . . The first of these forces is called the attraction of gravitation; and the term chemical attraction, or chemical affinity, includes more or less of the second force, according to the more or less extended sense in

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which the word chemistry is understood. The effects of gravitation on living beings are of a simple kind, and are pretty well known; therefore they need not detain us. With respect, however, to the attraction which takes place at insensible distances, the case is different. The results of this attraction in living beings are very complicated and important, and they require much investigation. . . .

There is no distinct line of demarcation between vital processes and those which are not vital. Vinous fermentation, for instance, has been generally looked upon as a merely chemical change; yet it has great claims to be entitled a vital process. It is always accompanied by the formation of the cells or sporules of the yeast fungus—the decomposition of the sugar into alcohol and carbonic acid bearing a direct relation to the quantity of yeast produced.¹ Many persons would doubtless say that the formation of the sporules is a vital process, and the production of alcohol and carbonic acid a chemical process inseparable from it. According to this view, whilst cell development is undoubtedly a vital process,² digestion and the formation of compounds to be secreted or excreted are chemical processes. There is no objection to such a distribution of terms, but it must be remembered that the decomposition of sugar into alcohol and carbonic acid is as closely connected with a pro-

¹ See Schleiden's *Principles of Scientific Botany*, translated by Dr. Lankester, p. 36; and Liebig's *Agricultural Chemistry*, 2nd ed. p. 282.

Schleiden is of opinion that the yeast cells originate without the influence of a living plant. If it be so, their formation may be looked on as a natural link between the non-vital and the vital—between ordinary chemistry and physiology. The words of Schleiden are: "At a certain temperature, which is perhaps necessary to the chemical activity of the mucus, there originates, without as it appears the influence of a living plant, a process of cell-formation (the origin of the so-called fermentation fungus), and it appears that it is only the vegetation of these cells which produces the peculiar changes that occur in the fluid."

² Schleiden, however, speaking of vegetable cells, says,—"If further we regard the easy transformation of the assimilated matters, and may, from artificially conducted experiments, draw the conclusion that the nitrogenous matter which I have called mucus, and which forms the cytoblast, is the substance which calls forth these transformations; and if we further remark that sugar and dextrine are more easily soluble than jelly, and that sugar and gum are changed into jelly, if the quantity of water is not increased, and which must be necessarily precipitated, we must regard the whole process of cell-formation as simply a chemical act. The gathering together of granules of mucus to form a cytoblast we can as little explain as that, when we form a solution of two salts, if we throw into the mixture a crystal of one or other salt, that salt alone crystalizes around it."—*Opus cit.* p. 35.

cess of organization as are the sensibility and contractility of animal tissues. This blending together of what we call vital and what we call chemical, need not surprise us, however, when we consider that all changes of composition, with their attendant phenomena, whether taking place within the living body or not, are alike the result of the attraction or affinity which exists amongst the ultimate atoms or molecules of matter. . . .

Procreation by sexes, which is the most usual mode of generation throughout both the vegetable and animal kingdoms, appears to have the effect of preventing deviations from the form and character of the species; for gardeners are enabled, by means of cuttings, shoots, bulbs and tubers, to propagate many cultivated varieties of plants which differ greatly from the species to which they belong, and would soon revert to it if able and permitted to propagate by the sexual method, that is by seeds.

As organized beings rise in the scale of complexity, the points of connection between the individuals of one generation and those of the next increase in number and extent. In the lower classes of invertebrated animals a single germ yelk serves for the production of numerous individuals, and in some cases for the production of several generations; but in the higher invertebrata, and in all the classes of vertebrated animals, "only a single, individual is propagated from each impregnated ovum."³

As we ascend through fishes and reptiles to birds, the number of the ova diminish and their relative size increases, till in some reptiles, and in all birds, the ovum, with its attendant yelk and albumen, is sufficient for the development of a nearly perfect animal, which undergoes all its metamorphoses before it has escaped from the shell, or obtained any nourishment beyond that contained in the egg.

