The principles of physiology applied to the preservation of health, and to the improvement of physical and mental education / [Andrew Combe].

Dedicated, by permission, to the King of the Belgians.

THE

PRINCIPLES OF PHYSIOLOGY

APPLIED TO THE

PRESERVATION OF HEALTH,

AND TO THE IMPROVEMENT OF

PHYSICAL AND MENTAL EDUCATION.

BY

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"Nor is it left *arbitrary*, at the will and pleasure of every man, to do as he *list;* after the dictates of a depraved *humour* and extravagant *phancy*, to live at what rate he pleaseth: but every one is bound to observe the *Injunctions* and *Law of Nature*, upon the penalty of forfeiting their *health*, *strength*, and *liberty* —the true and long enjoyment of themselves."—MAYNWAYRINGE.

WITH FIFTEEN WOODCUTS.

TWELFTH EDITION,
REVISED AND ENLARGED.

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WOODCUTS.

PREFACE TO THE PEOPLE'S EDITION.

When the present work was first published in 1834, it was warmly recommended to general attention by the Quarterly Journal of Education, on the ground that the physiological exposition embodied in its pages applied "most admirably to persons of all conditions, and to every variety of situation," and was thus calculated to benefit "the whole community." Such was unquestionably the aim with which the volume was written; and the favourable reception which it has met with, shews that the Reviewer's estimate of its utility has, to some extent at least, been borne out by public opinion.

With the view of removing as much as possible a chief obstacle to the work obtaining a circulation somewhat proportioned to the extent of the want it was designed to supply, it has hitherto been published in the form of a neat closely printed volume, at about half the cost of most books, or one-fourth of that of an ordinary novel, containing an equal quantity of letter-press. The result has been such as not only to confirm, in the strongest manner, the high estimate I had formed of the importance of physiology, but to demonstrate the readiness of the public to welcome a plain exposition of its nature and applications; for already, in the course of nine years, sixteen thousand copies have been exhausted in this country alone. But great beyond expectation as this success has been, and widely as the work has, in consequence, become diffused, there is reason to believe that it still remains almost inaccessible to thousands in the humbler walks of life, who, correctly appreciating the value of physiology, desire to avail themselves of its aid in the improved management of themselves and their families. Under this conviction I began, about five years ago, to prepare a still cheaper edition for publication; but obstacles, arising partly from infirm health and partly from personal considerations which it is unnecessary to detail, came in the way, and it is only now that their partial removal has allowed me to fulfil my intention, and to offer the present, or "People's Edition," with all the improvements I have been able to effect on it, at one-third of the original cost of the work.

That, in this form, the work will prove an acceptable and useful guide to many among the industrious classes of society, seems to me not improbable, from the fact that, in the United States of America, with a smaller population than our own, upwards of 30,000 copies of a very imperfect edition, published without my sanction, and at the higher price of 75 cents, or three shillings, were exhausted within the first six years. The very extent of such a sale appears to warrant the inference, that a large proportion of the purchasers must have been among the working classes; while the steady demand which still exists for two improved and neat editions, more recently published in that country, affords a presumption that the interest felt in the book has not been the result of a temporary fit of enthusiasm, but has proceeded from a sense of the inherent importance of the subject of which it treats.

In a general as well as a personal point of view, the favour with which the work has been received has been very gratifying, because it affords an instructive example how rapidly the public mind can advance in the appreciation of useful truths even in the face of strong and long-cherished prejudices. Ten years ago, the proposition that physiology should constitute a part of general education, was received by most persons with ridicule or doubt, and by very many with absolute disgust. Of late, on the contrary, opinion has been almost unanimous in its favour, and allusions to the doctrines and usefulness of physiology meet us on every side. In accordance with this, its laws are now frequently referred to by men of philosophic minds, as the standards by which every proposition for the physical, social, or moral improvement of man ought to be tested. This happy change is likely to be progressive, because it has arisen from the gradual diffusion of sounder ideas, and from the preference instinctively felt for useful truths, when once clearly presented to the understanding.

That, progress is really making in a right direction, may further be inferred from the numerous examples every day presenting themselves, of the successful application of physiological principle to the promotion of human improvement. Among many others, I may refer to the pains taken and the expense incurred, by Government in the proper ventilation, lighting, and heating of the new Houses of Parliament, and many of the public Offices and Hospitals; to the recent official investigation into the means required for promoting health in large towns; to the attention now devoted to secure an improved construction of houses, a better supply of water, more thorough draining, and a more adequate supply of the necessaries and comforts of life, as well as a proper system of education and moral training, for the labouring poor; and lastly, to the special provision so carefully

and intelligently made in the army and navy, for the health, morality, and comfort of the men. All these and many other examples afford striking proofs of the extent to which a perception of the influence of the laws of physiology is beginning to pervade the more enlightened portion of the community; and warrant the hope that a much higher degree of improvement may yet be reached by the wider diffusion and application of physiological knowledge than is at present generally expected. To effect this, however, not only parents and the teachers of the young, but the young themselves, of all ranks and both sexes, must be made familiar, at an early age, with the nature of their own organization, and *trained by example*, as well as by precept, to the practical observance of the laws by which their functions are regulated.

It is with a strong wish to contribute all in my power to this most desirable end, that I am anxious to place this volume within the reach of every class, and especially of the many parents and teachers, both male and female, who have never enjoyed an opportunity of acquiring correct information regarding the physical and mental constitution of man, and who, with the very best intentions, and the strongest desire to discharge their duty, often fall involuntarily into error from the want of it. Even with every aid, the task of the educator is not less arduous than important; and if his success does not always correspond to the zeal, talent, and industry which he brings to its performance, the cause is to be looked for in the prevailing ignorance of the nature of man, far more than in any deficiency peculiar to the individual. Every experienced medical man must be familiar with cases where efforts which, under the guidance of physiological knowledge, would have secured the richest harvest of results, have either been expended in vain, or even been productive of direct, and sometimes permanent, injury to the pupil. To parents and teachers, then, this volume is offered, in the hope that it may afford them both aid and comfort. That it is far from sufficient to satisfy all their wants, no one is better aware than its author; but it may nevertheless, in the absence of a better, help to guide them in a right direction, and enable them to pursue their important labours with increased credit and success. But it is right to warn them beforehand, that the benefit to be derived from the following pages must depend mainly on the spirit in which they are perused. The subjects treated of embrace so many important facts and principles of action, which are comparatively new to the general reader, that it is only by their careful and frequent study that he can become sufficiently familiar with them to avail himself of the applications of which they are capable, to the purposes of self-education and improvement, and to the preservation or recovery of health. To read merely as one reads a novel or a newspaper, can be productive of but little solid or permanent advantage; and therefore, while I value highly the grateful tribute implied in *endeavouring to act* (it may be, in silence) upon the principles I have unfolded, I feel indifferent to even the most eloquent and laboured eulogium, when it is not accompanied by any practical results. I am the more anxious to enforce this view, because many will, I believe, read with increased interest and advantage after their attention has been thus earnestly directed in the very outset to the practical character and aim of the work.

In further pursuit of this object, I have published two additional volumes of the same plain and practical character as that now in the hands of the reader, and, like it (to adopt the words of the German title-page), designed "especially for the use of parents, teachers, the young, and all who take an interest in their own welfare and happiness, or in that of others." In the first of these, on the subjects of *Digestion and Diet*, I have treated of the important functions of digestion and nutrition, and of the laws by which diet ought to be regulated, according to the age, constitution, and mode of life. In the second, *On the Management of Infancy*, I have endeavoured to explain the nature and laws of the infant constitution, and to point out the superior safety and advantage which would result from taking these as the standard by which to regulate every part of Infant Management, moral as well as physical, instead of being guided, as is frequently the case, by mere random observation, or blind adherence to custom or tradition. The very favourable reception with which these works have been honoured, as evidenced in the sale of several very large editions, affords of itself a strong presumption that the want which they were designed to supply has been deeply and extensively felt, and at the same time amply rewards me for the pains I have bestowed in their preparation.

EDINBURGH, 25 RUTLAND STREET,
November 1843.

THE

PRINCIPLES OF PHYSIOLOGY

APPLIED TO THE IMPROVEMENT OF

PHYSICAL, INTELLECTUAL, AND MORAL EDUCATION.

CHAPTER I.

INTRODUCTORY REMARKS.

Objects of the present volume.—Functions to be treated of.—Digestion considered in a separate work.—Guiding principle laid down, and its importance shewn.—Evils of ignorance.—Objections to physiological knowledge answered.—Testimonies to its practical usefulness.

The object of the present volume is to lay before the public a plain and intelligible description of the structure and uses of some of the more important organs of the human body, and to shew how information of this kind may be usefully applied both to the preservation of health, and to the improvement of physical, intellectual, and moral education. In selecting the functions to be treated of, I have preferred to examine those which, while they are the most influential in their operation on the general system, are, at the same time, the most easily understood, and the most directly under our own control. On the present occasion, however, I have, on due consideration, omitted all mention of the digestive organs, although both grounds of preference apply to them in an eminent degree. To have treated of them in a manner proportioned to their extensive influence in the animal economy, would have involved an amount of detail incompatible with the limits of a volume in which other important subjects necessarily fall to be discussed; while to have passed them over altogether would have been to leave unfulfilled one of the principal purposes for which I took up my pen. The only remaining alternative was, to treat of them in a separate volume of the same plain and practical character as the present. I have accordingly done so; and, judging from the success which has attended that work,* I infer that I have neither greatly erred in the resolution which I have adopted, nor miscalculated the value of the information which it was my object to disseminate.

In soliciting attention, as I have done in the following pages, to the manifold applications which may be made of the principles of physiology to the prevention of suffering, and the furtherance of human improvement, it has been my constant endeavour to exhibit the relation subsisting between the rules of conduct which I have occasion to recommend, and the particular laws of the organization according to which their influence is exerted, that the recommendation itself may rest, as far as possible, on the foundation of nature, and not on the doubtful authority of any individual. Many of the valuable treatises which have already appeared on the subjects of health and of education, seem to me to have failed in making an adequate impression on the public mind, chiefly from this basis not having been brought sufficiently into view; and thus not only have the evils arising from defective education been unjustly and invidiously charged against education itself, but the most opposite methods have been advocated and practised with equal earnestness and plausibility, where a direct reference to the laws of the organization would at once have revealed the source of the contradiction and afforded a protection against its occurrence.

It has been objected, that to teach any one how to take care of his own health is sure to do harm, by making him constantly think of this and the other precaution, to the utter sacrifice of every noble and generous feeling, and to the certain production of hypochondriacal peevishness and discontent. The result, however, is exactly the reverse; and it would be a singular anomaly in the constitution of the moral world were it otherwise. He who is instructed in, and familiar with, grammar and orthography, writes and spells so easily and accurately as scarcely to be conscious of attending to the rules by which he is guided; while he, on the contrary, who is not instructed in either, and knows not how to arrange his sentences, toils at the task, and sighs at every line. The same principle holds in regard to health. He who is acquainted with the general constitution of the human body, and with the laws which regulate its action, sees at once his true position when exposed to the causes of disease, decides what ought to be done, and thereafter feels himself at liberty to devote his undivided attention to the calls of higher duties. But it is far otherwise with the person who is destitute of this information. Uncertain of the nature and extent of the danger, he knows not to which hand to turn for safety, and either lives in the fear of mortal disease, or, in his ignorance, resorts to irrational and hurtful precautions, to the certain neglect of those which he ought to use. It is ignorance, therefore, and not knowledge, which renders an individual full of fancies and apprehensions, and robs him of his usefulness. It would be a stigma on the Creator's wisdom if true knowledge weakened the understanding and led to injurious results. And, accordingly, the genuine hypochondriac, whose blind credulity leads him to the implicit adoption of every monstrous specific, is not the person who has gained wholesome knowledge by patient study in the field of nature; but he, and he alone, who has derived his notions of the human constitution, and of the laws of nature, from the obscure recesses of his own unenlightened imagination.

Those who have had the most extensive opportunities of forming an opinion on this subject from experience, bear unequivocal testimony to the advantages which knowledge confers in saving health and life, time, and anxiety. Thus, Dr Beddoes, in alluding to the delicate constitutions of females of the higher ranks in this country, remarks, that he cannot "conceive how they can be rendered more hardy or *less nervous*, if that term is preferred, otherwise than by being seasonably taught the *principles* of self-management;" and adds, that he specifies "the principles," because "little good can be expected unless we proceed as in other instances where we exhibit to sense that connection between cause and ef-

* Already nearly *six thousand* copies of this work have been sold. It is entitled, The Physiology of Digestion, considered with reference to the Principles of Dietetics, 1 vol. post 8vo, with twelve illustrative woodcuts.

fect which constitutes the order of nature" (p. 26). In like manner, Dr Davies, of the East India Company's Depot at Chatham, distinctly states, that the man of mature age, who has been some years at a trade before enlisting, and who has consequently gained some knowledge of his own constitution, always makes the most valuable soldier, because "he not only conforms with more ease to the system of diet and restraint necessary to subordination, but, having more experience, he is *more observant of health, learns sooner how to take care of himself, to avoid or diminish causes of disease, and, when ill, he gives more aid in bringing about a state of convalescence.*" Dr Davies adds afterwards, that this "*knowing how to manage* is an *invaluable qualification* to a soldier embarking for service in a tropical climate;" and if it is invaluable to the soldier, it is assuredly not less safe and advantageous to the civilian.

If, indeed, ignorance were itself a preventive of the danger, or could provide a remedy when it approached, then it might well be said that "ignorance is bliss;" but as it gives only the kind of security which shutting the eyes affords against the dangers of a precipice, and consequently leaves its victim doubly exposed, it is high time to renounce its friendship and protection, and to seek those of a more powerful and beneficent ally. If ignorance could divest us even of the sense of anxiety attending the apprehension of evil, the consequent tranquillity of mind, deceptive though it were, would be at least some compensation for submitting to its rule. But, unhappily, so far from ignorance of the nature and extent of the threatening danger saving us from gloomy anticipations, the fact is notoriously the reverse; for the darkest picture ever drawn is assuredly that delineated by an ill-directed imagination. Every medical man can testify that, natural character and other circumstances being alike, those whose knowledge is the most limited are the fullest of whims and fancies, the most alarmed at every trifling ailment, the most credulous respecting the efficacy of every senseless and preposterous remedy, the most impatient of restraint, and the most discontented at suffering. There are some, no doubt, whose constitutional sensibility prevents them ever controlling their feelings, or being guided by the dictates of reason; but such persons are comparatively few in number, and even they become more tractable as well as more comfortable in spirit, when their minds are enlightened, and their true situation is distinctly understood.

If any of my readers be still doubtful of the propriety or safety of communicating physiological knowledge to the public at large, and think that ignorance is in all circumstances to be preferred, I would beg to ask him whether it was knowledge or ignorance which induced the poorer classes in every country of Asia and of Europe to attempt to protect themselves from cholera, by committing outrages on the medical attendants of the sick, under the plea of their having poisoned the public fountains? And whether it was ignorance or knowledge which prompted the more rational part of the community to seek safety in increased attention to proper food, warmth, cleanliness, and clothing? In both classes, the desire of safety and the sense of danger were the same, but the modes resorted to by each were as different in kind as in result: the efficiency of the one having formed a glaring contrast to the failure of the other.

In thus strongly advocating the benefits to be obtained by the wide diffusion of a general knowledge of the laws of health, I must, however, express my belief that the study of *diseases*, and their modes of cure, by unprofessional persons is not only unprofitable, but often deeply injurious—just because such persons cannot possibly possess the collateral knowledge required to form a correct judgment of all the attending circumstances, and are therefore extremely liable to fall into error, where every error is attended with risk. Let us suppose, for example, what I have seen and what has often happened, that a person of an apprehensive disposition, who has been occasionally subject to palpitation, takes up a medical treatise, and there finds that palpitation is a symptom commonly present where the heart is diseased. It is almost certain that such a person will, in his ignorance, make no farther distinction, but hurry at once to the conclusion that his own heart is affected, and that he must speedily die. The notion being once implanted in his mind, he will become anxious and watchful of every sensation, deny himself necessary exercise from fear of over-exertion, and necessary food from fear of a bloodvessel giving way, and in no long time will fall into a state of weakness and disease which will confirm every one of his apprehensions. But had this individual, instead of acting on his own *imperfect* knowledge, consulted his medical adviser, whose business it is to make himself acquainted with the *whole* of the case, he would have discovered immediately that the dreaded source of all this suffering was originally a simple fit of indigestion, which nature would have cured in three days, had not the machine been so perversely deranged by the very want of exercise and food, in which the patient was ignorantly seeking for safety. Even here, be it observed, the danger arises from the *incompleteness* of the knowledge possessed; and I would condemn the perusal of medical books only because the general reader cannot, except by going through a course of professional study, become qualified to make a proper use of their contents. And accordingly it is well known that few students escape fits of hypochondriacal apprehension when they first seriously enter on the study of diseases; and that they become free from them almost in proportion as their knowledge advances. It is then a most fallacious mode of arguing to contend that, because an imperfect acquaintance with disease is hurtful, a knowledge of the conditions and laws of health must, therefore, be also prejudicial.

CHAPTER II.

NATURE AND USES OF PHYSIOLOGY.

Physiology, Vegetable, Comparative, and Human.—Animate and Inanimate Bodies.—Objects of Physiology.—Usefulness of Physiological knowledge.—Illustrations.—Physiology ought to be a branch of general education.—Much suffering arises from its omission.—Proofs and examples of this in infancy, in general society, on ship-board, in factories, and in Parliament.—Leonard Horner's evidence.—Medical men blameable for the omission—dangerous fallacies arising out of it.—Physiological knowledge necessary for understanding the causes and cure of disease.—The author's case a good example of its utility in promoting recovery.—Slow origin of chronic diseases in continued neglect of the organic laws—their cure by continued obedience to them.—Practical uses of physiology overlooked even in medical education—great injury thence arising.—Causes of this oversight.—Quaint description of health and its value.—Physiology the basis of all educational measures, and therefore indispensable to teachers and parents.

Physiology, from *Φυσις, nature*, and *λογος, discourse*, signifies literally a discourse about natural powers, but, as now used, it applies exclusively to the doctrine of the uses or functions of the different constituent parts of beings endowed with the principle of life. As applied to the vegetable kingdom, it is called *Vegetable* Physiology; to the lower animals, *Comparative* Physiology; and to man, *Human* Physiology. In all of these instances, however, the objects of physiology are the same, viz. to unfold the mechanism and laws by which the various functions which characterize living bodies are carried on, and to explain the manner in which each species is fitted for the particular sphere of action in which the Creator intended it to exist.

The grand mark of distinction between animate and inanimate bodies, is to be found in the different rela-

tions in which they stand to the ordinary laws of the material world. Inanimate or inorganized bodies, such as a mineral or a metal, have no internal power of action, and of themselves can effect no change. Possessed of certain fixed and invariable properties, they stand uniformly in the same relation to each other, and act invariably according to the same general laws, so that what is once ascertained of them can be predicted with certainty to hold true for ever after; and therefore, in conducting our investigations, we know that the same effects will always follow the same causes with mathematical precision. But when the same elementary material becomes part of a living body, this rule no longer holds; the laws of chemical and physical action are greatly modified, or for a time counteracted. The now organized matter, having entered into new relations with other organized matter, henceforth obeys the laws of vegetable or animal life, and is not again subjected to those of purely chemical action, till it is either eliminated from the body, or till life is extinct; and, in point of fact, the putrefaction which instantly follows the extinction of the vital principle is neither more nor less than the ordinary laws of inanimate matter resuming their dominion when no longer opposed by a higher power.

An example or two will render the difference more apparent. All bodies gravitate towards the earth, according to a constant and well-known law. But animals are able to resist this law, so far as to preserve an attitude at variance with its tendency, or even to rise, like the eagle, many thousand feet in the air in opposition to their natural weight; but on the extinction of life they lose this power, and again become subject to the full influence of gravitation. In the same way many animals preserve an elevated and steady temperature, whether exposed to severe cold or to excessive heat; but, when life ceases, rapidly assume that of the objects by which they are surrounded. A human being may, for instance, be exposed to the intensest cold of the Polar regions without having his own internal temperature reduced by a single degree, so long as life endures; but, from the moment when life ceases, the heat which is lost is no longer replaced, and consequently his body becomes in a short time frozen and stiff like the other inanimate masses by which it is surrounded.

Here, then, is a grand boundary-line dividing the organized from the inorganized, the animate from the inanimate body. Chemistry and natural philosophy investigate the laws and conditions which regulate the action and movements of inanimate or inorganized objects; but, from what we have seen of the power of the vital principle in modifying these, it will be manifest that, however extensive and accurate our knowledge of the properties of the elementary materials of living bodies, considered separately, may be, we can thence infer nothing in regard to the qualities of the animal compound when endowed with life, but must resort to observation and study for the discovery of the conditions by which life is characterized, and under which it is carried on.

Physiology, or the history of the functions which characterize *living* beings, is thus a subject of peculiar interest; and human physiology, or that which is about to engage our attention, is as important in its practical consequences as it is attractive to rational curiosity. In its widest sense it comprehends an exposition of the functions of the various organs of which the human frame is composed; of the mechanism by which these are carried on; of their relations to each other; of the means of improving their development and action; of the purposes to which they ought severally to be directed; and of the manner in which exercise ought to be conducted, so as to secure for the organ the best health, and for the function the highest efficiency. A true system of physiology comes thus to be the proper basis, not only of a sound physical, but of a sound moral and intellectual education, and of a rational hygiène; or, in other words, it is the basis of every thing having for its object the physical and mental health and moral improvement of man: for so long as life lasts, the mental and moral powers with which he is endowed manifest themselves through the medium of organization, and no plan which he can devise for their cultivation, that is not in harmony with the laws which regulate that organization, can possibly be successful.

But, besides the power of resisting the operation of the ordinary chemical and physical laws, living bodies are distinguished by other properties peculiar to themselves. Unlike inorganized matter, which exists in the same form from the beginning, bodies endowed with the principle of life derive their origin from previously existing living bodies of the same nature as themselves; and they in their turn give birth to others, and in this way the succession is kept up. Unlike the inert material which retains its properties unaltered throughout endless ages, the living body is constantly undergoing changes from the first to the last moment of its existence; and these are exemplified, on the large scale, in the great stages of youth, maturity, old age, and death. Unlike inorganized matter, which neither grows nor decays, living bodies require a constant supply of nourishment to admit of their growth in youth, and to replace the worn-out particles which are regularly thrown off at every period of life; and unlike inanimate objects, the properties of which never alter, living bodies cease at last to exist, and their component elements, deprived of the principle of life, again become wholly subject to the ordinary laws of matter, and are speedily decomposed and scattered about, as if life had never been. The above properties, it may be observed, are common to vegetable and animal life; but animals possess others peculiar to themselves. Among the most remarkable of these are sensation, thought, voluntary motion, and the faculty of communicating to each other their thoughts and feelings through the medium of natural or artificial language. These are grand marks of distinction, and, considered in a general point of view, amply suffice to divide the two great classes of animated beings; for, while some animals exhibit individual powers in higher perfection, man stands far their superior, not only in combining in his own person all the senses and faculties which they possess, but in being endowed with moral and intellectual powers which are denied to them, and which at once place him at the head of the living creation, and constitute him a moral, religious, intelligent, and responsible being.

So numerous and important are the various organs of which the human frame is composed, and so closely are they linked with each other in their action, that, in treating of them, it is difficult, or rather impossible, to follow any arrangement which shall not involve considerable repetition, or which shall admit of every statement being at first fully understood. On the present occasion, however, a systematic mode of proceeding is not essential, my object being merely to communicate a general knowledge of some of the more important functions, partly with a view to the direct practical purposes to which such information may be applied, and partly for the sake of rousing public attention to the necessity of including this branch of science in every plan of what is called a liberal education.

Let it not be said that knowledge of this description is superfluous to the unprofessional reader; for society groans under the load of suffering inflicted by causes susceptible of removal, but left in operation in consequence of the prevailing ignorance of our own structure, and of the relations of the different parts of the system to each other and to external objects. Whether we consider the pressing evils to which many of the working classes are habitually exposed in the exercise of their various trades, without any attempt being made to ap-

ply the resources of knowledge to their relief or protection; or whether we contemplate the thousand forms in which the seeds of disease are allowed to be scattered about, especially in our larger towns, when even a small amount of physiological knowledge among the public would almost ensure their speedy removal, we cannot but feel greatly surprised that so little should have been done, during so long a time, to dissipate that ignorance from which, not the poor alone, but the noble and the wealthy, have often extensively suffered. In this respect, professional men have, I fear, been much to blame. They alone were the possessors of the knowledge required, and they alone could fully appreciate its value; and yet they have rarely made any effort either to diffuse it more widely or to rouse attention to its importance. The consequence has been, that every medical man must have felt and lamented, even while he was in some degree blamable for, the ignorance so generally prevalent in regard to the simplest functions of the animal system, and its necessary consequence—the absence of the judicious co-operation of friends in the care and cure of the sick; and that in the sufferings of even his own family and friends he must often have been punished for the physiological ignorance which he allowed to prevail around him.

It is from the same ignorance of the commonest facts in the constitution of the human body, and of the influence of external conditions upon its various functions, that we meet with so many men—among our legislators, for instance—of much good sense and information in every other respect, who not only subject themselves unwittingly to the active causes of disease, but give their sanction to laws and practices destructive equally to life and morality, and which, if they saw them in their true light, they would shrink from countenancing in the slightest degree. As one striking example, I may refer to a law which exists, or lately existed, in France, by which infants must be taken within a very short time after being born to the office of the *Maire*, if it is wished to have their births registered. But there is another law, written by the finger of the Creator on the very constitution of the infant being, with which this enactment is directly at variance; and, in consequence of this higher law, the infant is found to be incapable of bearing exposure to a low temperature without injury. The result is, that in winter, especially in places where the *Maire* resides at a distance, and where, consequently, the exposure is increased, a greater mortality takes place than is observed among infants placed under more favourable circumstances. Had the nature of the living functions been generally understood by the framers of such a law, it is obvious that it could never have been enacted; for to have done so knowingly would have been in substance to legalize infanticide.

In the preceding editions of this work I mentioned another instructive instance of the dangers arising from thus excluding even the simplest notions of physiology from common education. It was that of the death of two young men on board of the Magnus Troil in Leith harbour, in March 1833, arising from suffocation. They had gone to bed in the cabin as usual, but had shut the door so closely on account of the cold, that they were found in the morning the one dead and the other dying from mere want of air. Since that time, I have read in the newspapers of the day, accounts of six accidents precisely similar in every particular. The two last, in which two fine young men also perished, happened in the cabin of the sloop Mary Hardie, lying in Greenock harbour, in November 1840, from which it is manifest that such occurrences are by no means unfrequent. And yet it is quite clear that, had these unfortunate victims been made acquainted at school, even in a very general way, with the nature of the atmosphere, and with the relation of its elements to the function of respiration, they would have seen too clearly the danger of shutting themselves up in such a confined space, ever to have risked their lives in the way they did. A constant supply of pure air is indispensable to the formation of proper blood in the lungs, and consequently to the preservation of life and the wellbeing of the whole body; but formerly, when this condition was as little known or regarded as it was by these seamen, many persons were shut up together in small ill-ventilated rooms in schools, jails, and hospitals, and the natural result was a degree of mortality from fevers and other diseases, which, now that the laws of respiration are better known and more attended to, is never heard of.

For additional evidence of the evils arising to society from the neglect of physiological knowledge as a constituent part of a good education, I might refer to the lamentable ignorance displayed in Parliament, even by very intelligent and well-educated men, during the frequent discussions on the regulation of infant labour in factories and mills. But as I shall have occasion to touch upon this subject more than once in the subsequent chapters, I shall now only remark, that, previous to 1833, the law authorized the working of children between the years of eight and sixteen, in the close-heated atmosphere of a cotton-mill, for twelve hours a-day; and that as a great boon, by the Factories' Regulation Bill passed in that year, no children are now employed under nine years of age, while between that and fourteen the period of daily labour is not to exceed eight hours. Had our legislators been instructed in anatomy and physiology so far as to obtain even the most general notion of the constitution of the human body, and had they been aware of the intimate dependence of the mind on the condition of the bodily organization, they would at once have perceived the destructive tendency of the former system of labour and confinement, and the utter impossibility of combining with it that moral and intellectual cultivation which is so imperatively required. Instead of objecting to the limitation when it was proposed, they would have looked forward with dread to the physical and moral degradation which the system then in operation was fast effecting in the multitudes under its influence; and their only doubt would have been, whether even *eight* hours' labour in a close atmosphere was not too much for undeveloped children, and was not incompatible with that efficient moral and general training in the domestic circle, which is indispensable to the development of our best feelings, and, consequently, to the formation of peaceful, moral, and intelligent citizens. The evidence in the printed Parliamentary report is said to have been partially got up; but granting that it was so, it nevertheless contains a multitude of facts so entirely in accordance with the soundest and best understood principles in physiology, and which no counter-evidence can rebut, that one can only lament the ignorance which prevented many able and benevolent but prejudiced men from perceiving its true character, and yielding so far to the imperious dictates of nature and of duty as to legislate at once and effectively for the protection of the young. That there were great difficulties in the way of every alteration is quite true; but surely no question of mere gain to any or to every class ought to be allowed to stand *for ever* in the way, when the lives and happiness of multitudes of our fellow-creatures, and the tranquillity and real prosperity of the country, are at stake. Unless we *begin* somewhere, how can any improvement ever be accomplished?

Since the preceding remarks were first published in the earlier editions of the present work, I have been delighted to find from Mr Leonard Horner's recently published pamphlet,* that all the ominous predictions of ruin and misery made by many of the manufacturers, when contending against any legislative interference for the purpose of limiting the working hours of the children, have been entirely falsified, and that, after a seven years' trial, most of them are now satisfied that the law

* On the Employment of Children in Factories and other works. Longman and Co., 1840.

has been *beneficial even to themselves.* Thus it will always be when we enter upon a right course.

It would be easy to multiply to an indefinite extent similar examples of hurtful ignorance among both public bodies and private individuals; but as many of them will be mentioned incidentally when treating of the special functions of the animal economy, it is unnecessary to dwell farther upon them at present.

We are constantly meeting with anomalies in practical life, in the case of individuals little accustomed, when in health, to observe or to reflect on the influence of external circumstances and modes of living in disturbing the actions of the various animal functions, but at the same time easily and deeply impressed by all *extraordinary* occurrences affecting them. Thus, when any one is taken ill, his relatives or friends become extremely anxious to have his room properly ventilated; his body-clothes frequently changed and carefully aired; his food properly regulated in quantity and quality; his skin cleaned and refreshed; his mind amused and tranquillized; his sleep sound and undisturbed; and his body duly exercised;—and they state as the reason for all this care, and most justly, that pure air, cleanliness, attention to diet, cheerfulness, regular exercise, and sound sleep, are all highly conducive to health. And yet such is the inconsistency attendant on ignorance, that the patient is no sooner restored, than both he and his guardians are often found to become as careless and indifferent in regard to all the laws of health, as if these were entirely without influence, and their future breach or observance could in no way affect him! Just as if it were not better, by a rational exercise of judgment, to preserve health when we have it, than first to lose it, and then pay the penalty in suffering and danger, as an indispensable preliminary to its subsequent restoration!

One cause of such anomalous conduct is the dangerous and prevalent fallacy of supposing that, because glaring mischief does not *instantly* follow every breach of an organic law, no harm has been done. Thus, what is more common than to hear a dyspeptic invalid, who seeks to gratify his palate, affirm, that vegetables, for example, or pastry, or puddings, do not disagree with him, as he ate them on such a day and felt no inconvenience from them? and the same in regard to late hours, heated rooms, insufficient clothing, and all other sources of bad health, every one of which will, in like manner, be defended by some patient or other, on the ground that he experienced no injury from them on a *certain specified occasion;* while all, when the rule is not directly applied to themselves, will readily admit that, in the case of others, such things are, and *must be*, very hurtful.

Happy would it often be for suffering man could he see beforehand the modicum of punishment which his multiplied aberrations from the laws of physiology are sure to bring upon him. But as, in the great majority of instances, the breach of the law is limited in extent, and becomes serious only by the frequency of its repetition; so is the punishment gradual in its infliction, and slow in manifesting its accumulated effect; and this very gradation, and the distance of time at which the full effect is produced, are the reasons why man in his ignorance so often fails to trace the connection between his conduct in life and his broken health. But the connection subsists although he does not regard it, and the accumulated consequences come upon him when he least expects them.

Thus, pure air is essential to the full enjoyment of health, and reason shews that every degree of vitiation must necessarily be *proportionally* hurtful, till we arrive at that degree at which, from its excess, the continuance of life becomes impossible. When we state this fact to a delicately constituted female, who is fond of frequenting heated rooms, or crowded parties, theatres, or churches, and call her attention to the hurtful consequences which she must inflict on herself by inhaling the vitiated air of such assemblies, her answer invariably is, that the closeness and heat are very disagreeable, but that they rarely injure *her*:—By which she can only mean, that a single exposure to them does not always cause an illness serious enough to send her to bed, or excite acute pain; although both results are admitted sometimes to have followed. An intelligent observer, however, has no difficulty in perceiving that they *do* hurt her, and that although the effect of each exposure to their influence is so gradual as not to arrest attention, it is not the less progressive and influential in producing and maintaining that general delicacy of health by which she is characterized and from which no medical treatment can relieve her so long as its causes are left in active operation.

The debility so generally complained of in spring by invalids and persons of a delicate constitution, and which renders that season of the year so formidable in prospect and in reality so fatal, seems, in numerous instances, to result more from the accumulated effects of neglect during the preceding winter months, than from any thing directly inherent in the season itself. At the commencement of winter, such persons feel comparatively strong from the beneficial exposure to the open air, light, and exercise, which they enjoyed during the summer and autumnal months. But, in proportion as they are deprived of these advantages by the advance of winter, and are subjected to the evil consequences of confinement, deficient exercise, cold damp air, and deprivation of the stimulus of light, the strength of the constitution becomes impaired, and debility and relaxation begin to be felt, and make progress from day to day, till, on the arrival of spring, they have reached their maximum, and then either give rise to positive disease, or again gradually disappear on the return of the invigorating influence of longer and warmer days. Where, however, pulmonary disease or any unusual susceptibility pre-exists, this principle will not apply; for in such cases, the east winds prevalent in spring are directly injurious.

If the above view be correct, it is obvious that, in most cases, the hurtful cause is not, as is commonly supposed, so much any positive quality of the season, as the accumulated mass of the winter influences then reaching their maximum; and this is not perceived, only because the effect from day to day, although perfectly real, is too small to attract notice, while the aggregate result of the many days composing winter is striking enough. The fact that those who deny themselves the delight of late parties and crowded rooms, and are sufficiently robust to undergo the necessary exposure in winter, suffer much less in spring, seems to corroborate the above explanation.

Of the truth and practical value of the above doctrines, the author may be allowed to quote his own case, as an instructive example. In the autumn of 1831, he went to Italy in consequence of pulmonary disease; which, in January and February 1832, reduced him to such a state of debility as to leave no hope of his surviving the spring. Aware that his only chance lay in assisting nature to the utmost extent by placing every function in the circumstances best fitted for its healthy performance, he acted habitually on the principle of yielding the strictest obedience to the physiological laws and rendering every other object secondary to this. He did so, in the full assurance that, whether recovery followed or not, this was, at all events, the most certain way to secure the greatest bodily ease and the most perfect mental tranquillity compatible with his situation. The result was in the highest degree satisfactory. From being obliged to pause twice in getting out of bed, a slow but progressive improvement took place, and by long and steady perseverance continued till, at the end of two or three months, he was able to drive out and walk a little every day. From month to month thereafter, the amendment was so gradual as to be scarcely perceptible;

but, at the end of a longer period, the difference was striking enough. Thus encouraged, the author continued true to his own principles, and in resisting every temptation to which improving health exposed him: and the ultimate result has been that every successive year from 1832 up to the present time, 1841, has, with one or two exceptions, found him more healthy and vigorous than before, and that many of his professional friends, who long regarded his partial convalescence as destined to be of very brief duration, cannot yet refrain from an expression of surprise on observing it to be still perceptibly advancing at the end of ten years.

The author now publishes this example, both because, as an illustration of the advantages of acting in accordance with the laws of our nature, it is as instructive as any with which he is acquainted, and because it strikingly shews the gradual accumulation of almost imperceptible influences operating surely though slowly in restoring him to a degree of health and enjoyment which has richly repaid him for all its attendant privations. Had he not been fully aware of the gravity of his own situation, and, from previous knowledge of the admirable adaptation of the physiological laws to carry on the machinery of life, disposed to place implicit reliance on the superior advantages of fulfilling them as the direct dictates of Divine Wisdom, he never would have been able to persevere in the course chalked out for him, with that ready and long enduring regularity and cheerfulness which have contributed so much to their successful fulfilment and results. And, therefore, he feels himself entitled to call upon those who, impatient at the slowness of their progress, are apt after a time to disregard all restrictions, to take a sounder view of their true position, to make themselves acquainted with the real dictates of the organic laws, and, having done so, to yield them full, implicit, and persevering obedience, in the certain assurance that they will reap their reward in renewed health, if recovery be still possible; and if not, that they will thereby obtain more peace of mind and bodily ease than by any other means which they can use.

From the preceding explanation of the slow but gradually increasing effect of both noxious and healthful influences on the human body, it is obvious that while we cannot infer from a single application of a remedy or single fulfilment of a physiological law being unproductive of an instantly perceptible result, that it is therefore of no use; neither ought we to infer that because a *single* excess of any kind does not produce a *direct* attack of disease, it is therefore necessarily harmless; for it is only when the noxious agent is very powerful indeed that its deleterious influence on the system becomes instantly sensible. In the great majority of situations to which man is exposed in social life, it is *the continued or the reiterated application of less powerful causes* which gradually, and often imperceptibly, unless to the vigilant eye, effects the change, and ruins the constitution before danger is dreamt of; and hence the great mass of human ailments is of slow growth, and slow progress, and admits only of a slow cure. Whereas those which are suddenly induced by violent causes, are urgent in their nature and rapid in their course. And yet so little are we accustomed to trace diseased action to its true causes, and to distinguish between the essential and the accidental in the list of consequences, that, as already observed, if no glaring mischief has followed any particular practice, within at most twenty-four hours, nine out of ten individuals will be found to have come to the conclusion that it is perfectly harmless, even where it is capable of demonstration that the reverse is the fact.

The benevolence and wisdom of this arrangement are very conspicuous. There are many casual influences from the agency of which man will never be able entirely to protect himself. If they are speedily withdrawn from him, the slight disorder which they produce quickly ceases, and health remains essentially undisturbed. But, if they be left in operation for a considerable length of time, the derangement which they excite gradually and slowly increases, till at last a state of disease becomes established, which requires an equally long or longer period, and a steady observance of the laws of health, for its removal.

Such is the history of the rise and progress of most of the ailments which afflict the human family, and the source of the grand distinction between *acute* and *chronic* diseases. We are apt to wonder that a severe disease like inflammation should run its course in a few days, while dyspeptic and nervous ailments require months for their cure. But our wonder is diminished when we attend to the fact, that the one generally dates its rise from a strong cause applied within perhaps a few hours or a few days; while the others are the slow and gradual results of months or years of previous anxiety or neglect of dietetic rules and exercise, during which the ailment was maturing unnoticed and unsuspected. Had the real state of the matter been early perceived, and the causes been removed, the dyspeptic and the nervous invalids would have regained health and serenity in proportionally little time, and with proportionally little suffering. In such cases, Nature kindly allows some latitude of action free of serious penalty, as if on purpose to protect us from being hurt by such occasional exposure as we are necessarily subjected to by the ordinary vicissitudes of life; but it is always on condition of returning to obedience the moment the necessity is over. If we presume on the indulgence being permanent, the evil accumulates, and health is destroyed; but if we return in time to the right path, little inconvenience results. Where, however, the injurious influences are of a more energetic kind, equal latitude of exposure is obviously incompatible with safety. Were they not to enforce immediate notice, our corporeal organs might be irrecoverably altered by disease before we took the alarm, and it is therefore the purest benevolence to attach immediate suffering to them, in order to ensure that instant attention which alone can stay the rapidity of their progress.

In chronic or slowly arising diseases, then, the separation of the effect from its cause is only apparent and not real, and in practice it is essential to keep this in mind. A fit of insanity, for example, is often said to have come on *without any cause*, when, on minuter examination, causes can be easily traced operating through many previous months, only not of so violent a nature as to have at once upset reason, and the same will be found to hold in almost all those slow and insidious illnesses which so often baffle our best efforts; and although at present we cannot always discover their true origin, it is clear that we shall ultimately succeed much better if we believe them to have causes which *may* be found out, than if we regard them as mysteries which no study or attention can ever explain.

It is this apparent but unreal separation of the effect from its cause which has given rise to the variety of opinions entertained in regard to the qualities of the same agents, and which has, perhaps, tended more than any thing else to discourage rational regard to the means of preserving health; and yet this very variety is a proof at once of the absence of sound views of our own nature, and of the urgent necessity of possessing them. In society, accordingly, nothing is more common than to hear the most opposite opinions expressed in regard to the evils or advantages of particular kinds of clothing, food, and exercise. One person will affirm, with perfect sincerity, that flannel is pernicious, because it irritates the skin, and uniformly causes an eruption over the whole body; and that linen or cotton is an excellent article of dress, because it produces no such consequences. Another will tell us, with equal truth, that flannel is a capital thing, because it is pleasant to the feeling, and affords protection from cold and rheumatism, which linen does not. One will affirm that a long walk or violent muscular exercise is an excellent tonic, because it gives a keen

appetite, and a vivacity and alertness which are delightful. But another will declare that a long walk or severe exercise is exceedingly injurious and debilitating, because it destroys his appetite, and unfits him for exertion of mind or body, and always gives him headach. One will, in like manner, praise vegetables as the best diet, and another animal food as infinitely superior, and so on through the whole range of the physical objects which act upon the human frame; and the natural consequence of these apparent anomalies and contradictions is, that, when in health, we come practically to look upon the effects of air, food, exercise, and dress, as very much matters of chance, subject to no fixed rule, and therefore little worth attending to, except when carried to palpable extremes, or in the cure of disease.

In this way, man, instead of being able to protect his children by the results of his own experience in his journey through life, goes on from generation to generation, groping a little, then seeing a little, and then groping again, till he arrives, often prematurely, at the end of his existence, when he stumbles into his grave, leaving his posterity to pass unaided through the same series of experiments, and arrive at the same termination, as himself.