In the class mammalia, with the exception of the marsupial order, the embryo becomes rooted, by means of the placenta, in the uterus of its mother, from whom it thus derives the materials for its development and growth, up to the period of its birth. The young of all mammiferous animals are also supplied by the mother, for a considerable period after birth, with nourishment secreted from her own blood; and medical men have ample experience, as regards their own species, how much the prospect of health and life is diminished by the deprivation of this natural supply of nutriment.

³ Owen on Parthenogenesis, p. 62.

In many birds and mammals there is a further connection between one generation and the next, in the way of teaching the young, to a limited extent, how to procure food and escape danger. In the human species, enjoying the faculty of speech, this connection between succeeding generations is much more intimate. . . .

The communication of certain molecular changes taking place in the brain is by no means confined to the connection between parents and offspring, but extends collaterally in all directions, by means of vibrations in the air, or in the ethereal medium which prevades space. If the brain of an animal is in a particular state of molecular action, from any object that excites fear or joy, it may cause a similar state of the brain in others of its species, by uttering a cry, or merely assuming a particular demeanour. The faculty of speech gives to man a power of communicating his complex feelings and ideas, far exceeding that of the lower animals; and the invention of literature has greatly increased this power in civilized nations. By speech, not only can fresh sensations and ideas be communicated, but also that continuation of them called remembrance, by which they revive after, it may be, a long interval of suspended action. By the aid of literature, indeed, knowledge committed to writing may lie dormant for centuries, like the ears of wheat in the hand of the Egyptian mummy, and then again take up the process of growth, to increase and spread in another part of the world.

In addition to the series of continuous molecular changes having for their result the preservation of the individual and the species, there are others, occurring in living beings, which have an opposite tendency; they divert part of the substance of the individual from the actions which are natural to the species to another kind of action, in consequence of which this substance is employed in the multiplication and increase of the *materies morbi* of communicable diseases—an extensive group of maladies, each case of which is caused by some material that, as a general rule, has been produced in the system of another individual. The origin of these diseases, for aught we can tell, may be as remote as that of the beings they infest and exist on.

The communicable diseases—I use this term in preference to contagious, for various reasons⁴—the

communicable diseases, to which the human species is liable, are chiefly as follow:—syphilis, small-pox, measles, scarlet-fever, typhus, typhoid and relapsing fevers, erysipelas, yellow-fever, plague, cholera, dysentery, influenza, whooping-cough, mumps, scabies, and the entozoa. Some persons do not admit the whole of the above diseases to be communicable, and, on the other hand, the Registrar-General includes acute rheumatism, and scurvy, in his class of zymotic diseases, although there is no evidence that these complaints are communicable. . . .

The material cause of every communicable disease resembles a species of living being in this, that both one and the other depend on, and in fact consist of, a series of continuous molecular changes, occurring in suitable materials. The organized matter, as we must presume it to be, which induces the symptoms of a communicated disease, except in the case of the entozoa, can hardly ever be separately distinguished, like the individuals of a species of plant or animal; but we know that this organized matter possesses one great characteristic of plants and animals—that of increasing and multiplying its own kind.⁵ In the instances of syphilis, small-pox, and vaccinia, we have physical proof of this increase, and in other diseases the evidence is not less conclusive.

The molecular changes taking place in the *materies morbi* of some diseases resemble the changes in many living beings in another respect also: they permit of being suspended, under certain circumstances, and recommence at the point at which they ceased. Thus the matter of variola and of vaccinia can be carried, in the dry state, to distant parts of the world without injury, like the seeds of a plant.

No evident effects are produced at first by the reception of the material cause of any of these diseases. There is always a definite period, of longer or shorter duration, before the illness commences, which is called the period of incubation. As regards the *materies morbi* itself, this [is] a period of something more than incubation; it is a period of reproduction. All substances capable of causing a disturbance in the animal functions produce symptoms from the moment of their absorption or imbibition, when introduced in sufficient quantity; but

regard were paid to its etymology, to express some of the indirect modes of the communication of disease alluded to in the following pages.