This unnatural result must arise either from the laws which regulate the animal functions and the operations of external objects being variable and ever changing, or from the conditions of the living body on which they act being different in different persons, or in the same person at different ages or seasons; and it is not difficult to determine to which of these it is to be ascribed. It cannot be the first, for the laws of nature are invariable and unbending. The food which to-day nourishes and sustains the body, and which to-morrow, when sickness is present, raises the pulse and excites the heart to febrile action, has not altered its qualities or changed its relation to the healthy body. It is the state of the body that has changed, and caused the apparent discrepancy of effect. In judging, therefore, of the propriety, advantages, or evils of exercise, food, and clothing, we must take into consideration not only the kind of exercise, the kind of food, and the kind of clothing, but also the age, health, and kind of constitution of the individual who uses them, and adapt each to the degree in which it is required; and then we may rest assured that many of our difficulties will vanish, and certainty and consistency come proportionally into view.

Were the intelligent classes of society better acquainted with the functions of the human body, and the laws by which they are regulated, many of these anomalies in practice would disappear; the sources of much suffering would be dried up, and the happiness of the community at large be essentially promoted. Medical men would no longer be consulted so exclusively for the *cure* of disease, but would also be called upon to advise regarding the best means of strengthening the constitution, from an early period, against any accidental or hereditary susceptibility which might be ascertained to exist. More attention would be paid to the *preservation* of health than is at present practicable, and the medical man would then be able to advise with increased effect, because he would be proportionally well understood, and his counsel, in so far at least as it was based on accurate observation and a right application of principles, would be perceived to be, not a mere human opinion, but in reality an exposition of the will and intentions of a beneficent Creator, and would therefore be felt as carrying with it an authority to which, as the mere dictum of a fallible fellow-creature, it can never be considered as entitled.

It is true that as yet medicine has been turned to little account in the way of directly promoting the physical and mental welfare of man. But the day is perhaps not far distant, when, in consequence of the improvements both in professional and in general education now in progress, a degree of interest will become attached to this application of its doctrines far surpassing what those who have not reflected on the subject will be able to imagine as justly belonging to it, but by no means exceeding that which it truly deserves. In allusion to these remarks it may be not uninstructive to notice, that, in the case of the lower animals, the necessity of modifying the method of cultivation according to the peculiarities of constitution which they present, has been long perceived and consistently acted on, and with such success as to afford us good reason for applying the same rule to our own species, and for considering every mode of education as erroneous and inefficient, which is not in harmony with the higher nature of man. The extent, indeed, to which, by following this plan, we can carry our influence over the lower animals, and secure the development and efficiency of almost every organ and quality which we desiderate, has often been the theme of admiration and surprise; and there can scarcely be a doubt that were the same principle followed in the cultivation of the physical, moral, and intellectual powers of man, and were no rule received which is not in accordance with the laws of his constitution, a much higher degree of success would reward our exertions than has ever yet been experienced.

The little regard which has hitherto been paid to the laws of the human constitution, as the true basis on which our attempts to improve the condition of man ought to rest, will be obvious from the fact, that notwithstanding the direct uses to which a knowledge of the conditions which regulate the healthy action of the bodily organs may be applied, in the prevention, detection, and treatment of disease, there is scarcely a medical school in this country in which any special provision is made for teaching it; the pupil being left to elaborate it for himself from amidst information communicated to him for other purposes. It is, therefore, only too true that "*preventive medicine*, the destined guardian of infancy, youth, manhood, and old age, adapted to the interior of families, has yet no existence."* In some of the foreign universities, indeed, chairs have been instituted for diffusing instruction of this description; and, in France, a Journal of Hygiène has existed for several years. But, in this country, with the exception of the London University, which, since the publication of the former editions of this work, has done itself honour by being the first institution in Britain to require an acquaintance with Hygiène from intending candidates for its diploma, the subject has never been treated with anything like the regard which it assuredly deserves. In one point of view, indeed, the omission is not so extraordinary as it may at first sight appear. The prominent aim of medicine being to discriminate and to cure *disease*, both the teacher and the student naturally fix upon that as their chief object; and are consequently apt to overlook the indirect but substantial aid which an acquaintance with the laws of health is calculated to afford in restoring the sick, as well as in preserving the healthy from disease.

It is true that many medical men, sooner or later, work out this knowledge for themselves: but I have no hesitation in saying, that these are exceptions to the general rule, and that the greater number pass through life without a conception of its value in the prevention and cure of disease. Even those who ultimately become familiar with the subject almost always attain their knowledge only after having suffered from the want of it, and rarely master it so completely as they would have done had it been made a part of their elementary education, to which they saw others attach importance. In my own instance, it was only after having entered upon practice that I had first occasion to feel and to observe the evils arising from the ignorance which prevails in society in regard to it. Impressed afterwards more

* Lecture Introductory to a course of popular instruction on the constitution and management of the human body, by Dr Thomas Beddoes. 1797, p. 58.

deeply than ever with the interest and utility of the study, I contributed two or three articles on the subject to one of our periodical journals, and resolved to make them the basis of a more detailed and connected exposition, as soon as my own views should be matured by sufficient experience and reflection. This I have now attempted; not, I need scarcely add, with the view of making every man his own physician, or of recommending the general perusal of professional treatises—for both practices induce many more ailments than they cure; but simply with the hope that the method which I have followed, of connecting physiological details with practical applications, may be found useful and interesting to both the medical and the general reader.

The practical neglect of physiological knowledge in the training and education of the young, and especially of the professional student, seems to me to have arisen, to a great extent, from the unnatural separation of the different branches of medical science from each other by their cultivators and teachers, and the exclusive devotion of each to his own favourite department. The Anatomist, for example, teaches structure, and structure only, and refers to the Physiologist for an account of the uses to which it is subservient; and the Physiologist, on the other hand, expounds functions, but scarcely touches upon the instruments by which they are executed. The consequence is, that the student often becomes disgusted with what he considers dry anatomical details, when perhaps nothing would interest him more deeply were the purposes which the structure fulfils in the animal economy taught to him at the same time. Many, in like manner, fail to take any pleasure in the study of physiology, who would be truly delighted to hear the truths of which it treats expounded in connection with peculiarities of organization, and with more frequent reference to their practical applications. The Anatomist and Physiologist err, in short, in limiting themselves too exclusively to their own particular pursuits, and devoting too little attention to the relations which these bear to each other and to the great unit,—the living being, of which they form a part. So far, indeed, has this separation been carried, and so injurious is the habit thence arising of contemplating objects under the narrowest point of view, that I have known a very able teacher of physiology, in his public lectures, ridicule the very notion of laying down general rules for the preservation of health, and imagine that he set the matter entirely at rest by the simple assertion that *variety* is advantageous, and affirming that, therefore, *uniformity of obedience to any rules must be prejudicial*,—as if it were not of the very essence of general laws to be modified in their operation and results by the circumstances under which they act; and as if, because of such modifications, their influence might with safety be entirely neglected.*

The result of this erroneous system is, as already hinted, that the young practitioner is educated without having made himself sufficiently familiar with the conditions on which the *healthy* action of the animal economy depends, or having even rightly appreciated the importance of such knowledge; and that, consequently, in common with his patient, he not only neglects the important agency of hygienic influences in the cure of disease, but sometimes unwittingly allows the operation of morbid causes to go on without interference, where, by a timely warning on his part, serious illness might have been averted; or unconsciously permits the gradual ripening of hereditary tendencies into active disease, which rational precautions, early resorted to, might have kept in subjection throughout a long period of existence.

Some practitioners, I am aware, object to unprofessional persons attempting to make themselves acquainted with the structure or functions of the human body, and, in practice, think it best never to give any explanation to the patient of the principles on which it is proposed to conduct the treatment. But, generally speaking, it will be found that the cheerful co-operation of the patient is never so effectually secured as by addressing his understanding, and giving him an intelligible interest in what is proposed for his relief. In acute diseases, of course, explanation of any kind is often precluded. Here the professional man must act, and act with decision. But the great majority of ailments are of a chronic character, in the cure of which the steady co-operation of the patient is almost indispensable. And even when the malady is acute, the patient will submit to severe measures much more readily when ordered by an adviser who has been in the habit of addressing his reason when opportunity occurred, than when prescribed by one who has always followed the system of dictation.

So far from the rational care of health being justly chargeable with the imputation of selfishness, so often ignorantly thrown out against it, there is nothing which tends so much to relieve society from the burden of miseries not its own, as each individual taking such care of his constitution as shall enable him to cope successfully with the duties and difficulties of the situation in which he is placed. No man is so thoroughly selfish as he who, in the ardent pursuit of pleasure or of profit, heedlessly exposes his life to the hazard of a die, regardless of the suffering which he may entail upon those who depend on him for support. In the abstract, we all admit that the enjoyment of health is the first of earthly blessings, and that without it all others may be lavished in vain; and yet it has been quaintly asked, "Who is he that values *health* at the *rate* it is *worth*? Not *he* that hath it; he reckons it among the *common ordinary* enjoyments, and takes as *little notice* of it, or *less* regards it, than his long-*worn clothes*: perhaps more *careful* of his *garments*, remembering their *price*; but thinks his *health* costs him *nothing*, and coming to him at so easy a *rate*, values it accordingly, and hath little *regard* to keep it: is never truly sensible of what he *enjoyed* until he finds the *want* of it by *sickness*; then *health*, above *all things*, is earnestly desired and wished for."

In proportion, however, as we consider the matter with that attention which its importance really deserves, we shall become anxious rather to take care of health, when we have it, than first to lose it, and then exert ourselves to recover it. Such was evidently the feeling which elicited the following remarks from the same clear-sighted author.

"You that have health," says he, "and know not how to *prize* it, I'll tell you what it is, that you may love it better, put a higher *value* upon it, and endeavour to *preserve* it with a more *serious*, *stricter* observance and tuition.

"*Health* is *that* which makes your *meat* and *drink* both *savoury* and *pleasant*, else Nature's injunction of *eating* and *drinking* were a hard task and slavish custom.

"*Health* is *that* which makes your bed *easy* and your *sleep refreshing*; that revives your *strength* with the rising sun, and makes you *cheerful* at the light of another *day*; 'tis that which fills up the hollow and uneven places of your carcass, and makes your body *plump* and *comely*; 'tis that which *dresseth* you up in Nature's *richest attire*, and *adorns* your face with her *choicest* colours.

"'Tis *that* which makes *exercise* a *sport*, and walking abroad the enjoyment of your *liberty*.

"'Tis *that* which makes *fertile* and increaseth the natural *endowments* of your mind, and preserves them *long* from *decay*, makes your *wit* acute, and your *memory retentive*.

"'Tis *that* which supports the *fragility* of a corruptible body, and *preserves* the *verdure*, *vigour*, and *beauty* of youth.

"'Tis *that* which makes the *soul* take delight in her *mansion*, sporting herself at the casements of your eyes.

* The lecturer above alluded to afterwards changed his opinion so far as, not only to deliver a course of popular lectures on Physiology, but to publish in favour of its being considered an indispensable branch of general education.

"'Tis *that* which makes *pleasure* to be *pleasure*, and delights delightful, without which you can solace yourself in nothing of *terrene* felicities or enjoyments."

But "now take a view of yourself when *health* has turned its back upon you, and deserts your *company*; see then how the *scene* is changed, how you are robbed and spoiled of all your comforts and *enjoyments*.

"Sleep that was stretched out from *evening* to the *fair bright day*, is now broken into pieces, and *subdivided*, not worth the accounting; the *night* that before seemed *short* is now too *long*, and the downy bed presseth hard against the bones.

"*Exercise* is now *toyling*, and *walking abroad* the carrying of a *burthen*.

"The *eye* that flasht as lightning is now like the *opacous* body of a thick cloud; that rolled from *east* to *west*, swifter than a *celestial orb*, is now tired and weary with standing still;—that penetrated the *centre* of another *microcosm*, hath lost its planetary influence, and is become obtuse and dull," &c.

If such, then, be a true picture of the opposite conditions of health and disease, what stronger inducements can any one require to give him an interest in the "study and observance of Nature's institutions," seeing that they are the only means by which "the beloved ends and wished-for enjoyments" can be attained, and that we "may as likely keep or acquire *riches* by *prodigality*, as preserve *health* and obtain *long life* by *intemperance*, inordinate passions, a noxious air, and such like injurious customs, ways, and manner of living?"*

But it is not merely in preserving health and improving the physical condition of mankind, that physiology is calculated to prove eminently useful. It applies with at least equal force, and with still higher results, to the cultivation of the moral and intellectual nature of man, and in fact constitutes the only basis on which education can securely rest; and until this important truth be perceived and acted upon to its full extent, education will fall short in its beneficial results. So long as life continues, from the moment of birth to the hour of dissolution, the mind acts only through the medium of the living organization, and is directly influenced by every change in its state. In infancy, its powers are mobile and feeble, because the brain is as yet imperfectly developed and organized. In youth, its powers increase in readiness and vigour; because their material instruments have advanced so far towards maturity. In old age they again become feeble and wavering, from the gradual decay of the organization. In disease they are in like manner exalted or impaired by the excitement or oppression of the brain. Under the influence of wine they are roused to energetic activity, while under that of opium they become buried in sleep. At home and at school, the intellect and feelings are equally dependent on the brain for their power of working, and there, as on every other occasion and at every instant of life, they act always in obedience to, and in accordance with, the physiological laws of the constitution. It is clear, therefore, that if the teacher remain unacquainted with the connexion subsisting between the mind and body, and with the chief circumstances by which the action of the brain is influenced, he cannot regulate his treatment of the different mental faculties with any certainty or precision, so as to be sure of producing the result at which he aims; and, in many circumstances, it is just as likely that he may do precisely the reverse. This, indeed, too often happens, and I believe there is scarcely a school in the kingdom in which some part or other of the educational and general training is not at variance with the organic laws, and, therefore, productive of mischievous results, which might be at once obviated if the teachers possessed even a moderate acquaintance with physiology, and were willing to direct their conduct by its dictates.

* Maynwaringe on the Method and Means of Health, 1683.

In forming a proper estimate of the utility of physiology in the conducting of moral and intellectual as well as physical education, we must never lose sight of the fact that it is the organization with which mind is connected during life which requires to be exercised and trained, and on which the good effects of education are produced. In teaching the art of riding, fencing, skating, or dancing, we admit at once, that to ensure success regard must be had to the muscular constitution of the individual, and to the laws of muscular exercise. But it is not sufficiently considered that, in cultivating the intellectual and moral faculties, similar regard must be had to the nervous and cerebral constitution of the pupil, and to their laws of exercise. Why does the mind *weary* after being long intent upon any object of pursuit? Just because the brain, by means of which the mind acts, has become exhausted by over-exercise, in the same way as the muscles after too long a walk. Why, when the mind is weary of one subject, can it turn to another, from mathematics to music for example, with alacrity and pleasure? Because the wearied faculties and their organs are left in repose, and a different set have come into play which had not previously been in activity; just in the same way as a tailor may be very weary of his day's work, and yet be delighted to enjoy himself at a dance, because in the latter the weary muscles of the arm are left unemployed, and those of the legs and trunk, which were panting for exercise, are now gratified in their turn. To discover, therefore, the proper laws of mental and moral training, we must always have regard to the laws by which the action of the brain and nervous system is regulated; and as it is the special province of physiology to investigate and expound these laws, it follows that to the educationist, whether parent or teacher, a knowledge of physiology is indispensable to success.

Such accordingly is the case; but as I shall touch upon this subject at greater length when I come to treat of the functions of the brain, I need not dwell longer upon it at present. I have said enough to satisfy the candid reader that physiology cannot be neglected with impunity by those who either direct or conduct the education of the young.

CHAPTER III.

STRUCTURE AND FUNCTIONS OF THE SKIN.

The Skin—composed of three layers.—The Cuticle—its structure and uses.—The Mucous Coat—the seat of Colour.—The True Skin—its structure—the seat of perspiration—its nature—consequences of suppressed perspiration.—Sympathy between the Skin and other organs.—The Skin a regulator of Animal Heat—the seat of absorption.—Touch and Sensation.—Connection between the Skin and Nervous System.

In selecting the subjects of the following essays, I shall, as already stated, be guided partly by the intrinsic importance of the functions of which they treat to the wellbeing of the animal economy; and partly by the comparative ignorance which prevails in regard to them. As uniting both conditions in a very high degree, I shall commence with an explanation of the structure and functions of the skin.

The skin is that membranous covering which is spread over the whole surface of the body, and which serves to bind together, and to protect from injury, the subjacent and more delicate textures. In different animals, and at different parts of the body, it assumes different appearances. It is smooth, soft, and delicate in youth, and in females; firmer and more resisting in middle age and in males; flabby and wrinkled in old age, and after disease; puckered or disposed in folds in places that admit of extensive flexion, as over the finger-joints, and in the palm of the hand; and thick and horny where it is sub-

jected to the influence of pressure, as in the soles of the feet.

The structure of the skin, like that of every other part of the animal frame, displays the most striking proofs of the transcendent wisdom and beneficence of its great Creator. Though simple in appearance and in design, it is a compound of many elements, and the seat of as great a variety of functions. In a general sense, it may be described as composed of three layers of membrane, viz., the thin *scarf-skin* or *cuticle*, the *mucous coat* immediately beneath, and the thick *true skin*, as it is called, which is the most internal of all and directly envelopes the body. In a purely scientific treatise it would be necessary to enter upon a minute examination of the structure and origin of these different constituent parts. But in a work like the present, intended chiefly for the unprofessional reader and for practical purposes, it will be more interesting and instructive to confine ourselves to such a general view of the nature and functions of the skin as can be easily understood by every intelligent person, and made available in the ordinary management of ourselves and families. For this reason, instead of beginning with the consideration of the internal layer or true skin, as a scientific anatomist would do, I shall adopt the more usual method of commencing with the cuticle.

The *cuticle*, *epidermis* (from ἐπι upon, and δερμα the skin) or *scarf-skin*, is the outermost of the three layers of which the skin is composed, and is that which is raised in blisters. To the naked eye, it appears to be a thin continuous membrane, destitute of organization and without either bloodvessels or nerves. When cut or abraded it neither bleeds nor feels pain. From these peculiarities it has generally been regarded as altogether without life, and by many as merely an exhalation of albuminous mucus resembling a coating of varnish. On more careful examination, however, by the aid of a powerful magnifier, it is discovered to possess a uniform structure, and vessels have not only been detected in it, but are said to have been successfully injected, and to be very manifest in some preparations in the Museum of St Thomas's Hospital, which leave no doubt that these vessels belong to the sanguiferous system.* Breschet, accordingly, in his late interesting researches into the structure of the skin, expresses the opinion, that the epidermis is not an inorganic matter or a mucus expelled mechanically, but, "on the contrary, a tissue of a rather complicated organization, connected with the important functions of exhalation and absorption, by the faculty which it possesses of giving passage to, or allowing itself to be penetrated by, liquids." Breschet adds, however, that he considers its life as merely vegetative; and that it becomes coloured, exhales, and absorbs in the same manner as vegetables, its want of nerves rendering it insensible.†

The epidermis is at first secreted in a fluid state on the surface of the true skin, and in successive layers, the innermost and the most fluid of which constitutes the *mucous coat*, as it is called, and the outermost and driest the *cuticle* or external epidermis. This fluid mucus becomes organized after its secretion, and the cuticle, properly so called, is found to consist of very minute scales of an irregular trapezoidal shape, which overlap each other, are more or less striated, white and transparent, and placed upon a very thin network tissue (*un canevas aréolaire très mince*). When, by any change of position, the skin is folded upon itself, these scales overlap more and more in the same way as the scales of a serpent's skin; and, on the other hand, when the skin is unusually extended, they become separated from each other and connected only by the fine intervening membrane.

* British and Foreign Medical Review, vol. ii. p. 443.

† Nouvelles Recherches sur la Structure de la Peau. Par M. G. Breschet, D. M., &c. Paris, 1835.

It has long been a matter of dispute whether the cuticle is perforated by pores or not. The fact of its giving passage outwards to the perspiration, and also inwards to substances rubbed upon its external surface, seemed to indicate the affirmative; but, as the pores could not be distinctly recognised by the eye, there always remained some doubt as to the fact. Blumenbach, Rudolphi, and Meckel still deny their existence, and consider them as unnecessary. But Breschet has shewn that there really are distinct canals or vessels for excreting the perspiration, and that these vessels open upon the surface of the epidermis by a very oblique orifice almost parallel to the plane of the skin. This orifice, he says, is shut by the one side of the duct being pressed against the other, and when sweat is flowing it is easy to observe a slight rising of the epidermis just before the small drop is about to exude. (P. 27.) Practically speaking, the question is not one of much moment, provided it be remembered that its texture, whether perforated or not, is such as to admit of *exhalation* and *absorption* taking place, or, in other words, of fluids and other bodies passing *out* and *in* through its substance.

The structure of the cuticle is, in other respects also, in admirable harmony with its uses. Placed as an insensible intermedium between external objects and the delicate nervous expansion on the surface of the subjacent true skin, it serves as a physical defence against friction; and while, by impeding evaporation, it preserves the true skin in that soft and moist state which is essential to its utility, it also, by impeding, but not absolutely preventing, absorption, enables man to expose himself without injury to the action of numerous agents, which, but for its protection, would immediately be imbibed, and cause the speedy destruction of health and life. This is remarkably exemplified in several trades, where the workman is unavoidably exposed to an atmosphere loaded with metallic and poisonous vapours, or obliged to handle poisonous substances; and where, without the obstruction of the cuticle, the evils to which he is subjected would be aggravated a hundred-fold. Being destitute of nerves, the cuticle is not hurt by the direct contact of external bodies, and being very thin, it blunts without impairing the distinctness of the impression made on the nerves of sensation. The necessity of this latter provision becomes very obvious when the cuticle is abraded or removed by vesication. The surface below is then found to be too tender and irritable for the exercise of touch, and conveys to the mind scarcely any other sensation than that of pain.

For the same reason, those parts of the skin which are most exposed to pressure and friction, such as the palms of the hands and soles of the feet, are provided with a thicker cuticle to defend them from injury. The greater thickness of the cuticle in such situations is manifestly the intentional work of the Creator, for it is perceptible even at birth, before use can have exercised any influence. Indeed, were the tender skin not so protected, every violent contraction of the hand upon a rough and hard surface, and every step made on uneven ground, would cause pain, and disable us for exertion.

By another beneficent provision, calculated to afford increased protection according to the necessities of the individual, it happens that, when a part is much used, the cuticle covering it becomes thicker and thicker within certain limits, till in extreme cases it becomes as thick, hard, and resisting as horn. It is this thickening of the epidermis on the lady's finger that alone enables her to wield with impunity that important instrument the needle. And it is the same thickening that fits the blacksmith and the mason, the stone-breaker and the boatman, to ply their trades, without that painful blistering which the young apprentice or unaccustomed labourer so regularly undergoes, and which must have continued to recur for ever, had the cuticle been organized with bloodvessels and nerves, or not subjected

to this law of becoming thicker wherever increased protection is required.

Another modification of the cuticle to suit a modification of circumstances, is that observed in the nails. These belong to the cuticle, and separate with it; and, like it, they have no visible bloodvessels or nerves, and may be cut or bruised without pain. When the hand or foot is macerated in water, the nails and the cuticle shew their identity of organization, by separating together from the dermis or true skin below. The nails, like the cuticle, serve chiefly to protect the subjacent parts from injury; and accordingly, in those lower animals whose manner of life subjects their feet to continual pressure, and requires no nice exercise of touch, Nature has provided horny and resisting hoofs for their protection, instead of merely a thickened epidermis.

To produce thickening of the cuticle, exercise must be gradual, and not too severe. If, for example, a person takes a very long walk, rows a boat, or makes use of a heavy hammer, for a few hours, without having been accustomed to such an effort, there is no time for the cuticle to thicken, and defend itself from the unusual friction. The parts below, being inadequately protected, become irritated and inflamed, and throw out a quantity of watery fluid or *serum* on their surface, which raises up the cuticle in blisters, and by making it painful to continue the pressure, obliges the person to desist from an exercise which, if continued, would evidently soon alter the structure of the sentient nervous filaments, and for ever unfit them for their proper uses: So that even in this result, beneficence and wisdom are prominently displayed.

Immediately beneath the scarf-skin, and between it and the true skin, is the next layer, called the *mucous coat*, *rete mucosum*, or *mucous network*, which is remarkable chiefly as being the seat of the colouring matter of the skin. It is seen with difficulty on dissection, except in Negroes, in whom it is thick. It is exceedingly attenuated in Albinos, and is in fact thick in proportion to the depth of colour. When first secreted, it is destitute of bloodvessels and nerves, but, like the cuticle, is permeable by other bodies. The colouring matter is said to be the same as that of the blood; Davy and Blumenbach, however, regard it as carbon.

For all practical purposes, the mucous coat may be viewed generally as merely a thin soft covering, placed between the outer and the inner skin, to protect the nerves and vessels of the latter, and give them their requisite softness and pliancy. Breschet considers it as originally a fluid mucus, similar both in its nature and mode of production to that which is secreted on the surface of the other mucous membranes; but soon after its secretion it becomes united with a colouring matter secreted by a distinct apparatus; and from this union the different colours of hair, horns, plumage, and scales, result. The mucous matter is itself secreted by glandular bodies situate near the inner surface of the skin, and seen at *c* in the woodcut on page 12, representing the structure of the skin as it appears under a powerful magnifier. This mucus is conveyed towards the surface of the true skin by the ducts or vessels seen to proceed upwards from the rounded glands at c. Breschet is of opinion, as already mentioned, that the epidermis is formed by the gradual drying, in successive layers, of this fluid mucus, and that the cuticle, and what is called the mucous coat, are merely the outer and drier, and the inner and moister, parts of the same thing, and he consequently includes both under the name of epidermis. The inner and more fluid layer is mixed with the colouring matter already referred to, and which is secreted by a glandular-looking apparatus, situate near the surface of the true skin, and seen in the woodcut at *g*, running along horizontally under the base of the *papillæ* or eminences *h*, on the outer surface of the skin. The mucous coat thus formed being of a dark colour in the Negro, has been supposed to diminish the heating influence of the sun's rays in tropical climates by the higher radiating power which is possessed by a black than by a light surface; but there is reason to doubt the soundness of the theory at least, for black is well known to excel in *absorbing* or taking in, as well as in radiating or giving out, heat; and late experiments on the coast of Africa seem to shew, that the temperature of the Negro is actually about two degrees higher than that of the European under the same circumstances.

The mucous coat is the seat of the beautiful and variegated colouring observed in the skins of many fishes and other animals, in which it has often a high and almost metallic splendour.

The third or inmost layer, called the *true skin*, *cutis*, *dermis*, or *corion*, is by far the most important of the three, both in structure and functions, and indeed constitutes the chief thickness of the skin. In the woodcut this is manifest enough from the dermis occupying all below the level of *g*, while the very small portion above it includes all the layers of the epidermis, or, in other words, both the epidermis and mucous coat. In structure, the dermis is a dense, firm, and resistant tissue, possessed of great extensibility and elasticity, and of a colour more or less red in proportion to the quantity of blood it receives and contains. Its looser internal surface, which is united to the cellular membrane in which the fat is deposited, presents a great number of cells or cavities, easily seen on the inner surface of the skins of animals, which penetrate obliquely into the substance, and towards the external surface of the skin, and also contain fatty matter. These *areolæ* or cells are larger on some parts of the body than on others; they are very small on the back of the hand and foot, the forehead, and other places where fat is never deposited, and the skin is very thin; while they are large in the palm of the hand and sole of the foot, where the skin is consequently thicker and fat abounds. These cells are traversed by innumerable bloodvessels and filaments of nerves, *a b* in the woodcut, which pass through to be ramified on the substance or outer surface of the skin, where they shew themselves in the form of numerous small papillæ or points, *h*, which are very visible on the surface of the tongue, and on the fingers and palm of the hand. These papillæ constitute the true organs of sensation, and are therefore most thickly planted where the sense of touch is most acute.

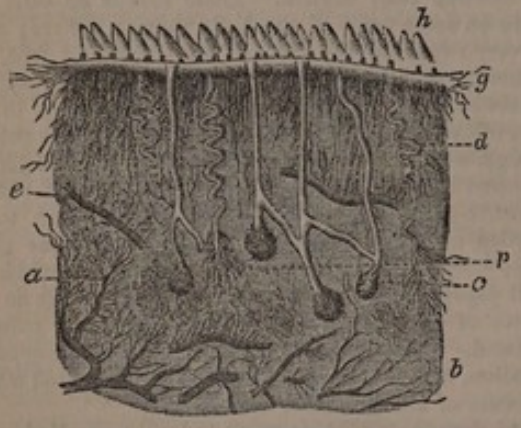
The dermis, indeed, is so abundantly supplied with blood and nervous power, that, for practical purposes, it may almost be regarded as composed of vessels and nerves alone; and it is important to notice this fact. The universal and equal redness of the skin in blushing is itself a proof of great vascularity; but a still stronger consists in our being unable to direct the point of the finest needle into any spot without puncturing a vessel and drawing blood. The same test proves the equal abundance of nervous filaments in the skin, for not a point can be punctured without transfixing a nerve and causing pain; and it is well known that, in surgical operations and accidental wounds, the chief pain is always in the skin, because it is profusely supplied with nerves on purpose to serve as an instrument of sensation.

Such are the appearances presented by the dermis on a superficial examination. When subjected, however, to a minuter scrutiny under the microscope, its organization is discovered to be at once complex and delicate in the highest degree. Instead of being merely a network of bloodvessels and nerves upon a ground of membrane, it is found to consist of a variety of distinct parts, each performing a distinct function. By virtue of its firm and elastic texture, it is well adapted for the protection of the parts beneath; while, by means of its innumerable secreting glands and excretory ducts, it is admirably suited for its office of *exhalant* of waste matter from the system; by means of another set of vessels it is enabled to act as an *inhalant* or *absorbent*; and lastly, by

means of the nervous papillæ on its surface, it is not less admirably qualified to act as the principal *organ of sensation and touch*.

As a protector of the parts below, the dermis acts chiefly mechanically, so that we need not dwell upon this part of its uses, but proceed first to consider it as an organ of *secretion* and *exhalation*.

For a long time the *perspiration* or sweat was considered simply as an exudation of the more watery portion of the blood from the very minute ramifications of the bloodvessels; and hence the fact of the skin being extremely vascular was supposed to be a perfectly sufficient explanation of the origin and very large quantity of matter thus thrown out of the system. This, however, is a very incorrect view of the subject. The sweat is not a mere watery exudation, but a distinct secretion effected by glands, or small bodies of a glandular nature, expressly provided for the purpose. According to Breschet, to whose investigations we are much indebted for a more accurate knowledge of the structure of the skin, these bodies are situate in great numbers in the substance of the dermis, and consist of what, for want of a better name, he calls a glandular *parenchyma* (from a Greek word signifying *to strain through*). On referring to the annexed woodcut, representing a highly magnified view of the component parts of the skin—its glands, ducts, bloodvessels, and nerves, we perceive, indistinctly, a small oval-shaped glandular body at *p*, with a spiral line proceeding from its upper part. The first of these is the *sweat-secreting* gland, and the latter is the *duct*, seen also at *d*, along the sinu-



osities of which the sweat is conveyed till it reaches the surface, and escapes by open mouths between the papillæ in the form of an invisible vapour. Several other glands and spiral ducts may be also seen; but in nature they are, of course, neither so distinct nor so far apart as they appear in the woodcut. In reality they are small in size and almost crowded together through the whole substance of the skin; and hence when the body is overheated by exercise, the sweat literally flows from every pore, because every pore is simply the outlet of a corresponding duct; and their very minuteness and number have been the causes why their existence and uses were not sooner discovered.

Viewed as an exhalant the skin cannot fail to be regarded with great interest, from the constant influence which it exercises over the welfare of the animal economy. But few have any just notion of the actual extent and importance of the exhalation, such as we shall now attempt to exhibit it.

During the whole period of life, the bodily organization is in a state of constant decay and renovation, and when any suspension of, or derangement in, the due balance between these processes occurs the health immediately suffers, and fatal consequences are often the result. The skin, the kidneys, the bowels, and the lungs, constitute the channels or outlets by which the waste matter is removed, and of these, the excretion, or throwing out, by the skin is by far the most abundant. In the ordinary healthy state of the body, no exhalation is *seen*, but the skin is *felt* to be soft and slightly moist. If, however, a cool and well-dried mirror is brought nearly into contact with its surface, a damp moisture is speedily observed to gather upon it, shewing that in reality an exhalation of vapour is constantly going on. The same fact is shewn by the speedy impregnation of flannels or other clothes in contact with the skin, indicated by the peculiar dampness and smell which it imparts to them. Being invisible to the eye and impalpable to the touch, this, the usual form of exhalation, is called the *insensible perspiration*, to distinguish it from that more copious and fluid secretion which is produced under severe exercise or the influence of great heat, and which, being both visible and tangible, is known as the *sensible perspiration* or *sweat*.

The obvious importance of the cutaneous exhalation to the welfare of the system at large, has led to many attempts to form an accurate estimate of its amount, but so many difficulties have stood in the way of obtaining precise results, and the difference in different constitutions, and even in the same person at different times, is so great, that we must be satisfied with an approximation to the truth. Among the first inquirers whose accuracy can be in any degree relied on, Sanctorius deserves to be honourably mentioned. With a zeal and perseverance worthy of greater success, he carefully weighed himself, his food, and his excretions, in a balance, every day for thirty years, and came to the conclusion that *five* out of every eight pounds of substances taken into the system pass out of it again by the skin, leaving only three to pass off by the bowels, the lungs, and the kidneys. The celebrated Lavoisier and M. Seguin afterwards entered on the same field of inquiry, and with more satisfactory results, as they were the first to distinguish between the cutaneous and pulmonary exhalations. M. Seguin shut himself up in a bag of glazed taffetas, which was tied over his head and provided with a hole, the edges of which were glued to his lips with a mixture of turpentine and pitch, so that the pulmonary exhalation might be thrown outwards and the cutaneous alone be retained in the bag. He first weighed himself and the bag in a very nice balance, at the beginning of the experiment; then at the end of it, when he had become lighter in proportion to the quantity of exhalation thrown out by the breathing; and lastly, he weighed himself out of the bag, to ascertain how much weight he had lost in all; and by subtracting the loss occasioned by the lungs, the remainder of course exhibited the amount carried off by the skin. He attended minutely also to the collateral circumstances of diet, temperature, &c.; and allowance being made for these, the results at which he arrived were the following:—

The *largest* quantity of insensible perspiration from the lungs and skin together, amounted to thirty-two grains per minute; three ounces and a quarter per hour; or *five pounds per day*. Of this, the cutaneous constituted three-fourths or sixty ounces in twenty-four hours. The *smallest* quantity observed amounted to eleven grains per minute, or one pound eleven and a half ounces in twenty-four hours, of which the skin furnished about twenty ounces. The *medium* or average amount was eighteen grains a minute, of which eleven were from the skin, making the cutaneous perspiration in twenty-four hours about *thirty-three ounces*. When the extent of surface which the skin presents, calculated at 2500 square inches, is considered, these results do not seem extravagant. But even admitting that there may be some unperceived source of fallacy in the experiments, and that the quantity is not so great as is here stated, still, after making every allowance, enough remains to demonstrate that exhalation is a very important function of the skin. And although the precise amount may be disputed, it is quite certain that the cutaneous exhalation is more abundant than the united

excretions of both bowels and kidneys, and that, according as the weather becomes warmer or colder, the skin and kidneys alternate in the proportions of work which they severally perform; most passing off by the skin in warm weather, and by the kidneys in cold. The quantity exhaled increases after meals, during sleep, in dry warm weather, and by friction or whatever stimulates the skin; and diminishes when digestion is impaired, and in a moist atmosphere.

What we have considered relates only to the *insensible* perspiration. That which is caused by great heat or severe exercise is evolved in much greater quantity; and by accumulating at the surface, it becomes visible, and forms sweat. In this way a robust man, engaged in hard labour and exposed to intense heat, may lose *five* pounds' weight in the course of an hour, and this loss happen even twice a-day for a length of time.* When, on the other hand, the surface of the body is chilled by cold during inactivity, the bloodvessels of the skin become contracted in their diameter, and hinder the free entrance of the red particles of the blood, which are therefore of necessity collected and retained in greater quantity in the internal organs, where the heat varies very little. The skin consequently becomes pale, and its papillæ contract, forming by their erection what is called the goose's skin. In this state it becomes less fit for its uses; the sense of touch can no longer nicely discriminate the qualities of bodies, and a cut or bruise may be received with comparatively little pain. From the oppression of too much blood, the internal parts, on the other hand, work heavily: the mental organs are weakened, sleepiness is induced, respiration is oppressed, the circulation languishes, and digestion ceases; and if the cold be very intense, the vital functions are at last extinguished without pain, and without a struggle. This is a picture of the extreme degree; but the same causes which, in an aggravated form, occasion death, produce, when applied in a minor degree, effects equally certain, although not equally marked or rapid in their appearance.

Taking even the lowest estimate of LAVOISIER, we find the skin endowed with the important charge of removing from the system about twenty ounces of waste matter every twenty-four hours; and when we consider that the quantity is not only great, but sent forth in so divided a state as to be invisible to the eye, and that the whole of it is indirectly given out by the very minute ramifications of the bloodvessels which supply the secreting organs of the skin, we perceive at once why these vessels are so extremely numerous that a pin's point cannot touch any spot without piercing them. We see also an ample reason why, independently of the debilitating impression made through the medium of the nervous system, checked perspiration should prove so detrimental to health,—because, for every twenty-four hours during which such a state continues, we must either have a large amount of useless and now poisonous matter accumulating in the body, or have some of the other organs of excretion greatly overtasked to get rid of it by other means; which obviously cannot happen without disturbing their regularity and wellbeing. People know the fact, and wonder that it should be so, that cold applied to the skin, when the body is inactive, or continued exposure in a cold day, often produces a bowel-complaint, a severe cold in the chest, or inflammation of some internal organ: But were they taught, as they ought to be, the structure and uses of their own bodies, they would rather wonder that it did not always produce one of these effects.

In tracing the connexion between suppressed perspiration and the production of individual diseases, we shall find that those organs which possess some similarity of function sympathize most closely with each other. Thus the skin, the bowels, the lungs, the liver, and the kidneys, sympathize readily, because they have all the common office of throwing waste matter out of the system, each in a way peculiar to its own structure; so that if the exhalation from the skin, for example, be stopped by long exposure to cold, the large quantity of waste matter which it was charged to throw out, and which in itself is hurtful to the system, will most probably be thrown upon one or other of the above-named organs, whose function will consequently become excited; and if any of them, from constitutional or accidental causes, be already weaker than the rest, as often happens, its health will naturally be the first to suffer. In this way, the bowels become irritated in one individual, and occasion bowel complaints; while in another it is the kidneys, and in a third the lungs, which become affected. When, on the other hand, all these organs are in a state of vigorous health, a temporary increase of function takes place in them, and relieves the system, without leading to any local disorder; and the skin itself speedily resumes its activity, and restores the balance among them.

One of the most obvious illustrations of this reciprocity of action is afforded by any convivial company seated in a warm room in a cold evening. The heat of the room, the food and wine, and the excitement of the moment, stimulate the skin, cause an afflux of blood to the surface, and increase in a high degree the flow of the insensible perspiration; which thus, while the heat continues, carries off an undue share of the fluids of the body, and leaves the kidneys almost at rest. But the moment the company goes into the cold external air, a sudden reversal of operations takes place; the cold chills the surface, stops the perspiration, and directs the current of the blood towards the internal organs, which presently become excited—and, under this excitation, the kidneys, for example, will in a few minutes secrete as much of their peculiar fluid as they did in as many of the preceding hours. The reverse of this, again, is common in diseases obstructing the secretion from the kidneys; for the perspiration from the skin is then altered in quantity and quality, and acquires much of the peculiar smell of the urinary fluid.

Since the publication of the earlier editions of the present work, the attention of the profession has been strongly directed to the influence of cold in exciting disease in the kidneys as a consequence of suppressed perspiration, especially in persons of an unhealthy constitution. To Dr Bright belongs the honour of having detected the unsuspected frequency and very serious and often fatal nature of the disease alluded to, and now generally known under the name of *Bright's disease*, or *Granular Degeneration of the Kidneys*. In Dr Osborne's excellent little work on the subject,* it is expressly stated, that, "*on reviewing the causes of the disease in thirty-six cases, in twenty-two individuals it could be directly referred to suppressed perspiration.*" (P. 31.) Dr Osborne explains this result by saying, that "when cold is applied over the whole surface in a continuous manner for some time, and no inflammation or general fever has resulted, then an increased secretion from the kidneys is usually observed; and the necessity of frequent evacuations of the bladder during the frosts of winter, has become proverbial and is familiar to every one. When the suppression of perspiration, however, instead of being transient, is rendered permanent, then permanent irritation of the kidneys is produced, and in the great majority of cases, the result is the disease of the kidneys now before us." (P. 31.) Dr Christison, in like manner, admits the frequency of cold as the exciting cause, and makes the remarkable statement that, "*where cold was not the apparent cause, I have never met with an instance where the patient could ascribe his illness to any thing else.*"†

* Southwood Smith's Philosophy of Health, vol. ii. p. 3

* Osborne on Dropsies, 2d edition, London, 1837.

† Christison on Granular Degeneration of the Kidneys.—Edinburgh, 1840. P. 108.

The very frequent occurrence of bronchitis and diarrhœa, the former an affection of the lining membrane of the lungs, and the latter of that of the bowels, along with disease of the kidneys, affords an interesting corroboration of the remark in a preceding page, explanatory of the sympathy of the excreting organs with each other. In eighteen out of thirty-six cases, Dr Osborne found bronchitis co-existing with the affection of the kidney, and in eleven some form of intestinal disease. Dr Osborne justly considers, that "the co-existence of these affections with the disease in question is best explained by this circumstance—that *they are all the effect of the one cause, namely, suppressed perspiration.*"

When the lungs are weak, and their lining membrane is habitually relaxed, and secretes an unusual amount of *mucus* or phlegm from its surface, as often happens in persons of an indolent lymphatic constitution, the mass of blood thrown inwards upon the lungs by cold applied to the skin, increases that secretion to a high degree. Were this secretion to accumulate, it would soon fill up the air-cells of the lungs, and cause suffocation; but to obviate this danger, the Creator has so constituted the lungs, that accumulated mucus or any foreign body coming in contact with them excites the convulsive effort called coughing, by which a violent and rapid expiration takes place, with a force sufficient to hurry the mucus or other foreign body along with it; just as peas are discharged by boys with much force through short tubes by a sudden effort of blowing. Thus, especially in indolent old Indians and persons who have lived long in a warm climate, a check given to perspiration, by diminishing the quantity of blood previously circulating on the surface, naturally leads very often to increased expectoration and cough, or, in other words, to chronic catarrh.