⁵ See a paper by Mr. Grove, of Wandsworth, *Med. Times*, vol. xxiv. p. 640.

⁴ The word contagious is employed in a very different manner by different authors, and it could scarcely be employed, if any

the specific animal poisons, as they are called, are very rarely, if ever, introduced in such quantity as to produce sensible effects; the disturbance in the system, which constitutes the diseases they induce, being due to the crop or progeny of the matter first introduced.

One character of communicable diseases is, that they are apt to be extremely prevalent at particular times and places. This character, which arises strictly out of their communication from individual to individual, has obtained for many of these diseases the name of epidemics—a name which may be applied to nearly all of them, although some are prevented, under ordinary circumstances, from showing their epidemic character. Thus syphilis, for instance, keeps a pretty even course in this metropolis, because there is a steady amount of vice for its support, and a still greater amount of virtue to keep it in check; but when it is introduced amongst a community of savages, indulging in promiscuous intercourse, it rages as a fearful epidemic. The extent of population and of intercourse has great influence over the epidemic character of communicable diseases. The various irruptive fevers are constantly present in London, and are only liable to fluctuations in their prevalence. In less populous districts, however, there are not enough subjects to support their constant presence. One or other of them is often absent for a number of years, and, when re-introduced, spreads to a great extent. There is one disease which neither the metropolis, nor the country at large, nor even the whole of Europe, will supply with victims except for a time. The cholera has been twice spread over the world within the memory of the present generation, and seems to be dying out a second time everywhere but in the south of Asia. Fatal as it is to the human species, it is itself so difficult of support that the world seems scarcely large enough for it, and, were it not for its pastures in India, it would be in danger of passing altogether out of existence, like the dodo of the Mauritius.

So far as can be learnt from what remains of ancient medical literature, the communication of diseases was not generally recognised till a recent period. Even Sydenham did not recognise the communicability of any acute febrile disease except the plague. He did not even recognise the communicability of small-pox. . . .

For want of knowing any other cause, epidemics were attributed, by the ancients, to the atmosphere, without any evidence; just as political and social

events were believed to be occasioned by the stars. Now as people are not only exposed to the atmosphere, as soldiers in battle are to bullets, but are actually immersed in it, as fishes are in the sea, it became necessary to explain why certain persons were attacked and others not attacked, and the word predisposition was used as affording an explanation. The alleged predisposition, however, was nothing visible or evident: like the elephant, which supports the world, according to Hindoo mythology, it was merely invented to remove a difficulty.

As the composition and physical properties of the air began to be better understood, it became evident that the atmospheric hypothesis of epidemics did not explain their phenomena, even with the assumption of a predisposition existing in some persons and not in others. It is not possible, for instance, that a disease caused by anything in the general atmosphere should progress in opposition to the wind, or should remain for weeks in a place before extending to the next parish on either side. . . .

It is quite possible, and, indeed, almost certain, that the material cause of some communicable diseases may be wafted a short distance through the air, like the seeds and spores of many plants. The matter of small-pox pustules, for example, retains its powers after being dried, and may be shaken from articles of clothing, and thus wafted through the air. This is probably true of other diseases. It is, however, only a mode of communication of the disorders in question, and would not warrant us in speaking of their atmospheric origin. . . .

When the communication of diseases began to be recognised, it was thought to depend, in most cases, on effluvia given off from the patient into the surrounding air: even syphilis, for some time after its appearance in Europe, was believed to be propagated in this way, and persons suffering from it were driven out of the towns and villages to live or die in the fields, lest they should infect others with their breath, although the disease was not attributed to any misconduct on their part.⁶ Now as effluvia of any kind must reach all who approach the patient, the idea of a predisposition existing in some persons and not in others, has been retained to explain why certain individuals only are attacked with the diseases. We are informed by M. Ricord and others that when the pus from a chancre, in its active or increasing stage,

⁶ Astruc, lib. i. ch. iv.

is introduced by inoculation, it never fails to communicate the disease. The matter of small-pox pustules hardly ever failed, when inoculation was practised, to cause the complaint in those who had not had it already; and vaccination does not fail more than once in several hundred times, when properly performed. So far, therefore, as we have analogy to guide us, we are warranted in concluding that when the morbid matter of any disease is received into the system, in the way required in that particular disease, it is almost certain to produce its specific effects, except in the instances in which the patient has gained an immunity by a former attack. Consequently, until it can be shown that the materies morbi of any communicable disease has really entered the economy of those who do not take the malady, there is no reason to invoke a supposed predisposition, or predisposing causes, to account for its existence in the persons in whom we find it. To be of the human species, and to receive the morbid poison in a suitable manner, is most likely all that is required.⁷ . . . The influence of climate and season have been much overestimated, having been even accused of causing epidemics. We constantly, also, hear climates called healthy or unhealthy; which is as incorrect as it would be to call them fruitful or barren. California, for instance, was proverbial for the healthiness of those who resided there, and this healthiness was attributed to its climate. No sooner, however, was the discovery of gold made, than the cholera was conveyed across the mountains, by crowds of people, who left the route strewn with the dead bodies of those who died on the journey. Dysentery and other diseases began to prevail amongst the diggers, and the medical men found plenty of employment; although it cannot be supposed that a few hundred people, scratching here and there for gold, had altered the climate of country. . . .

There is one circumstance which seems to indicate that the specific cause of intermittent fevers undergoes a development or multiplication within the system of the patient, — it is, that a period of dormancy, or incubation, has been observed, in many cases, between the visit to the unhealthy locality and

the illness which followed; for, as I have already remarked, every poisonous or injurious substance causes symptoms as soon as it has been absorbed in sufficient quantity. . . .

But, to return to those diseases which are known to be communicable, there are certain spots, more limited than the districts or localities previously mentioned, in which they find easy means of communication:—I allude to the courts and allies crowded with the poor. It happens that there is generally no lack of offensive gases or disagreeable smells in these spots. Now it is well known that the gases arising from decomposition cause no fevers or other epidemic diseases, when they are made artificially in the laboratory. The same is true when they occur more naturally in the dissecting room; and it has also been proved that persons who get their living by working amongst decaying animal and vegetable matters are not more liable to these diseases than other persons.⁸ Still there are some medical men, and a benevolent section of the general public, who attribute the excess of epidemic disease, found in crowded and poor localities, to what are called noxious effluvia. They cannot say that these effluvia predispose to the diseases, for persons from the country are often attacked too soon after their arrival in such places to allow of this mode of action, and they do not inquire whether peculiar facilities may not exist for the conveyance of specific virus from one person to another, but they hold that the noxious effluvia, together, perhaps, with an undefined something in the general atmosphere, may cause or increase any epidemic disease whatever; and, when a nuisance is discovered, the prevalence of any kind of disease at the place is said to be explained, although we are not told how. The gentlemen who hold these popular opinions do not seem to recognise specific causes of disease. They are, with respect to diseases, in the position that some of our ancestors were in with respect to plants and animals, when they believed in spontaneous or equivocal generation, and thought that dirt engendered vermin, and that mushrooms arose from horse-dung. . . .

Amongst the poor, who are less unfortunately situated, there is often very little cleanliness, and, when a number of persons reside, sleep, and eat in a small room, in which also the cooking is conducted, it is extremely difficult, when an individual is confined

⁷ I do not deny that the period of life, being ill or well nourished, and other evident conditions of the patient, influence his liability to certain epidemic diseases. The predisposition objected to above is that which is assumed, without any symptoms of its existence, merely from the fact of the patient taking the disease.