The lungs excrete, as already noticed, and as we shall afterwards more fully see, a large proportion of waste materials from the system; and the kidneys, the liver, and the bowels, have in so far a similar office. In consequence of this alliance with the skin, these parts are more intimately connected with each other in healthy and diseased action than with other organs. But it is a general law, that whenever an organ is unusually delicate, it will be more easily affected by any cause of disease than those which are sound: so that, if the nervous system, for example, be weaker than other parts, a chill will be more likely to disturb its health than that of the lungs, which are supposed, in this instance, to be constitutionally stronger; or, if the muscular and fibrous organizations be unusually susceptible of disturbance, either from previous illness or from natural predisposition, *they* will be the first to suffer, and rheumatism will ensue; and so on. And hence the utility to the physician of an intimate acquaintance with the previous habits and constitutions of his patients, and the advantage of adapting the remedies to the nature of the cause, when it can be discovered, as well as to the disease itself. Thus, in Bright's disease, which so often proceeds from checked perspiration, Dr Osborne mentions, that whenever he succeeded in restoring perspiration over the whole surface, he never failed in removing the general dropsy by which the affection of the kidneys is accompanied. In like manner, a bowel-complaint may arise from a check to perspiration or from over-eating; but although the thing to be cured is the same, the *means* of cure ought obviously to be different. In the one instance, an emetic or laxative to carry off the offending cause, and in the other a diaphoretic to open the skin, will be the most rational and efficacious remedies. Facts like these expose well the glaring ignorance and effrontery of the quack, who affirms that his one remedy will cure every form of disease. Were the public not equally ignorant with himself, their credulity would cease to afford to his presumption the rich field in which it now revels.

The close sympathy between the skin and the stomach and bowels has often been noticed; and during epidemic influenza, it is not uncommon for persons of weak digestion to suffer as much from an affection of the stomach as others do from that of the chest. In both instances, there is the same depressing sense of debility and illness without any violent local disease by which it can be accounted for, and in both there is often the same slow recovery. It is well understood, too, that most of the obstinate eruptions which appear on the face and rest of the surface, owe their origin to disorders of the digestive organs, and are most successfully cured by treatment directed to the internal disease. Even among the lower animals, the sympathy between the two is so marked as to have arrested attention. Thus, in speaking of the horse, Delabere Blaine says, "by a well-known consent of parts between the skin and alimentary canal in general, but between the first passages and the stomach in particular, it follows, in almost every instance, that when one of these becomes affected, the other takes on a sympathetic derangement also, and the condition is then morbid throughout. From close observation and the accumulation of numerous facts, I am disposed to think, that so perfect is this sympathetic consent between these two distant parts or organs, that they change the order of attack as circumstances occur. Thus, when the skin is primarily affected, the stomach becomes secondarily so, and *vice versa*," so that "a sudden check to the natural or acquired heat of the body, particularly if aggravated by the evaporation of a perspiring state," as often brings on disease of some internal organ, as if the cause were applied directly to the organ itself.*

In noticing this connexion between the suppression of perspiration and the appearance of internal disease, I do not mean to affirm that the effect is produced by the physical transference of the suppressed exhalation to the internal organ. In many instances, the chief impression seems to be made on the nervous system; and the manner in which it gives rise to the resulting disease is often extremely obscure. Our knowledge of the animal functions is, indeed, still so imperfect, that we daily meet with many occurrences of which no explanation can be given. But it is nevertheless of high utility to make known the fact, that a connexion does exist between two orders of phenomena, as it calls attention to their more accurate observation, and leads to the adoption of useful practical rules, even when their mode of operation is not understood. Nothing, indeed, can be more delusive than the rash application of merely physical laws to the explanation of the phenomena of living beings. Vitality is a principle superior to, and continually modified by, the laws which regulate the actions of inanimate bodies; and it is only after life has become extinct that these laws regain the mastery, and lead to the rapid decomposition of the animal machine. In studying the functions of the human body, therefore, we must be careful not to hurry to conclusions before taking time to examine the influence of the vital principle in modifying the expected results.†

It is in consequence of the sympathy and reciprocity of action existing between the skin and the internal organs, that burns, and even scalds of no very great extent, prove fatal, by inducing internal, generally intestinal, inflammation. By disordering or disorganizing a large nervous and exhaling surface, an extensive burn causes not only a violent nervous commotion, but a continued partial suspension of an important excretion; and, when death ensues at some distance of time, it is

* Blaine's Outlines of the Veterinary Art, 3d edition, p. 65.

† The reader will find some excellent practical remarks on the sympathy between the skin and the thoracic and abdominal viscera, in Dr James Johnson's "Treatise on Derangements of the Liver, Internal Organs, and Nervous System," published some years ago. They deserve every attention on the part of the profession, as shewing how affections of different organs influence each other.

almost always in consequence of inflammation being excited in the bowels or sympathizing organ. So intimate, indeed, is this connexion, that some surgeons of great experience, such as the late Baron DUPUYTREN, of the Hôtel Dieu, while they point to internal inflammation as in such cases the general cause of death, doubt if recovery ever takes place, when more than one-eighth of the surface of the body is severely burnt. And whether this estimate be correct or not, the facts from which it is drawn clearly demonstrate the importance of the relation subsisting betwixt the skin and the other excreting organs.

In some constitutions, a singular enough sympathy exists between the skin and the bowels. Dr A. T. THOMSON, in his work on Materia Medica (p. 42), mentions that he is acquainted with a clergyman who cannot bear the skin to be sponged with vinegar and water, or any diluted acid, without suffering spasm and violent griping of the bowels. The reverse operation of this sympathy is exemplified in the frequent production of nettle-rash and other eruptions on the skin, by shell-fish and other substances taken into the stomach. Dr Thomson tells us, that the late Dr Gregory could not eat the smallest portion of the white of an egg, without experiencing an attack of an eruption like nettle-rash. According to the same author, even strawberries have been known to cause fainting, followed by a petechial efflorescence of the skin.

We have seen that the insensible perspiration removes from the system, without trouble and without consciousness, a large quantity of useless materials, and at the same time keeps the skin soft and moist, and thereby fits it for the performance of its functions as the organ of an external sense. In addition to these purposes, the Creator has, in his omniscience and foresight, and with that regard to simplicity of means which betokens a profoundness of thought inconceivable to us, superadded another, scarcely less important, and which is in some degree implied in the former; I mean *the proper regulation of the bodily heat*. It is well known that, in the polar regions and in the torrid zone, under every variety of circumstances, the human body retains nearly the same temperature, however different may be that of the air by which it is surrounded. This is a property peculiar to life; and, in consequence of it, even vegetables have a power of modifying their own temperature, though in a much more limited degree. Without this power of adaptation, it is obvious that man must have been chained for life to the climate which gave him birth, and even then have suffered constantly from the change of seasons; whereas, by possessing it, he can retain life in a temperature sufficiently cold to freeze mercury, and is able for a time to sustain, unharmed, a heat more than sufficient to boil water, or even to bake meat. Witness the wintering of Captains Parry and Ross and their companions in the Polar Regions; and the experiments of Blagden, Sir Joseph Banks, and others, who remained for many minutes in a room heated to 260°, or about 50° above the temperature of boiling water. The chief agents in this wonderful adaptation of man to his external situation, are undoubtedly the skin and the lungs, in both of which the power is intimately connected with the condition of their respective exhalations. But it is of the skin alone, as an agent in reducing animal heat, that we are at present to speak.

The sources of animal heat are not yet demonstrably ascertained; but that it is constantly generated and constantly expended, has been long known; and if any considerable disproportion occurs between these processes, it is at the immediate risk of health. During repose, or passive exercise, such as riding in a carriage or sailing, and in a temperate atmosphere, no more heat is produced than is readily carried off by the insensible perspiration from the lungs and skin, and by the contact of the colder air; but during active exercise, when the amount of heat generated is increased, an increased expenditure becomes immediately necessary: this is effected by the skin and lungs being excited to higher action; by the latter sending out the respired air loaded with vapour, and the former exhaling its fluid so rapidly as to form sweat. Accordingly, we find that, in cold countries, and in frosty weather, the exhalation from the skin is reduced to a very moderate amount, the superabundant heat being rapidly carried off by contact with a cooler air; and that, in warm climates, where the heat is not carried off in this way, the surface is constantly bedewed with perspiration, and a corresponding appetite exists for liquids by which the perspiration may be kept up to a sufficient degree. Every one must have experienced the grateful effects of this provision, in passing from the dry, restless, and burning heat, like that of fever, to the soft and pleasant coolness which follows the breaking out of the sweat.

Attention to the order of events affords the requisite knowledge of the means employed for carrying off the increased heat which is produced when a person is exposed to a warm air and powerful sun, or engaged in severe exercise. At first, the body is felt to be actually warmer, the skin becomes dry and hot, and the unpleasant sensation of heat is soon at its maximum. By-and-by, a slight moisture is perceived on the surface, followed by an immediate increase of comfort. In a short time afterwards, this moisture passes into free and copious perspiration; and if the heat or exertion be still kept up, the sweat becomes profuse and drops from the body or wets the clothes which envelope it. A decrease of animal heat unavoidably accompanies this, because, independently of any vital action contributing to this effect, as is most probable, the mere physical evaporation of so much fluid is itself sufficient to carry off a large quantity of caloric. The curious experiments of Edwards tend to shew that evaporation is really the only means required for reducing animal heat to its proper degree; but the results obtained by him require to be confirmed, and the experiments varied and carried farther, before the inquiry can be considered as completed. The sagacity of Franklin led him to the first discovery of the use of perspiration in reducing the heat of the body, and to point out the analogy subsisting between this process and that of the evaporation of water from a rough porous surface, so constantly resorted to in the East and West Indies, and other warm countries, as an efficacious means of reducing the temperature of the air in rooms, and of wine and other drinks, much below that of the surrounding atmosphere. The quantity of fluid evaporated from the skin during profuse sweat, so far exceeds that given out during the highest insensible perspiration, that, as already seen on page 13, five pounds in weight have been lost by this means in a single hour—an amount evidently sufficient to carry off the largest quantity of superfluous animal heat which can ever be present. In the performance of this function, the skin is, indeed, assisted by the exhalation from the lungs; but as both act on the same principle, the explanation is not affected by this circumstance.

In very warm weather, the dog is always seen with the tongue lolling out of his mouth, and copiously covered with frothy secretion. This is merely another modification of the means used for reducing animal heat. The dog perspires very little from its skin, and the copious exhalation from the mouth is the expedient resorted to by Nature for supplying its place.

Bearing in mind the preceding explanation of the functions of the skin, the reader will peruse with interest the following remarks from Dr Thomson's work formerly quoted. "Dr Davy, in his Travels in Ceylon, states, from his personal observation, that on first landing in a tropical climate, the standard heat of the body of a European is raised two or three degrees, and febrile symptoms occur, which require temperance, the avoiding every cause of excitement of the vascular sys-

tem, and the use of aperient medicines. All authors, and indeed every observing person who has visited the torrid zone, agree that with the languor and exhaustion resulting from the high temperature of the atmosphere, there is a greatly increased mobility of the nervous system. *The action of the cutaneous vessels amounts to disease*, and produces that eczematous or vesicular eruption of the skin, known by the name of prickly heat, which occurs in Europeans who visit the West Indies on their first landing. On the other hand, this function of the skin is so much weakened, almost paralyzed, when the climate from which a person is passing is dry and bracing, and that into which he has passed is humid and relaxing, that congestions of blood take place in the larger vessels, the body becomes susceptible of the least impression of marshy exhalations, and agues and similar diseases are produced."*

We shall now be able to understand why in summer we suffer most from heat in what is called moist close weather, when no air is stirring; and why warm climates that are at the same time moist, are proverbially the most unwholesome. The chief reason is the diminished evaporation from the skin, which such a condition of the atmosphere produces, partially shutting up the natural outlet of the superfluous heat of the body; and as it at the same time checks the exit of the waste matter which ought to be thrown out, and which is known to be as injurious to the system as an active poison taken into the body from without, the hurtful consequences of such weather and climates, and the fevers, dysenteries, and colds, to which they give rise, are partly accounted for. A moist state of the atmosphere also stimulates *absorption*, and hence, if noxious effluvia are at the time floating in the air, they are more easily received into the system. It is on this account that night air is so unwholesome, particularly in malaria districts, which are loaded with moisture and miasma or marsh poison; for, when the air is dry as well as hot, free evaporation takes place, and absorption is almost null, so that little or no inconvenience is felt, and health often remains uninjured. Delaroche has established this point conclusively by experiment. He exposed animals to a very high temperature in a dry air, and found them to sustain no mischief; but when he exposed them in an atmosphere saturated with moisture, to a heat only a few degrees above that of their own bodies, and greatly lower than in the former instance, they very soon died. Here we see also the reason why, in ague and other fevers, the suffering, restlessness, and excitement of the hot stage can never be abated till the sweat begins to flow, after which they rapidly subside; and why the remedies which, when given in the hot stage, added to the excitement and distress, may now be productive of the best effects.

The function next to be noticed, viz. *Absorption*, is in some measure the opposite of the last. By its instrumentality, substances placed in contact with the skin are taken up and carried into the general circulation, either to be appropriated to some new purpose, or to be afterwards thrown out of the body.

Absorption or *inhalation*, being a distinct function of the skin, is carried on by vessels appropriated to the purpose, and thence named *absorbents* or *inhalants*, and closely resembling, if they are not identical with, what in other parts are called *lymphatic* vessels. Breschet says, that they are situate in that part of the mucous coat which forms the outer layer of the skin, namely, the epidermis, and that they may be seen commencing on its outer surface in rounded extremities in the form of a *cul-de-sac* without any orifice. He acknowledges, at the same time, that it is so difficult to distinguish their true origin, that he has described rather what seemed to him to exist, than what he was certain of really existing; but in the more internal layers of the mucous coat, the absorbents, he says, are easily seen by the aid of a magnifying glass. In the skin itself the absorbents are so small and numerous that, when injected with mercury, the surface is said, by Dr Gordon, to resemble a sheet of silver. In health they are too small to admit the red globules of the blood, and hence, from their contents being nearly transparent, they are sometimes named *lymphatics*.

Of the reality of absorption from the surface of the skin, we have a familiar example in the process of vaccination as a protection from smallpox. A small quantity of cowpox matter is inserted under the cuticle on the surface of the true skin, and there left. In a short time it is acted upon, and taken into the system by the absorbent vessels. In like manner, mercurial preparations rubbed on the skin for the cure of liver-complaint are absorbed, and affect the constitution precisely as when received into the stomach. Many even of the common laxatives, such as rhubarb and croton oil, have of late been successfully administered in the same way, and the rapid absorption of poison from bites of rabid animals and wounds in dissection through the same channel, is familiar to every one. It is from the active principle of the Spanish flies used in blisters being taken up by the cutaneous absorbents, that irritation of the kidneys and urinary organs so often attends the employment of that remedy.

Some ascribe great importance, and others very little, to cutaneous absorption. In some diseases, such as diabetes, in which, occasionally for weeks in succession, the urinary discharge exceeds, by many ounces daily, the whole quantity of food and drink, without the body losing proportionally in weight, we can account for the system being sustained only by supposing moisture to be extensively absorbed from the air by the skin and lungs, in the same way as the carbonic acid of the air is absorbed by the leaves of plants, and constitutes their principal nourishment. Of late, indeed, it has been proved by actual experiment, that additional weight is often acquired in the course of even a few hours, where nothing whatever of either a solid or fluid nature has been taken. The fact of the skin possessing an active absorbing power in common with the lining membrane of the lungs cannot, therefore, be called in question; and hence, although the ancients may have gone too far in believing that, when food could not be retained in the stomach, a person might be nourished by placing him in a bath of strong soup or milk, they were nevertheless correct in principle; and their only error was in regarding the absorbing power as greater in extent and more indiscriminating in nature than it really is. Some, indeed, deny that any absorption would take place at all, because it is doubtful whether, as a general fact, the body gains in weight by immersion in a warm bath. But the inference is not well founded, for thirst is well known to be relieved in this way; which can only happen from the absorption of fluid. Weight, however, *is* also occasionally gained; and even when it is not, as much water must have been absorbed during immersion as would make up the loss sustained by perspiration, which is believed to go on more rapidly in warm water than in the open air.

That animals absorb copiously when immersed in water, has been amply proved by Dr Edwards and other physiologists. Dr Edwards selected lizards as the subjects of experiment, because he regarded their scaly skins as unfavourable for absorption. After reducing the bulk of a lizard by several days' exposure to a dry air, he immersed its tail and hind legs in water, and found that absorption took place to such an extent as to restore the original plumpness of *all* parts of the body. The same result attended a variety of other trials, so that the fact does not admit of doubt. In man, absorption from the surface is greatly retarded by the intervention of the cuticle; and it is universally admitted that when this obstacle is removed, the process goes on

* Thomson's Materia Medica, p. 66.

with great vigour. Thus arsenic applied to cancerous sores, and strong solutions of opium to extensive burns in children, have been absorbed in quantities sufficient to poison the patients. Colic in its severest forms has followed similar external applications of the salts of lead. Mercury, also, in the form of fumigation, has often been used where rapid action was required, because in the state of vapour it is very speedily taken up by the cutaneous absorbents.

It is quite certain, then, that the skin does absorb. The only doubt is as to what extent the cuticle operates in preventing or modifying that action. When friction accompanies the external application, the cuticle, as we see exemplified in the use of mercurial and other liniments, is not an efficient obstacle. But when friction is not resorted to, and the substance applied is of a mild unirritating nature, such as oil, it may remain in contact with the skin for a long time, without being taken into the system in appreciable quantities. If, however, it is irritating, like Spanish flies, absorption speedily begins, and is carried on through the cuticle, as is proved by the effects produced on the urinary organs.

When the perspiration is brought to the surface of the skin, and confined there either by injudicious clothing or by want of cleanliness, there is much reason to suppose that its residual parts are again absorbed, and act on the system as a poison of greater or less power, according to its quantity and degree of concentration, thereby producing fever, inflammation, and even death itself; for it is established by observation, that concentrated animal effluvia form a very energetic poison. The fatal consequences which have repeatedly followed the use of a close waterproof dress by sportsmen and others, and the heat and uneasy restlessness which speedily ensue where proper ventilation is thus prevented, seem explicable on some such principle.

It is believed by many that marsh miasmata and other poisons are absorbed by the skin as well as by the lungs, and Bichat considered the fact as established in regard to the effluvia of dissecting-rooms. There are many reasons for concurring in this belief. The plague, for instance, is much more readily communicated by contact than by any other means, and this can happen only through the medium of absorption. Besides, it is observed that those who work with oil and other greasy substances which obstruct the pores of the skin, often escape the contagion when all around them suffer. Flannel and warm clothing, in like manner, which have been proved to be extremely useful in preserving those who are unavoidably exposed to the action of malaria and of epidemic influences, manifestly act chiefly by protecting the skin. A late writer on the Malaria of Rome strongly advocates this opinion, and expresses his conviction that the ancient Romans suffered less from it, chiefly because they were always enveloped in warm woollen dresses. This opinion, he says, is justified by the observation, that since the period at which the use of woollen clothing came again into vogue, intermittent fevers have very sensibly diminished in Rome. Even in the warmest weather, the shepherds are now clothed in sheep-skins. Brocchi, who experimented extensively on the subject, obtained a quantity of putrid matter from the unwholesome air, and came to the conclusion, that it penetrated by the pores of the skin rather than by the lungs. Brocchi ascribes the immunity of the sheep and cattle, which pasture night and day in the Campagna, to the protection afforded them by their wool.* These remarks deserve the serious attention of observers,—particularly as, according to Patissier, similar means have been found effectual in preserving the health of labourers digging and excavating drains and canals in marshy grounds, where, previously to the employment of these precautions, the mortality from fever was very considerable.

* Edin. Phil. Journ. January 1833.

It is a general law, that every organ acts with increased energy when excited by its own stimulus; and the application of this law to the different functions of the skin may help to remove some of our difficulties. The skin exhales most in a warm dry atmosphere, because the latter dissolves and carries off the secretion as fast as it is produced; and the same condition is unfavourable to absorption, because nothing is present upon which the absorbents of the skin can act. In a moist atmosphere, on the other hand, the absorbents meet with their appropriate stimulus, and act powerfully; while exhalation is greatly diminished, because the air can no longer carry off the perspiration so freely. Apparently from this extensive absorption we find the inhabitants of marshy and humid districts remarkable for the predominance of the lymphatic system, as has long been remarked of the Dutch; and, as malaria prevails chiefly in situations and seasons in which the air is loaded with moisture, and is most energetic at periods when absorption is most active and moisture is at its maximum, the probability of its being received into the system chiefly by cutaneous absorption is greatly increased, and the propriety of endeavouring to protect ourselves from its influence by warm woollen clothing becomes more striking. In the army and navy, accordingly, where practical experience is most followed, the utmost attention is now paid to enforcing the use of flannel and sufficient clothing as a protection against fever, dysentery, and other diseases, particularly in unhealthy climates. In the prevention of cholera, flannel was decidedly useful.