⁸ See Bancroft on Yellow Fever.

to bed by illness, to prevent his excretions being partaken of by all the inmates; indeed, with the uncleanly habits of many of the poor, this is altogether impossible. Under these circumstances we find that, when typhoid fever or cholera enters such a dwelling, it is very apt to go through the house, as the phrase is. It often attacks the friends also, who visit and eat and drink with the inmates, whilst the medical and clerical visitors escape. But when cholera or typhoid fever occurs in cleanly families, where the nursing, the cooking, the sleeping, and the eating go on in separate apartments, it is hardly ever found to spread.

It is not improbable that the specific cause of influenza and measles is drawn in with the breath, as these diseases affect chiefly the respiratory organs, and spread almost equally amongst all classes of the community. . . . It has been said that animal poisons do not act when taken into the stomach; but this is incorrect, for cantharides, the sausage and bacon poisons, and others, act when taken in this manner; and it should also be remembered that the virus of a specific disease is not strictly a poison, in the sense of that of the viper, for it is capable and requires to be multiplied in the system, before its effects appear.

There is evidence tending to show that typhoid fever, yellow fever, and plague, as well as cholera, are communicated by accidentally swallowing the morbid excretions of the patients, and that these latter may sometimes be conveyed to a distance with the drinking water, or other articles of diet, without losing their specific properties.⁹ Thus the communication of these diseases may be more or less direct or indirect, even when it takes place virtually in the same manner. The first authenticated case of cholera which occurred in London in the autumn of 1848, was that of John Harnold, a seaman of the steam ship *Elbe*, newly arrived from *Hamburgh*, where the disease was prevailing. He died in a lodging at *Horsleydown*, near the river. The next case was that of a man who came to lodge in the same room; and a few hours afterwards cases occurred in *Lower Fore Street*, *Lambeth*, and in *White Hart Court*, *Chel-*

sea, amongst people who had no water for drinking or any other purpose, except what was obtained by dipping a pail into the *Thames*. Thus the cholera poison from *John Harnold* appeared to be distributed like the seeds of a river-side plant, some of which germinate and grow up by the side of their parent, whilst others are conveyed some distance by the tide, and take root on another part of the shore.

Those sudden extensions of the cholera, which are called outbreaks, were in many cases due to the mixture of the cholera-evacuations with the water used for drinking and preparing food. This was shown to be the case in the *Wandsworth Road*, in *Bermondsey*, and in *Rotherhithe*, during the summer of 1849.¹⁰ It has been often argued that sudden outbreaks of cholera are incompatible with its propagation from person to person, but we know of no circumstances to restrict the number of persons who may receive the disease from one or two patients, under favourable circumstances for the distribution of the morbid matter. . . .

Medical men are naturally apt to form their opinions respecting the communication of diseases from their own experience, rather than from the general history of the maladies, and thus they believe in its contagion, when a disease, such as cholera or typhoid fever, generally spreads directly from person to person in their practice; but in districts or connections in which the indirect and less obvious mode of contracting disease is, from physical causes, the prevailing one, they are apt to become what are called non-contagionists.

It may very fairly be asked whether communicable diseases do not sometimes arise spontaneously—that is, from other causes than their communication, just as ordinary combustion, putrefaction, and some other continuous molecular changes, very often commence anew, from various causes, without any continuity with previous changes of the same kind, and it is not improbable that some communicable diseases may arise, so to say, spontaneously. The erysipelatous inflammation, for instance, which attacks the neighbourhood of wounds, probably arises now and then without being communicated; otherwise we must suppose the material which causes it to be almost as widely diffused as the spores of some of the fungi. There is, however, great reason to believe that the larger number of communicable dis-

⁹ Dr. Jenner lately called my attention to an instance occurring at the village of *North Boston*, *Erie County*, *N.Y.*, in which typhoid fever was probably communicated to a number of families by the contamination of the water of a well which they used. See *Clinical Reports of Continued Fever*, by *Austin Flint*, *M.D.*, *Buffalo*, 1852, p. 380; also, *Med. Times and Gazette*, *March 12*, 1853, p. 261.