From the above exposition of the laws of absorption, and from the facts referred to at page 16, may it not be feasibly inferred, that the efficacy of great heat in preventing contagion from the plague, is partly owing to the consequent dryness of the atmosphere no longer presenting the requisite stimulus to the absorbents, but, on the contrary, powerfully exciting the action of the exhalants? Damp directly stimulates the absorbents, and hence may arise its hurtfulness as a vehicle. The system, too, it is well known, is peculiarly susceptible of infection when the stomach has been for some time empty, as before breakfast. May not this be accounted for by the then greater activity of absorption?*

From grouping all the constituent parts of the skin into one whole, and perceiving so many operations connected with that tegument, some may be apt to suppose it an exception to a principle already hinted at, that no single part can execute more than a single direct function. In reality, however, it is only by taking the guidance of this principle that we can extricate ourselves from the apparent confusion. We have already seen that exhalation and absorption are each connected with distinct textures in the skin. On farther examination, we shall find the office of Touch and Sensation intrusted exclusively to another constituent part, *the nervous*; for, in serving as the instrument of feeling, the skin acts in no other way than by affording a suitable surface for the distribution and protection of the nerves which receive and transmit to the brain and mind the impressions made on them by external bodies. In this respect the skin resembles the other organs of sense, in all of which the nerve is the true instrument of the sense; the eye, the ear, the nose, and the skin, being simply structures fitted to bring the nerve into relation with the qualities of colour, sound, smell, roughness, and smoothness, by which they are respectively affected;—and they differ from each other, because sound differs from colour, colour from smell, and smell from roughness or smoothness; and because sound or colour can be

* In Dr Madden's work on Cutaneous Absorption, and also in two excellent articles on the Skin in Nos. IV. and XII. of the British and Foreign Medical Review, the reader will find additional information concerning the structure and functions of the skin, and especially on the subject of its absorbing power.

taken cognizance of by its own nerve, only when the latter is provided with an apparatus fit to be acted upon by the vibrations of the air, or by the rays of light. In every instance, it is the external object acting upon a *nerve* which gives rise to the impression received from the organs of sense.

The skin being the seat, and the nerve the immediate instrument, of sensation or sensibility, it becomes an object of interest to ascertain in what manner the nerve is distributed over the skin so as to enable it to come into contact with external bodies without the risk of sustaining injury from their roughness or hardness. On this point we shall find much information in the work of Breschet already referred to.

On examining the woodcut on page 12, a great number of pointed or conical eminences, *h*, will be seen to cover the surface of the skin. These are called, from their shape, *papillæ*, or little paps, and very often, from their structure, *nervous papillæ*. These papillæ consist of minute nervous ramifications, separated from each other by the space which gives passage to the perspiratory pores. Their shape is that of a small cone with its base resting on the dermis, and its apex terminating in an obtuse point. Every nervous branch entering a papilla penetrates into the epidermis like a sword into its scabbard, so that the depressions on the internal surface of the epidermis represent exactly the number and disposition of the papillæ. On entering the papillæ, the nerves lose their common investing membrane or sheath (neurilema), and are then protected by a covering from the epidermis itself. By this arrangement, the tactile extremity of the nerve which enters into the papillæ, is allowed to come into more direct contact with the qualities of the external objects which it is intended to recognise, and thus to appreciate them more correctly. In this way, touch is exercised by thousands of these little organs, all placed side by side, as it were, and communicating together by means of the nervous network spread over the whole surface of the body from one papilla to another; and the proof that the nerve really penetrates into the papilla is, that although the epidermis may be removed with impunity, acute pain is felt the moment the papilla itself is injured. Even the mere contact of the air causes pain when the protecting epidermis is removed.

Small as the individual papillæ are, and still smaller as are the nervous ramifications which constitute their chief bulk, each of them receives into its centre a minute branch of a bloodvessel as the condition of its life and action. When the surface of the body is warm, and its circulation active, touch and sensation are acute, because their nerves then receive abundance of stimulating blood. But when the surface is chilled by cold, and the circulation through the skin is almost null, sensation becomes so blunt that wounds may be inflicted without exciting pain; because then the nervous papillæ, being imperfectly supplied with blood, can no longer act with readiness or vigour.

Such being the structure of the skin, it follows that every part of it, however remote, must be provided with filaments from the nerves of sensation, that we may become immediately sensible of the presence and action of external bodies. If any part were destitute of this property, its texture and vitality might be destroyed without our being conscious of the fact; whereas, in consequence of this provision of sensitive nerves, no object can touch the skin without our being instantly made aware of its presence and properties. A case described by Dr Yelloly, in the third volume of the Medico-Chirurgical Transactions, illustrates in a striking manner the great utility of these nerves in warning us of danger. "The patient's hands," says Dr Yelloly, "up to the wrists, and the feet half-way up the legs, are perfectly insensible to any species of injury, as cutting, pinching, scratching, or burning. . . *He accidentally put one of his feet, some time ago, into boiling water, but was no otherwise aware of the high temperature than by finding the whole surface a complete blister on removing it.*"

While, however, sensation is common to the whole surface of the body, there are parts of the skin more immediately destined by Nature for the exercise of Touch, and for the better appreciation of all the qualities of which it is cognizant. Such are the hands and tongue in man, the proboscis in the elephant, the tail in some of the monkey tribes, and the tentacula in fishes. Now, in accordance with the explanation given of the dependence of sensation upon nervous endowment, it is remarkable that all the parts destined for this special exercise of Touch, receive the most abundant supply of sensitive nerves. Thus the nerves going to the hand and arm, the most perfect instruments of Touch and Sensation in man, are at their dorsal roots five times larger than those which are destined for its motion; and, in like manner, the nerve supplying the tactile extremity of the proboscis of the elephant, exceeds in size the united volume of all its muscular nerves. On the other hand, in animals covered with hair or feathers, whose Touch and Sensation are comparatively defective, the muscular nerves far exceed in size those of Sensation; and wherever Nature has endowed any particular part with high sensitive powers, she is invariably found to have distributed to that part, and to it alone, a proportionally higher nervous endowment. In man, accordingly, innumerable nervous papillæ, destined for the exercise of Touch, may be distinctly seen in parallel irregular rows on the fingers and palm of the hand, and every body knows how acute the sense is in these parts. In fishes, on the other hand, no nervous papillæ can be detected on the surface of the skin; but many of them have tentacula or projections generally about the mouth, for the special purpose of exercising Touch, and these are always plentifully supplied with branches from the fifth pair of nerves.

The nervous tissue of the skin is thus not only an important instrument for receiving and conveying to the mind accurate impressions in regard to the properties of external objects, but it is even essential to our continued existence. The pain which is caused by injuries is no doubt very disagreeable, but in its uses it is a positive blessing, in warning us against the danger, and even certain destruction, which would speedily overtake us if we had no such monitor at hand. If we had no nerves on the surface to communicate to us a lively impression of cold, we might inadvertently remain inactive in a temperature which would not only suspend perspiration, but benumb the powers of life; or we might, as we have already seen, approach so near the fire or boiling fluids, as to have the organization destroyed before we knew: Whereas, by the kind interposition of the nerves, we cannot, when perspiring freely, be exposed to the cold air without an unpleasant sensation being experienced, impelling us to attend to our safety, and to keep up our heat either by additional clothing or by active exercise. When both the nervous and the vascular parts of the skin are in healthy action, a pleasant soft warmth is felt over the body, which is in itself a delight, and which gives to the mind a lightness and hilarity, or pleasant consciousness of active existence, the very opposite of the low and languid depression which so generally accompanies continued defective action in the skin, and which forms a marked feature in many nervous affections.

For the due exercise of Sensation, the nerves must be in a proper state of health. If, for example, the cuticle protecting the nervous papillæ be abraded, or removed by vesication, the naked nerves are too powerfully stimulated by the contact of external bodies, and, instead of receiving and transmitting the usual impressions of heat, cold, and configuration, they communicate scarcely any feeling except that of pain; while, if the cuticle become thickened by hard labour, the impression made on the nerves is proportionally lessened, and little information is conveyed by them to the mind.

I have already remarked that a due supply of arterial blood is another requisite for the action of the nerves of sensation, and that if they be deprived of this, as by exposing the body to a degree of cold sufficient to drive the blood from the surface, the nerves become almost insensible, and severe wounds may be received in this state without the individual being conscious of the accident, or feeling the slightest pain. For the same reason, severe cold, after a certain time, ceases to be painful, and death ensues like deep sleep and without suffering. But when a frozen limb is thawed, and the returning circulation begins to set the nerves in action, suffering forthwith commences, and the over-action is in danger of leading to inflammation. The same phenomena, in an inferior degree, must be familiar to every one, in the prickling and tingling so commonly complained of on heating cold hands or feet too rapidly at a good fire,—symptoms which arise from the return of the blood stimulating the nerves to undue action.

It is the nervous tissue of the skin which takes cognizance of the temperature of the bodies by which we are surrounded, and imparts to the mind the sensation of warmth and coldness. In the healthy state, the sensation is a correct index of the real temperature; but in disease, we often complain of cold and shivering when the skin is positively warmer than natural. In this way, people whose digestion is weak and circulation feeble complain habitually of cold, and of cold feet, where others, differently constituted, experience no such sensations. Exercise dissipates this feeling and increases heat, by exciting the circulation of the blood, throwing more of it to the surface, and thereby increasing the action of the cutaneous vessels and nerves.

Some mental emotions operate upon the skin, and impair its functions much in the same way as cold. Grief, fear, and the depressing passions, by diminishing the afflux of arterial blood, render the skin pale, and at the same time diminish perspiration and nervous action; while rage and other violent passions, by augmenting the afflux of blood, elevate the temperature of the surface, and give rise to the red flush, fulness, and tension so characteristic of excitement. Sometimes, indeed, the effect of mental emotions on the skin is so great as to induce disease. In speaking of impetigo, Dr Bateman alludes to two gentlemen in whom the eruption arose from "great alarm and agitation of mind;" and adds, that he "witnessed some time ago the extraordinary influence of mental alarm on the cutaneous circulation, in a poor woman who became a patient of the Public Dispensary. A sudden universal anasarca (dropsy under the skin) followed, *in one night*, the shock occasioned by the loss of a small sum of money, which was all she possessed."* Facts like these establish a connection between the brain and nervous system and the skin, which it is important not to overlook.

The reverse influence which the condition of the nervous matter distributed over the surface of the body exerts on the rest of the system is also well known, and is exemplified in the effects of exposure to intense cold. The first sensation of chill excited in the nerves of the skin is quickly succeeded by that of numbness and insensibility; and if the exposure be continued, the impression is speedily communicated to the brain, and confusion of mind, followed ultimately by the extinction of life, comes on. When, on the other hand, as in tropical climates, the surface is relaxed by excessive heat, the brain speedily participates in the relaxation, and the mind is unfitted for sustained or vigorous action.

Invalids and literary men often suffer severely from excess of action in the brain, and deficiency of activity in the nerves of the skin and remoter organs. The nervous stimulus, which is essential to digestion and to the health and warmth of the skin, cannot be provided when the brain is too exclusively exercised in thinking or feeling; and from the want of this stimulus the tone of the digestive and cutaneous organs is greatly reduced; the also, that the activity and restless energy of [illegible] to keep up a free and equal circulation even in the remotest parts of the body, and that this free circulation tends in its turn to maintain an equality of temperature in them all. *Cold* bathing and lighter clothing, therefore, may now be resorted to with a rational prospect of advantage, provided they be properly regulated and duly proportioned to the state of the individual. But *when, from a weak constitution or unusual susceptibility, the skin is not endowed with sufficient vitality to originate the necessary reaction which alone renders these safe and proper,—when they produce an abiding sense of chillness, however slight in degree,—we may rest assured that mischief will inevitably follow at a greater or shorter distance of time, and we should at once modify or discontinue them.*

In ordinary, and especially in boarding schools, great mischief is often inflicted on the young from inattention to this guiding principle. I have known many instances in which delicate young girls have suffered seriously and permanently from being confined to cold rooms in winter, with little or no fire, and with nothing beyond their ordinary in-door clothing, and, at the same time, on account of the weather, not allowed any active exercise in the open air by which their natural heat could be increased. The consequence has been a state of habitual suffering during many months of the year, a lowered tone of health, a retarded development of the constitution, a cold paleness of the surface and extremities, often accompanied by chilblains, and a spiritless languor of mind, which forms a striking contrast to the natural vivacity of youth. These evils, too, it is well to remark, are not inflicted from design, or even from carelessness. In most instances they spring from

composed of a glandular parenchyma situate a little below the papillæ, seen at *g* in the woodcut like a rounded line or cord running along their base, and presenting innumerable little threads projecting from its upper edge towards the papillæ. These threads are the ducts by which the colouring principle is poured out upon the surface of the dermis, there to become mixed with the soft and diffluent mucus, and to impart that colour by which the skin is distinguished in different individuals and races. From this view, it will be observed that the dermis or true skin is itself without colour, and that the latter, properly speaking, resides in the mucous coat. The red suffusion of the skin in blushing, however, does not arise from this cause, but from the unusual afflux of blood distending the innumerable minute vessels which form a vascular net-work on the surface of the dermis, and which are essential to the due performance of its functions as the seat of perspiration and of sensation.

Besides the parts just described, there are also numerous small follicles or glands contained in the substance of the skin, more abundant where hairs are implanted, and in the vicinity of the orifices of natural canals than in other regions, but existing in all parts except the palms of the hands and soles of the feet. They are about the size of a millet-seed, and the skin which contains them is thin, reflected on itself, and very vascular. Their cavities are filled with an oily humour, and each opens by an orifice at the external surface of the skin. It is this oily matter which prevents water from penetrating easily and relaxing the cuticle, and the absence of which, when it has been removed by the soda used in washing clothes, allows the skin of the hands and fingers to assume that wrinkled and shrivelled appearance common among washerwomen.

* Bateman on Cutaneous Diseases, p. 150.

CHAPTER IV.

CONDITIONS OF HEALTH OF THE SKIN, AND ITS INFLUENCE ON THE GENERAL SYSTEM.

the organs of sense.

The skin being the seat, and the nerve the immediat instrument, of sensation or sensibility, it becomes an ob ject of interest to ascertain in what manner the nerve i distributed over the skin so as to enable it to come int contact with external bodies without the risk of sustain ing injury from their roughness or hardness. On thi point we shall find much information in the work Breschet already referred to.

On examining the woodcut on page 12, a great nun ber of pointed or conical eminences, *h*, will be seen cover the surface of the skin. These are called, fro their shape, *papillæ*, or little paps, and very often, fro their structure, *nervous papillæ*. These papillæ consi of minute nervous ramifications, separated from ea other by the space which gives passage to the perspir tory pores. Their shape is that of a small cone with i base resting on the dermis, and its apex terminating an obtuse point. Every nervous branch entering a p pilla penetrates into the epidermis like a sword into i scabbard, so that the depressions on the internal surfa of the epidermis represent exactly the number and di position of the papillæ. On entering the papillæ, t nerves lose their common investing membrane or shea (neurilema), and are then protected by a covering fro the epidermis itself. By this arrangement, the tacti extremity of the nerve which enters into the papillæ, allowed to come into more direct contact with the qu lities of the external objects which it is intended to r cognise, and thus to appreciate them more correctly. this way, touch is exercised by thousands of these litt organs, all placed side by side, as it were, and comm nicating together by means of the nervous netwo spread over the whole surface of the body from one

From the foregoing exposition of the structure and functions of the skin, the principles on which its physiological management ought to be conducted will be sufficiently apparent; but as knowledge becomes valuable only in proportion as it is rendered subservient to the improvement and happiness of man, I shall offer no apology for now directing the attention of the reader to some of the advantages which may be derived from the practical application of the information which has just been communicated.

Assuming the natural constitution of the skin for our guide, it follows that the conditions essential to its healthy action are, *first*, that a free and equal circulation of blood shall take place over every part of its surface; *secondly*, that a free and equal perspiration shall be kept up in every part in due proportion to the circumstances in which the individual is placed; *thirdly*, that the *residuum*, or remains of the perspired matter, and all external impurities accidentally deposited on the surface of the body, shall be scrupulously and timeously removed; and, *lastly*, that the contact of noxious external agents likely to be absorbed by the skin should be carefully avoided and removed.

As the means which are most effectual in *ensuring a free and equal circulation of blood over the whole surface of the skin*, are, at the same time, more or less directly efficacious *in keeping up a due degree of perspiration, and in removing impurities* from the surface, I shall, to avoid unnecessary complication, treat of them all under the same head. Those among them which chiefly require our attention, are bodily exercise, suitable clothing, friction, and bathing.

The temperature of the skin is a pretty good test of the state of both circulation and perspiration on its surface. When the skin is comfortably warm, its depth of colour, pleasant softness, and moisture, indicate that the blood circulates freely through its minuter vessels, and that the perspiration is healthy and active. When, on the other hand, the surface is chilled and pale, we may be perfectly certain that its circulation is inactive, and perspiration deficient. Hence the proper regulation of its temperature is, in one sense, the first requisite to the preservation of its health.

When the skin is habitually cold, not only are the circulation and perspiration impeded or obstructed, and the injurious waste matter thus retained within the system; but the great mass of blood is thrown in undue proportion upon the internal organs, and, by over-distending their bloodvessels, tends directly to impair their health, and induce serious and often fatal disease.

The most frequent causes of this injurious coldness of the surface, are bodily inactivity, or a want of active exercise in the open air, want of sufficient clothing, and sitting in cold rooms. When a person sits all day at a desk or in a drawing-room, especially in winter, coldness of the feet and a chilly dry paleness of the skin are almost sure to be produced. But on going into the open air and taking active and invigorating exercise, the chill soon begins to disappear, the complexion deepens, and a genial heat and moisture of the skin succeed; and these results become habitual if the exercise be repeated with sufficient regularity and frequency. Exercise, then, is an indispensable requisite to the health of the skin; but as I shall have occasion to treat of it very fully in a subsequent chapter I shall not enter farther upon its consideration here.

The influence of *unsuitable or inadequate clothing* in impairing, and of *suitable clothing* in protecting and restoring, the functions of the skin, is very visible at all ages, in all ranks of society, and in all seasons. In infancy, and especially among the poor, want of proper clothing and the consequent exposure to cold are frequent causes of death, and still more frequent causes of sickness. From the recent *Reports of the Registrar-General of Births, Deaths, and Marriages in England* for 1838–9, it appears that one-third of all the deaths registered, or 342 per 1000, occur under two years of age. On inquiry, it is found that the proportion of such deaths among the poor is far greater than among the middle and richer classes. A very influential, although by no means the only, cause in producing this excess among the poor, is the inadequate protection afforded to the new-born infant against the effects of the sudden transition which it makes in passing from a high and almost unvarying temperature in the mother's womb, to one greatly inferior and constantly liable to change. At birth the skin is delicate, extremely vascular, and highly susceptible of impressions, so much so that cases have occurred in which a leech-bite has caused a fatal hæmorrhage. The circulation is, in fact, cutaneous; for the lungs, the stomach, the liver, and the kidneys, are as yet newly brought into activity, and feeble in their functions. If the infant then be rashly exposed to a cold atmosphere, the mass of blood previously circulating on the surface of the body is immediately driven inwards by the contraction of the cutaneous vessels, and, by over-stimulating the internal organs, gives rise to fever, bowel-complaints, inflammation, croup, or convulsions, which sooner or later extinguish life. Hence warm and light clothing is indispensable in infancy, and especially during the winter and spring months; and if, under the absurd expectation of hardening the constitution, the infant be daily plunged into cold water at that tender age, or rashly exposed to the open air during very cold weather, or to currents from doors or windows, the consequences can scarcely be otherwise than injurious.

In my recently published *Treatise on the Physiological and Moral Management of Infancy*, I have entered into some details in proof of the great influence of cold on infant mortality, and particularly of that arising from a law now or lately prevalent in France, which

requires newly-born children to be carried to the office of the *Maire* to be registered, a custom which Dr Edwards has shewn to be productive of a rate of mortality proportioned to the coldness of the season and climate, and to the distance which the infant is carried from the parent's house. What more striking proof than this can be required of the evils arising from the ignorance of legislators in regard to the constitution of the human body? No man who understood physiology could ever have sanctioned a law, the practical effect of which is to consign annually so many victims to an untimely grave.

Many parents, however, from over-anxiety to avoid one form of evil, run blindfold into another scarcely less pernicious, and not only envelope infants in innumerable folds of warm clothing, but keep them confined to very hot and close rooms. It would be well for them to recollect, when they do so, that extremes are always hurtful, and that the constitution may be enfeebled, and disease induced by too much heat and clothing, and too close an atmosphere, as effectually as by cold and currents of air. The skin, thus opened and relaxed, perspires too easily, and is readily affected by the slightest variations of temperature; whence arise colds and other ailments, which it is their chief intention to guard against; and the internal organs, being at the same time deprived of their fair proportion of blood, become enfeebled and afford inadequate nourishment and support to the rest of the body

But it is not in infancy alone that sickness and mortality are produced from the imperfect regulation of the temperature of the skin. In youth, and especially during the debility arising from rapid growth, the proper regulation of the clothing demands more attention than is generally bestowed on it. Many young persons of both sexes are in the habit of going about in winter and in cold weather with a dress light and airy enough for a northern summer, and they think it manly and becoming to do so; but those who are not very strongly constituted suffer a severe penalty for their folly. The necessary effect of deficient circulation and vitality on the skin, is, as we formerly said, to throw a disproportionate mass of blood inwards; and when this condition exists, insufficient clothing perpetuates the evil, until internal disease is generated, and health irrecoverably lost. Insufficient clothing not only exposes the wearer to all the risk of sudden changes of temperature, but it is still more dangerous (because in a degree less marked, and therefore less apt to excite attention till the evil be incurred) in that form which, while it is warm enough to guard the body against extreme cold, is inadequate to preserving the skin at its natural heat. Many youths, particularly females, and those whose occupations are sedentary, pass days, and weeks, and months, without ever experiencing the pleasant glow and warmth of a healthy skin, and are habitually complaining of chillness of the surface, cold feet, and other symptoms of deficient cutaneous circulation. Their suffering, unfortunately, does not stop here, for the unequal distribution of the blood oppresses the internal organs, and too often, by insensible degrees, lays the foundation of tubercles in the lungs, and other maladies, which shew themselves only when arrived at an incurable stage. Young persons of a consumptive habit will generally be found to complain of this increased sensibility to cold, even before they become subject to those slight catarrhal attacks which are so often the immediate precursors, or rather the first stages, of pulmonary consumption. All who value health, and have common sense and resolution, will therefore take warning from signs like these, and never rest till equilibrium of action be restored. For this purpose, warm clothing, exercise in the open air, and regular daily friction with a hair-glove or flesh-brush, are excellently adapted, and should be diligently pursued.

It is true that in youth the skin is more vigorous in constitution than it was in infancy; and that the several animal functions being now more equally balanced, the system is less susceptible of disorder from external causes, and can endure with impunity changes of temperature which at either an earlier or more advanced age would have proved highly injurious. It is true, also, that the activity and restless energy of youth tend to keep up a free and equal circulation even in the remotest parts of the body, and that this free circulation tends in its turn to maintain an equality of temperature in them all. *Cold* bathing and lighter clothing, therefore, may now be resorted to with a rational prospect of advantage, provided they be properly regulated and duly proportioned to the state of the individual. But *when, from a weak constitution or unusual susceptibility, the skin is not endowed with sufficient vitality to originate the necessary reaction which alone renders these safe and proper,—when they produce an abiding sense of chillness, however slight in degree,—we may rest assured that mischief will inevitably follow at a greater or shorter distance of time, and we should at once modify or discontinue them.*

In ordinary, and especially in boarding schools, great mischief is often inflicted on the young from inattention to this guiding principle. I have known many instances in which delicate young girls have suffered seriously and permanently from being confined to cold rooms in winter, with little or no fire, and with nothing beyond their ordinary in-door clothing, and, at the same time, on account of the weather, not allowed any active exercise in the open air by which their natural heat could be increased. The consequence has been a state of habitual suffering during many months of the year, a lowered tone of health, a retarded development of the constitution, a cold paleness of the surface and extremities, often accompanied by chilblains, and a spiritless languor of mind, which forms a striking contrast to the natural vivacity of youth. These evils, too, it is well to remark, are not inflicted from design, or even from carelessness. In most instances they spring from ignorance alone, and from a wish to harden the constitution, which they are in reality calculated to destroy. In boarding-schools for boys, I have known the same pernicious principles acted upon, and with lamentable consequences; but in them the evil is, to some extent, counteracted by the restlessness and craving for active exercise in the open air, which at that age can scarcely be repressed under any system of prohibitive discipline. A moderate acquaintance with physiology on the part of teachers would save them from this destructive error.

Habitual coldness of the feet is another source of suffering and bad health, both in schools and in general society; and in both it arises chiefly from inactivity or indolence. Sedentary females, literary men, clerks, &c., almost invariably suffer from this cause; and, in schools, even the young suffer from not being allowed sufficient exercise in active sports to circulate their blood. The formal boarding-school walk of half an hour or an hour *on fine days*, is a mere dull shadow of what exercise ought to be in youth, and is of no avail in infusing warmth and vigour into chilblained hands and feet. But of this I shall have occasion to speak again in a subsequent chapter. In the mean time, I shall only caution the reader as to the use, or rather abuse, of warm-water bottles now so commonly resorted to, to impart heat to the feet when in bed. Like all other substitutes for the operations of Nature, warm bottles fail in the purpose for which they are used, and tend to aggravate the evil. Instead of promoting a healthier circulation through the vessels of the feet, they weaken by relaxing them, and leave them less able than before to generate *natural heat*. Every body admits that a warm foot-bath used every evening is relaxing and hurtful. But in reality a hot-water bottle in contact with the feet for hours every night acts on precisely the same principle, and proves scarcely less injurious. By the irregularity of circulation which it brings about, it

induces flushing and headach, while it does not correct the cause of the coldness of the feet. In females, accordingly, it often produces a local weakness and discharge altogether incompatible with health. To remove such coldness, exercise, friction, and proper attention to diet and to the bowels, are the most effectual means; and, in addition to these, the use of the cold salt-water foot-bath, for two or three minutes at a time, once or even twice a-day, will be very serviceable by invigorating the circulation, and exciting a healthy reaction similar to the glow which comes on after sea-bathing. The only legitimate use of hot-water bottles is to air or moderately warm the sheets, by placing two or three of them in different parts of the bed late in the afternoon, and having them removed at least an hour or so before going to bed. But even this indulgence should be resorted to only in aid of better means, and when there is positive necessity for external warmth. The plan of going to sleep with the feet in contact with a warm bottle is a very bad one, and ought never to be adopted as a habit.

The inactivity implied in a sedentary mode of life leads to another abuse, against which every thinking person ought to guard. I allude to the overheating of sitting and bedrooms by large fires or stoves. External heat thus applied invariably diminishes the heat-producing power of the animal system, and renders it, as a necessary consequence, more and more dependent on external warmth at the expense of increasing debility and susceptibility of cold. Many persons, when cautioned on this subject, triumphantly point to a thermometer in the same room as indicating a temperature of perhaps only 65°. But this is a fallacious test. There is a great difference between an equable temperature of 65° diffused *through the whole air* as in summer, and a corresponding temperature *in a part of any room, the air of which is rapidly and constantly changing.* To raise the thermometer of such a room to 65° in winter, at 10 or 15 feet distance from the fire, we must have a heat of perhaps 75° nearer the fire, and a large quantity of heat must be given out by radiation, and directly absorbed by the body. In a room warmed by a large fire, too, there is constantly a strong current of air rushing towards the chimney, to which we have no parallel in the equal temperature of a summer-day. But the air thus entering the room from without is necessarily colder by very many degrees than the air contained in it; so that, to keep the thermometer steadily at 65°, we must keep up a fire large enough to *instantly* warm that large mass of cold air. To succeed in this, however, the fire must be such as to throw out a quantity of heat by radiation and contact far beyond what is present in the same quantity of air at the same apparent heat in summer, and by this radiated heat, the body is scorched and relaxed. Whereas in summer, the walls, the furniture, and the air of the room being all at an equilibrium of heat, no such current or rapid loss is going on. The consequence is, that let any one in winter come from the open air into a room of a temperature of 65° at ten feet from the fire, and he will instantly exclaim, How overheated the room is; although those who are accustomed to it may affirm the contrary, and point, as a proof, to the thermometer. This sensation of overheating is not the result of the mere transition; for no length of time will make the warmth agreeable to a healthy person of active habits; and, practically, those who indulge in the warmth certainly suffer all the evils arising from overheated rooms. I have so often noticed this that I can speak on the subject with confidence. For invalids confined to the house it is a matter of much importance, and, as a general rule, I should consider a thermometrical temperature of 55° in winter in a bedroom or sitting-room, where there is a current of air, as fully equal to a steady temperature of 65° in summer, and consequently quite as high as ought ever to be indulged in.

For a similar reason, while sufficiency of clothing is attended to, excessive wrapping up must be as carefully avoided. Great differences in the power of generating heat and resisting cold exist in different individuals, and it would be absurd to apply the same rules to those who never feel cold, as to those who are peculiarly sensitive. The former may be benefited by cold bathing and degrees of exposure which would be fatal to the latter. The rule is, therefore, not to dress in an invariable way in all cases, but to put on clothing in kind and quantity *sufficient in the individual case to protect the body effectually from an abiding sensation of cold, however slight.* Warmth, however, ought not to be sought for in clothing alone. The Creator has made exercise essential as a means; and if we neglect this, and seek it in clothing alone, we act at the risk, or rather with the certainty, of weakening the body, relaxing the surface, and rendering the system extremely susceptible of injury from the slightest accidental exposures, or variations of temperature and moisture. Many good constitutions are thus ruined, and many nervous and pulmonary complaints brought on, to embitter existence, and to reduce the sufferer to the level of a hot-house plant.

Female dress errs in one important particular, even when unexceptionable in material and quantity. From the tightness with which it is made to fit on the upper part of the body, not only is the insensible perspiration injudiciously and hurtfully confined, but that free play between the dress and the skin, which is so beneficial in gently stimulating the latter by friction at every movement of the body, is altogether prevented, and the action of the cutaneous nerves and vessels, and consequently the heat generated, rendered less than that which would result from the same dress more loosely worn. Every part and every function are thus linked so closely with the rest, that we can neither act wrong as regards one organ without all suffering, nor act rightly without all sharing in the benefit.

We can now appreciate the manner in which wet and cold feet are so prolific of internal disease, and the cruelty of fitting up schools and similar places without making adequate provision for the welfare of their young occupants. The circumstances in which wet and cold feet are most apt to cause disease, are those where the person remains inactive, and where, consequently, there is nothing to counterbalance the unequal flow of blood which then takes place towards the internal parts; for it is well known that a person in ordinary health may walk about or work in the open air with wet feet for hours together without injury, provided he put on dry stockings and shoes immediately on coming home. It is therefore not the mere state of wetness that causes the evil, but the check to perspiration and the unequal distribution of blood to which the accompanying coldness gives rise. I am acquainted with an instance in which a robust and healthy tradesman, by incautiously standing in the sea, when in a state of profuse perspiration, for five minutes, in repairing a steam-boat, brought on severe constitutional disturbance, followed by pulmonary disease, which confined him to the house during the whole of *four* winters. Twenty-three years have now elapsed since the cause was applied; but although his health is gradually improving, he still suffers from cough and breathlessness, and is very susceptible of cold and illness from every trifling exposure. This person instantly shifted himself on coming out of the water, which at the time he had been led to believe was a sufficient precaution. But had he known something of his bodily constitution, he would have seen the danger before he exposed himself to it, and would have escaped the heavy penalty which his ignorance brought upon him.

The preceding observations refer chiefly to the quantity and fitting of the clothing; but the quality or material of which it is composed is also a consideration of much importance.

The advantages of wearing flannel next the skin have been long and familiarly known, and they are easily explicable on the principles expounded above. Being a bad conductor of heat, flannel prevents that of the animal economy from being quickly dissipated, and protects the body in a considerable degree from the injurious influence of sudden external changes. From its presenting a rough and uneven though soft surface to the skin, every movement of the body in labour or in exercise, gives, by the consequent friction, a gentle stimulus to the cutaneous vessels and nerves, which assists their action, and maintains their functions in health; and, being at the same time of a loose and porous texture, flannel is capable of both absorbing and giving passage to the cutaneous exhalations to a larger extent than any other material in common use. In some very delicate constitutions, it proves even too irritating to the skin, and in hot climates sometimes excites too great a flow of perspiration. In the former case, fine fleecy hosiery, and in the latter, cotton, will in general be easily endured, and will greatly conduce to the preservation of health. Many are in the custom of waiting till winter has fairly set in before beginning to wear flannel. This is a great error in a variable climate like ours, especially when the constitution is not robust. *It is during the sudden changes from heat to cold, which are so common in autumn, before the frame has got inured to the reduction of temperature, that protection is most wanted, and flannel is most useful, and also during the sudden transitions in spring.* Even during the summer months, the changes of temperature at different times of the day, and the degrees of activity in which we are engaged, are so very different, that flannel is scarcely less valuable as a protection than during the colder months of the year. Towards sunset the air often becomes so cold in summer after a very warm day, as to become the cause of a sudden chill to those who are not on their guard against it. This is a frequent occurrence even in the climates of France and Italy, from the moisture which is then condensed by the cooling of the air. Upon the whole, therefore, I am disposed to recommend persons of a delicate constitution not to leave off the use of flannel even in summer, but rather, if they find it too warm, to wear it over, instead of under, the shirt, as in winter. This will modify its effects, and at the same time scarcely impair its protecting power against sudden changes.

The advantages of flannel as a preservative from disease, in warm as well as in cold climates, are now so well understood, that in the army and navy its use is cogently, and with great propriety, insisted on. Sir George Ballingall, in his valuable *Lectures on Military Surgery* (p. 92), has some very judicious remarks on the influence of warm clothing in preserving the health of soldiers. After adducing the testimony of Sir James Macgrigor, to shew that in the Peninsula the best clothed regiments were generally the most healthy, Sir George mentions, that, when in India, he had himself a striking proof of the utility of flannel in checking the progress of a most aggravated form of dysentery in the second battalion of the Royals. Captain Murray, also, late of H.M.S. Valorous, told me, that he was so strongly impressed from former experience with a sense of the efficacy of the protection afforded by the constant use of flannel next the skin, that when, on his arrival in England in December 1823, after two years' service amid the icebergs on the coast of Labrador, the ship was ordered to sail immediately for the West Indies, he directed the purser to draw two extra flannel shirts and pairs of drawers for each man, and instituted a regular daily inspection to see that they were worn. These precautions were followed by the happiest results. He proceeded to his station with a crew of 150 men; visited almost every island in the West Indies, and many of the ports in the Gulf of Mexico; and, notwithstanding the sudden transition from extreme climates, returned to England without the loss of a single man, or having any sick on board on his arrival. It would be going too far to ascribe this excellent state of health solely to the use of flannel; but there can be little doubt that this was an important element in Captain Murray's success. Far, however, from trusting to it alone, Captain Murray was as careful in guarding against other sources of disease as against variations in temperature; and with this view every precaution was at the same time used, by lighting stoves between decks and scrubbing with hot sand, to ensure the most thorough dryness, and proper means were put in practice to promote cheerfulness among the men. When in command of the Recruit gun-brig, which lay about nine weeks at Vera Cruz, the same means preserved the health of his crew, when the other ships of war anchored around him lost from twenty to fifty men each.

That the superior health enjoyed by the crew of the Valorous was attributable chiefly to the means employed by their humane and intelligent commander, is shewn by the analogy of the Recruit; for although constant communication was kept up between this vessel and the ships in which sickness prevailed, and all were exposed to the same external causes of disease, yet no case of sickness occurred on board of it. Facts like these are truly instructive, by proving that man possesses much power of protecting himself from injury, when he has received the necessary instruction, and chooses to adapt his conduct to the circumstances in which he is placed.

With regard to the rest of the clothing, it is impossible to lay down any fixed rules: all that can properly be said is, that it should be light, free, and unrestrained, and in such quantity as to afford the necessary protection without relaxing the surface too much. It ought, therefore, to vary not only according to the season and the weather, but according to the active or passive state of the wearer. As active exertion is favourable to the production of animal heat, less clothing is necessary for walking than for driving or sailing. For this reason we see the labourer strip in proportion to the severity of his toil, while the passive female in a well-hung carriage lolls wrapped up in cloaks and furs. But when overheated by exercise, we should be careful not to throw aside our wrappings too suddenly after coming home. The safest way is to saunter about the room for a few minutes till the natural heat be attained, and then to throw off the superfluous covering. Many get chilled by neglecting this precaution, and blame the walking out for the cold which they caught rather after their return. In like manner, many injure themselves in severe weather by getting chilled, and trusting to subsequent exercise to restore their heat. Whereas going out already cold is the surest way to get thoroughly chilled, and to be hurt by it. Those resist external cold best who go out comfortably warm, and with an active state of the cutaneous circulation.

In aid of the third requisite of clothing—that it should be sufficiently porous to give easy passage to the insensible perspiration, and sufficiently absorbent to take up a considerable portion of moisture when sweating is induced,—it is necessary that whatever is worn should be frequently changed, aired, and washed, to free it from the impurity necessarily arising from so constant and extensive an exhalation from the skin. In the case of flannel, for example, which imbibes perspiration very readily, it is an excellent plan, instead of wearing the

same for several successive days, either to change it very frequently, or to make use of two sets of flannel, each being worn and aired by turns on every alternate day. A frequent change, however, is certainly the preferable practice. For the same reason, a practice common in Italy merits universal adoption. Instead of beds being made up in the morning the moment they are vacated and while still saturated with the nocturnal exhalations which, before morning, even become sensible to smell in a bed-room, the bedclothes are thrown over the backs of chairs, the mattresses shaken up, and the window thrown open for the greater part of the day, so as to secure a thorough and cleansing ventilation. This practice, so consonant to reason, imparts a freshness which is peculiarly grateful and conducive to sleep, and its real value may be inferred from the well-known fact, that the opposite practice, carried to an extreme—as in the dwellings of the poor, where three or four beds are often huddled up with all their impurities in a small room—is a fruitful source of fever and bad health, even where there is no deficiency of nourishment or of ventilation during the day. In the abodes of the poor Irish residing in Edinburgh, I have seen bedding for fourteen persons spread over one floor not exceeding twelve feet square: when morning came the beds were huddled above one another to make sitting-room during the day, and at night were again laid down, charged with accumulated exhalations. If fever were not to appear in such circumstances, it would be indeed marvellous; and we ought to learn from this, that if the extreme be so injurious, the lesser degree implied in the prevalent practice cannot be wholesome, and ought, therefore, not to be retained when it can be so easily done away with.

The exhalation from the skin is composed of a large quantity of water which passes off in the form of invisible vapour or of fluid sweat, and of various salts and animal matter, a portion of which is absorbed and retained in the texture of the clothes, and another portion of which remains adherent to the skin, and forms on it a layer of impurities. Hence the frequent removal of this residue by washing becomes an indispensable condition of health, the observance of which, particularly in early life, when waste and nutrition are both very active, prevents the appearance of the cutaneous diseases otherwise so common in infancy. Not only, therefore, is daily washing of the body required at that and indeed at every age, but frequent change of clothing is also essential; and for this reason it is much to be wished that a plan of washing the clothes of the poor at a cheap rate, similar to that so successfully in operation in Liverpool, were adopted in all our larger towns. At present, the trouble, time, and expense, imposed upon the mother of a family among the working classes in washing and drying the clothes of its individual members, are so great as to present an almost irresistible temptation to the neglect of cleanliness; and when we wonder at the dirt and disorder of a labourer's house, we are too apt to forget the disadvantages under which its inmates are placed, and the cost of toil and money at which cleanliness is obtained where there are several children to take care of, and cooking and other household operations going on at the same time. Hence, among the poorer classes in large towns, want of cleanliness prevails to a very great extent, and proves highly injurious to both health and morality. Actuated by considerations of this description, a few benevolent individuals in Liverpool combined, a few years ago, to hire and fit up a cellar in a convenient situation, with the requisite boilers, tubs, and drying stoves, where the poor might have the means of washing their bed and body clothes at an exceedingly trifling expense of both time and money; and after several years' trial the results have been most encouraging. Not only have the poor been eager to avail themselves of the privilege thus held out to them; but numerous instances have

line and animal impurities [illegible] the perspiration, it is equally certain that frequent *bathing or washing of the skin* is not less indispensable to remove the impurities adhering to its surface, and which would otherwise tend in the long run to obstruct its pores, impede its functions, and disturb its health. It is apparently for this reason that, in the eastern and warmer countries, where perspiration is very copious, ablution and bathing have assumed the rank and importance of religious observances. Those who are in the habit of using the flesh-brush daily, are at first surprised at the quantity of white dry scurf which it brings off; and those who take a warm bath for half an hour at long intervals, cannot have failed to notice the great amount of impurities which it removes, and the grateful feeling of comfort which its use imparts. The warm, tepid, cold, or shower bath, as a means of preserving health, ought to be in as common use as a change of apparel, for it is equally a measure of necessary cleanliness. Many, no doubt, neglect this, and enjoy health notwithstanding; but many, very many, suffer from its omission, and even the former would be benefited by employing it. The perception of this truth is gradually extending, and baths are now to be found in fifty places for one in which they could be obtained twenty years ago. Even yet, however, we are far behind our Continental neighbours in this respect. They justly consider the bath as a necessary of life, while we still regard it as a luxury. I believe that I am within the truth when I say that in one hospital in Paris, a greater number of baths have been administered to the poor during the last year, than to the whole working population of Great Britain during the last ten years.

When we consider the importance of the exhaling functions performed by the skin, it seems almost incredible that ablution and bathing of every description should be so much neglected in charitable institutions, in seminaries for the young, and even by many persons who consider themselves as patterns of cleanliness. Mr Stuart, in speaking of the North Americans, remarks that "the practice of travellers washing at the doors, or in the porticos or stoops, or at the wells of taverns and hotels once a-day, is most prejudicial to health; the ablution of the body, which ought never to be neglected, *at least twice a-day* in a hot climate, being altogether inconsistent with it." "In fact," he adds, "I have found it more difficult in travelling in the United States, to procure a liberal supply of water at all times of the day and night in my bed-chamber, than to obtain any other necessary. *A supply for washing the face and hands once a-day seems all that is thought requisite.*"* But bad as this is, I fear that numbers of sensible people may be found much nearer home, who limit their ablutions to the *visible* parts of their persons, and would even express surprise if told that more than this is necessary to health. Certain it is that many never wash their bodies unless they happen to be at sea-bathing quarters in summer, or are oppressed with heat, when they will resort to bathing as a means of comfort, but without thinking at all of its efficacy *as a means of cleanliness* in preserving health. In many public charities and schools, in like manner, bathing or ablution is never thought of as a proper or practicable thing, except for the sick; and yet it is obviously of great importance to every one, especially to the

* Three Years in America, vol. ii. p. 440.

young.* These facts shew that there is quite as much truth as sarcasm in the remark of a late writer, that "we every day see whole families purged and vomited by the order of their physicians, but rarely or never do we hear of their being recommended to wash their skins."†

For *general* use, the tepid or warm bath seems to me much more suitable than the cold bath, especially in winter, and for those who are not robust and full of animal heat. Where the constitution is not sufficiently vigorous to secure reaction after the cold bath, as indicated by a warm glow over the surface, its use inevitably does harm. A vast number of persons, especially of those leading a sedentary life, are in this condition; while, on the contrary, there are few indeed who do not derive evident advantage from the regular use of the tepid bath, and still fewer who are hurt by it.

Where the health is good, and the bodily powers are sufficiently vigorous, the cold bath during summer, and the shower-bath in winter, may serve every purpose required from them. But it should never be forgotten that they are too powerful in their agency to be used with safety by *every one*, especially in cold weather. In proportion as cold bathing is influential in the restoration of health when judiciously used, it is hurtful when resorted to without discrimination; and invalids therefore ought never to have recourse to it without the sanction of their professional advisers.