¹⁰ *Snow on the Mode of Communication of Cholera*, p. 12; *Med. Gaz.* vol. *xliv.*, p. 747; *Med. Times*, vol. *xxiv.*, p. 561.

eases never arise from any other cause than the communication of the specific virus from a previous patient. Dr. Watson has given very strong proofs of this, in regard to small-pox, in his lectures, and proofs almost as strong might be adduced in respect to other diseases. We know very well from history that the plague spreads fearfully in this country, when it is imported, and, if it ever arises spontaneously, why should we have been without a case of it for nearly two centuries? We sometimes hear it asked, "Then how did the first case arise?" The question might as well be asked with respect to the first tiger or the first upas tree; but our ignorance of the first origin of natural phenomena need be no obstacle to the investigation of their present causes. . . .

With respect to preventing the communication of disease, it is worthy of remark that there are two diseases whose mode of propagation is well known to almost everybody, and almost everybody has it in his power to avoid them—I allude to syphilis and the itch. It will perhaps one day be seen whether other communicable diseases may not be as easily avoided, when their mode of communication is known. In the meantime it is very well ascertained that cleanliness is a great protection against many of them, as are also space, daylight, and ventilation. The cleanliness which, it may be observed, cannot be attained without sufficient space and daylight, should not be a cleanliness for mere appearances; it should be a rational cleanliness, like that by which the chemist keeps his tests pure and distinct, and the farmer his land free from weeds. There should be not only personal cleanliness, but cleanliness in every department of the household—cleanliness in builders and owners of house property, to deter them from sinking wells so near to cesspools and drains, that their contents may percolate without proper filtration—cleanliness in water companies, to prevent them from sending water containing sewage to their customers, as was done on the south side of the Thames till very lately—and cleanliness in sanitary reformers, to deter them, in their fear of offensive effluvia, from abolishing cesspools and having the sewers flushed, and thus sending all the recent excrementitious matters into the rivers, until they have ascertained that people are no longer obliged to drink the water of these rivers. . . .

The prevention of epidemic or communicable diseases is a subject which deserves increased investigation. These diseases influence the life, the death, and the numbers of the human race, more than all other causes. The very learned physician Dr. Gor-

don Latham is of opinion that the downfall of the Roman Empire was due as much to several severe epidemics as to any other cause; and although I am far from apprehending any such calamity now, as "a speedy return of the middle ages," there are circumstances occurring which deserve our vigilance. The increased and more rapid traffic between nearly all parts of the world, especially that by means of large steam-ships, renders it probable that diseases, hitherto confined to particular divisions of the globe, may gain a wider range, and thus increase the number of diseases in nearly every country. For now, when the commercial interest and influence preponderate over every other, the day is gone by for strict quarantine, which, indeed, was ever but a doubtful measure, as it was liable to evasion, and could not be enforced on the smuggler.

The question of contagion in various diseases has often been discussed with a degree of acrimony that is unusual in medical or other scientific inquiries. The cause of the warmth of feeling that has been displayed has, in most cases, probably been unknown to the disputants. It is the great pecuniary interests involved in the question, on account of its connection with quarantine. In the preface to his work on the Plague of Aleppo, Dr. Russell says,—"But however indisputable the fact of the plague being contagious may be deemed by modern physicians, it may be remarked that it has been strongly opposed, as often as the subject of quarantine has fallen under the deliberation of the legislature; and the public, at such times, have been constantly pestered by an inundation of pamphlets, which, without advancing anything new, merely retailed arguments which had long before been refuted."

Since 1791, when the above was written, the commerce of this country has increased a hundred-fold, and for every ten thousand pounds that were jeopardised by quarantine then, a million is in danger now. . . .

The mode of propagation and the means of prevention of epidemic diseases require, as I said, increased investigation; and if any inducements were wanted to stimulate my present audience to that inquiry, it would only be necessary to remind you that, by investigating one of these diseases, a former Fellow of this Society was enabled to make the greatest discovery that has ever been made in the practice of medicine, and to render the greatest benefit to his species which they have probably ever received. I need hardly say that I refer to Jenner.