Even where cold bathing is likely to be of service, when judiciously employed, much mischief often results from prolonging the immersion too long. I lately met with a case of this kind in a boy of fifteen years of age, who became nearly insensible from remaining half an hour in the sea, while bathing at Portobello. It was some days before he was sufficiently restored to be considered out of danger. In delicate subjects, injury is often caused by cold bathing, at a time when the vital powers are too languid to admit of the necessary reaction—before breakfast, for example, or after fatigue. For this reason, many persons derive much benefit from bathing early in the forenoon, who, when they bathe in the morning before taking any sustenance, do not speedily recover their natural heat and elasticity of feeling.

For those who are not robust, daily sponging of the body with cold water and vinegar, or with salt water, is the best substitute for the cold bath, both as a means of freeing the skin from its impurity and as a tonic; and it may be resorted to with safety and advantage in most states of the system; especially when care is taken to excite in the surface, by subsequent friction with the flesh-brush or hair-glove, the healthy glow of reaction. It then becomes an excellent preservative from the effects of changeable weather. When, however, a continued sensation of coldness or chill is perceptible over the body, sponging ought not to be persisted in; dry friction, aided by the tepid bath, is then greatly preferable, and often proves highly serviceable in keeping up the due action of the skin.

For habitual use, the tepid or warm bath is certainly the safest and most valuable, especially during the autumn, winter, and spring, and for invalids; and every house ought to be provided with one as an indispensable requisite for health and comfort. A temperature ranging from 85° to 90°, according to the state of the individual, is the most suitable; and the duration of the immersion may vary from fifteen minutes to an hour or more, according to circumstances. As a general rule, the water ought simply to be warm enough to feel pleasant without giving a positive sensation of heat; the degree at which this happens varies considerably according to the constitution and to the state of health at the time. Sometimes, when the generation of animal heat is great, a bath at 95° will be felt disagreeably warm and relaxing; while, at another time, when the animal heat is produced in deficient quantity, the same temperature will cause a chilly sensation. The rule, then, is to avoid equally the positive impressions of heat and of cold, and to seek the agreeable medium. A bath of the latter description is the reverse of relaxing; it gives a cheerful tone and activity to all the functions, and may be used every day, or on alternate days, for fifteen or twenty minutes, with much advantage.

A person of sound health and strength may take a bath at any time, except immediately after meals. But the *best* time for valetudinarians is in the forenoon or evening, two or three hours after a moderate meal, when the system is invigorated by food, but not oppressed by the labour of digestion. When the bath is delayed till five or six hours after eating, delicate people sometimes become faint under its operation, and, from the absence of reaction, are rather weakened by the relaxation it then induces. As a general rule, active exertion ought to be avoided for an hour or two after using the warm or tepid bath; and unless we wish to induce perspiration, it ought not to be taken immediately before going to bed; or if it is, it ought to be merely tepid, and not of too long duration.

These rules apply of course only to persons in an ordinary state of health. If organic disease, headach, feverishness, constipation, or other ailment exist, bathing ought never to be employed without medical advice. When the stomach is disordered by bile, it also generally disagrees. Under ordinary circumstances, however, and with ordinary prudence, the warm bath is not only a safe and valuable preservative of health, but an active remedy in disease. Instead of being dangerous by causing liability to cold, it is, when well managed, so much the reverse, that the author of these pages has used it much and successfully for the express purpose of diminishing such liability, both in himself and in others in whom the chest is delicate. In his own instance, in particular, he is conscious of having derived much advantage from its regular employment, especially in the colder months of the year, during which he has uniformly found himself most effectually strengthened against the impression of cold, by repeating the bath at shorter intervals than usual.‡

Considering the nature of the occupations in which most of the labouring classes are engaged, and the soothing and refreshing effects as well as the cleanliness derived from the use of the tepid bath, there cannot be a doubt that a great public benefit would be attained by providing baths for their use at a very easy rate, and encouraging them to resort to them by personal influence and frequent expositions of their advantages. In many factories where there is constantly steam or warm water running waste, baths for the workmen and their families might be fitted up at a very trifling cost, and their use do much to subdue that craving for stimulus which drives so many to the gin-shop; and also to allay that irritability of mind so apt to be induced by exces-

* While revising these pages, a friend has mentioned to me a case strikingly illustrative of the necessity of attending to the condition of the skin, and of the sympathy subsisting between it and the bowels. A lady, who is in other respects very cleanly in her habits, has never been accustomed to the use of the bath, or to general ablution of any kind, and, in consequence, the action of the skin is very imperfect. As a substitute, however, for its exhalation, she has, all her life, been affected with *bowel complaint*, which no treatment, directed to the bowels, has been able to remove. It is probable that the natural course of the exhalation could not now be restored.

† Medico-Chirurg. Rev. No. LXVI. p. 523.

‡ I am delighted to find my opinion of the value of the bath and of attention to the cutaneous functions in the prevention of pulmonary disease, and indeed the whole practical doctrines of the present chapter, corroborated by the authority of Sir James Clark, in his admirable works on Consumption and Climate—of the latter of which a much improved edition has just appeared. Both are well deserving the attention of parents and others interested in the health of the young, and especially of those who are delicately constituted.

sive labour. When the trade is dirty, a tepid bath and change of clothing on quitting it for the day would be the saving of many men who at present fall into vice by imperceptibly losing that self-respect and regard for decency of appearance which are among the strongest safeguards of character and morality; and I rejoice to think that in several manufactories the hint thrown out in the former editions of this work has been acted upon, and followed by more than the anticipated advantages. To derive full benefit from it, however, some knowledge of the animal economy must be communicated, and the desire excited among the more intelligent workmen to avail themselves of the boon. The more ignorant and the more unintellectual the individual, the less will he appreciate the offered advantage; but patient and good-humoured encouragement will soon get over all difficulties, and excite a right feeling on the subject.

In Edinburgh, a bath-establishment has of late been opened by Mr Goulding, formerly of the Infirmary, for the purpose of supplying baths at a moderate rate to the middle, and at a cheap rate to the working classes—the cost to the latter being only sixpence. This institution is, I understand, much resorted to. In like manner, extensive baths were opened in Dublin, by the benevolent exertions of Mr Clason, where twenty tickets could be had at a shilling each, with the privilege of also giving a bath to a poor person. If the latter was taken exclusively, it could be had for either fourpence or sixpence. Mr Clason offered to establish similar baths in different parts of Dublin if the medical men would encourage them by actively recommending their use; but such was the indifference proceeding from ignorance of their advantages to persons in health that no such encouragement could be obtained. Those already in existence are, however, in constant employ; and we may hope, now that a greater interest is excited about the welfare of the working classes, that something will be done to disseminate sounder views, and to turn them to practical account in improving the condition and happiness of our less fortunate fellow-creatures.

On the Continent, the vapour and hot air baths are had recourse to both as an agreeable means of removing the impurities and exciting the action of the skin, and in the cure of disease, to a vastly greater extent than they are in this country. Their use is attended by the very best effects, particularly in chronic ailments, and where the water-bath is felt to be oppressive by its weight; and there can be no question that their action is chiefly on the skin, and through its medium on the nervous system. As a means of cleansing the skin, determining the blood to the surface, promoting cutaneous exhalation, and equalizing the circulation, they are second to no remedy now in use; and consequently, in a variety of affections which the encouragement of these processes is calculated to relieve, they may be employed with every prospect of advantage. The prevalent fear of catching cold, which deters many from using the vapour-bath, even more than from warm bathing, is founded on a false analogy between its effects and those of profuse perspiration from exercise or illness. The latter weakens the body, and, by diminishing the power of reaction, renders it susceptible of injury from sudden changes of temperature. But the effect of the vapour-bath properly administered is very different. When not too warm or too long continued, it not only removes a load of impurities beyond what was imagined to exist, but increases instead of exhausting the strength; and, by exciting the vital action of the skin, gives rise to a power of reaction which enables it to resist cold better than before. This I have heard many patients remark; and the fact is well exemplified in Russia and the north of Europe, where, in the depth of winter, it is not uncommon for the natives to rush out of a vapour-bath and roll themselves in the snow, and be refreshed by doing so; whereas were they to attempt such a practice after severe perspiration from exercise, they would inevitably suffer. It is the previous stimulus given to the skin by the vapour-bath which is the real safeguard against the coldness of the snow.

The truth of this principle is strikingly illustrated by the practice now in vogue in some parts of Germany, and particularly at Graefenberg, where it was first introduced by Dr Priessnitz, of treating diseases by first inducing severe sweating, and then administering the cold bath, not only daily, but several times a-day. The patient is first stripped naked and wrapped up rather tightly in blankets, and laid down till sweating comes on, which seldom happens in less than an hour. As soon as this commences, the window is thrown open, and he is made to drink a glassful of cold water every quarter of an hour or half hour. This increases the perspiration so much that the sweat sometimes drops from the blanket to the extent of seven pounds weight. When the sweating has continued sufficiently long he is unswathed; and, covering himself with a cloak, hurries to the cold bath, *into which he plunges bathed in perspiration*. While in the bath he is made to exercise his limbs as much as possible, in order to excite the necessary cutaneous reaction. The greater the reaction, the more favourable will be the result.

According to our ordinary notions, this practice would seem to be of the most dangerous character; but in reality it is not so; for, when judiciously managed, it is said to be both safe and advantageous. Dr Priessnitz admits, as every body does, that cold drinks, or the cold bath, *in a state of violent perspiration from exercise or the use of sudorifics*, is very dangerous; but one grand point of difference between such a state and that in which he prescribes cold bathing, is that, according to his plan, *neither the breathing nor the circulation is quickened or excited*, and both are thus ready to concur in undiminished force in the necessary reaction. But in sweating after violent exercise or sudorifics, as he justly remarks, the respiration and circulation have already been excited, and are, to a proportionate extent, exhausted, so that they are overpowered instead of being roused to reaction by the cold. Hence Dr Priessnitz affirms, and it is said with truth, that, *provided the breathing is not hurried, and the surface is not chilled by exposure to the air* before plunging into the cold bath, no risk whatever is incurred, however copious the perspiration. It is added, that if these precautions were strictly observed by ordinary bathers in summer, we should hear of fewer accidents from bathing in a state of perspiration; and the same remarks are said to apply to drinking cold water and eating ices. Active exercise, however, is most wisely and strenuously urged as a part of the treatment. But for farther particulars, I must refer the reader to an interesting account of Dr Priessnitz's method of cure in the 66th Number of the *Medico-Chirurgical Review*.

Common experience affords another illustration of the principle implied in the caution to avoid becoming chilled before going into the cold bath. If, in a cold winter day, we chance to sit for some time in a room imperfectly warmed, and feel, in consequence, a sensation of chilliness over the body, we are much more likely to catch cold on going out than if we had been sitting in a room comfortably warm. In the latter case, the cutaneous circulation and nervous action go on vigorously; heat is freely generated, and the vital action of the skin is in its full force. The change to a lower temperature, if accompanied with exercise to keep up vitality, is then felt to be bracing and stimulating rather than disagreeable. But it is widely different when the surface is already chilled before going out. The vitality of the skin being diminished, reaction cannot follow additional exposure; the circulation leaves the surface and becomes still more internal; and if weakness exist in the throat or chest, cold is the almost certain result. Many suffer from ignorance of this principle.

The vapour-bath is thus calculated to be extensively useful, both as a preservative of health and as a remedial agent. Many a cold and many a rheumatic attack, arising from checked perspiration or long exposure to the weather, might be nipped in the bud by its timely use. In chronic affections, not only of the skin itself, but of the internal organs with which the skin most closely sympathizes, as the stomach and intestines, the judicious application of the vapour-bath is productive of great relief. Even in chronic pulmonary complaints, it is, according to the Continental physicians, not only safe, but very serviceable; particularly in those affections of the mucous membrane which resemble consumption in so many of their symptoms. Like all powerful remedies, however, the vapour-bath must be administered with proper regard to the condition and circumstances of the individual; and care must be taken to have the feet sufficiently warm during its use. If, from an irregular distribution of the steam, the feet be left cold, headach and flushing are almost sure to follow. The surest precaution is to place the feet in a vessel of tepid water while using the vapour-bath.

It happens occasionally, either from some peculiarity of constitution, or from some unusual condition of the skin, indicated by great dryness and a liability to erysipelatous and scaly eruptions, that the moisture of the water or vapour-bath is at first rather prejudicial and unpleasant, and becomes grateful only in proportion as the skin regains its healthy state. In such cases the warm *air-bath* is said to be remarkably successful, and is rapidly gaining ground in the metropolis.

Although the preceding remarks apply specially to the skin considered as an *exhalant*, yet most of them are equally applicable to it when viewed as the seat of an important *nervous* function. For so intimately and beautifully are all the parts of the frame connected with each other, that what is really good for one rarely, if ever, fails to be beneficial to the rest. Thus, while exercise, adequate clothing, the bath, friction, and cleanliness, are very efficacious in promoting the insensible perspiration, removing the impurities which it leaves behind, and equalizing the circulation, they are almost equally influential in promoting the vital action of the innumerable nervous filaments ramified on the skin, and the tone of which is as essential as that of the bloodvessels to the proper discharge of the cutaneous functions. In the large and afflicting class of Nervous and Mental diseases, attention to the skin becomes therefore almost a *sine qua non* of successful treatment. As a preservative, too, it is influential. In most nervous ailments, languor and inaction of the skin shew themselves simultaneously with the earliest dawn of mental uneasiness, and often attract notice before the morbid feelings of the mind have acquired either permanence or strength. At this early period, the use of the bath will frequently prove very efficacious in restoring health.

Many imagine the tepid and warm bath to be weakening, but experience shews that they are so only when abused. When not too warm, and not prolonged beyond 20 or 30 minutes, the tepid bath may be employed daily with advantage and perfect safety by persons in health; while invalids, whose condition requires its use, are often strengthened by a much longer and equally frequent immersion. I have seen it resorted to for an hour daily, for months in succession, by nervous invalids, with much benefit to health and strength; and in France it is employed to a much greater extent. At the vast hospital of Salpétrière at Paris, and also at Charenton, M. Esquirol has, for many years, directed it to be extensively used for two, three, and even five or six hours a-day, and with excellent effect. When I visited the hospital for the insane at Charenton, and M. Esquirol's admirable private asylum at Ivry, in September 1831, that gentleman spoke to me in very strong terms of the benefits resulting from the practice, and declared that he had ever found it, when used with ordinary prudence, a safe and valuable remedy; and that, in reality, it failed to do good in some cases more from the patient remaining in it too short a time, than from its want of power to relieve.

In the Medico-Chirurgical Reviews for January and April 1833, a very interesting outline is given of an article published in the *Revue Medicale*, illustrative of the efficacy of the tepid bath and the affusion of cooler water on the head during the last few minutes of immersion, in the cure of a variety of nervous and head affections of considerable obstinacy and severity. Dr Johnson, the editor of the Review, adds his testimony to the success of the practice, and the results obtained agree entirely with my own experience; but, as these papers relate to the treatment of *disease*, it would be out of place to do more here than recommend them to the attention of the professional reader. I may mention, however, that Dr Recamier frequently orders the bath to be repeated two, three, or even four times in a day. So little reality is there in its supposed debilitating effect.

I notice these facts to shew that attention to the health of the skin is really as influential in preserving the tone of the nervous system, and in contributing to mental and bodily health and comfort, as, from the important functions which it performs, one would naturally expect it to be; and the neglect with which it has long been treated can be explained only by the ignorance which still prevails regarding its nature and uses. I must add, however, that while I attach so much importance to the use of the bath, it is not for the purpose of inducing persons in bad health to have recourse to it of their own accord. This they ought never to do, as they may chance to suffer from using it unseasonably. No rules of universal application can be laid down, and this is not the place for a professional disquisition.

Another valuable means of keeping up an equal circulation and a due degree of perspiration over the whole surface of the skin, and at the same time of aiding in the removal of the impurities which attach to it, consists in the daily and diligent *use of friction by means of a flesh-brush or horse-hair glove*,—the latter to be preferred where the skin is not too sensitive or delicate. But to derive due advantage from friction, it should be steadily continued every night and morning till a glow is excited over the whole surface, and the skin acquires a soft velvety feel. It should also be practised by the individual, and not by an assistant. It then serves partly for exercise, and, to a sedentary person, becomes its most invaluable substitute when perseveringly persisted in for months. In delicate states of the constitution, when a great susceptibility of cold exists, and in all varieties of nervous depression, with a dry cold skin, its usefulness can scarcely be overrated. But then it is one of those preservatives or remedies which require time to produce their full effects. It may be weeks before a languid or hysterical female, or hypochondriacal *litterateur*, will be aware of deriving any comfort from its use, and it is consequently sometimes difficult to induce the patient to make a proper trial of it. But I have never known any one, however sceptical at first, continue it regularly and diligently for several months without gratefully acknowledging the benefits which it conferred. I have known, indeed, some cases of severe nervous suffering of many years' standing, in which the relief afforded by friction of the skin was so marked as to elicit from the patients the earnest declaration that no motive could induce them to desist from its use. In rheumatic constitutions, it is especially beneficial, and a clear indication of its usefulness being more appreciated, is the constant announcements of "*electrical*" hair-gloves and other means of friction in the newspapers of the day.

That friction is useful also in removing impurities from the skin, will be evident to every one who chooses to apply a hair-glove to his own skin, after passing a day or two without either friction or ablution. He will then speedily find the glove become whitened from the small powdery scales which it detaches from the epidermis, and experience a very perceptible increase of comfort. From the equalizing action of friction on the circulation and nerves of the skin, it acts farther as a pleasing sedative after mental excitement or anxiety, and thus favours quiet and refreshing sleep, where otherwise none might be obtained.

But it may be said, that baths cannot be had at all times and in all places. This may be very true; but although we cannot always command them, it is right that we should know their value, and take active measures to procure them. When we fail, soap and water may still be obtained everywhere, and leave no apology for neglecting the skin; or, as already mentioned, if the constitution be delicate, water and vinegar, or water and salt, used daily, form an excellent and safe means of cleansing and gently stimulating the skin; to the invalid they are highly beneficial, when the nature of the indisposition does not render them improper. A rough and rather coarse towel is a very useful auxiliary in such ablutions. Few of those who have steadiness enough to keep up the action of the skin by the above means, and to avoid strong exciting causes, will ever suffer from colds, sore throats, or similar complaints; while, as a means of restoring health, they are often incalculably serviceable. If one-tenth of the persevering attention and labour bestowed to so much purpose in rubbing down and currying the skins of horses, were bestowed by the human race in keeping themselves in good condition, and a little attention were paid to diet and clothing,—colds, nervous diseases, and stomach-complaints would cease to form so large an item in the catalogue of human miseries. Man studies the nature of other animals, and adapts his conduct to their constitution; himself alone he continues ignorant of and neglects. He considers himself as a being of a superior order, and not subject to the laws of organization which regulate the functions of the inferior animals; but this conclusion is the result of ignorance and pride, and not a just inference from the premises on which it is ostensibly founded.

The writer of these remarks has, unfortunately for himself, had extensive experience in his own person of the connexion between the state of the skin and the general health, and especially the health of the lungs; and can therefore speak with some confidence as to the accuracy of his observations, and the benefit to be derived from attending to the condition of the skin in chronic pulmonary complaints and indigestion. Many affections of a consumptive character are preceded or begin by deficiency of vital action in the skin and extremities, and a consequent feeling of coldness in the feet and on the surface, and susceptibility of catarrhal affections from apparently inadequate causes, often long before any pressing symptom, directly connected with the lungs, occurs to attract notice. In this state, means systematically directed to restoring the cutaneous circulation will frequently be successful in warding off consumption; and, even when the disease is formed, the same means will help to prolong life and relieve suffering, while they will go far to effect a cure in those chronic affections of the bronchial membrane, which simulate consumption and are sometimes undistinguishable from it, and which, when mismanaged, are equally fatal.

The two remedies which enjoy the oldest and most general reputation in the successful treatment of pulmonary and consumptive disease and of general bad health, have this quality in common, that both owe much of their influence to their exciting the cutaneous functions, and equalizing the circulation. I allude to sailing, and riding on horseback. Many authors speak of both in the highest terms, and Sydenham is well known to have considered the latter as almost a specific. Dr Rush of Philadelphia, too, extols it with nearly equal force. Of late, a regular course of emetics has been very strongly recommended in the early stages of consumption, and apparently on good grounds. In hooping-cough, chronic catarrh, and other obstinate pulmonary affections, they have also been long in vogue, both with the vulgar and with the profession. So far as my observation goes, all of these remedial means are productive of advantage, chiefly in proportion as they determine the blood to the surface, which squeamishness, sea-sickness, and riding, all do in a powerful manner. Riding seems to have this effect, partly from the bodily exercise giving general vigour to the circulation, and partly from the continued gentle friction between the skin and the clothes stimulating the cutaneous vessels and nerves. This latter effect is of more importance than many believe. Those, accordingly, who are proof against sea-sickness derive least benefit from a voyage; while those who suffer under it long are compensated by the amelioration which it induces in the more serious malady. The writer of these remarks became ill in the month of January 1820, and soon presented many of the symptoms of pulmonary consumption. In spite of the best advice, he continued losing ground till the month of July, when he went by sea to London, on his way to the south of France; but, finding himself unable for the journey, he was obliged to return from London, also by sea. Being extremely liable to sea-sickness, he was squeamish or sick during the whole of both voyages—so much so as to be in a state of gentle perspiration for a great part of the time. After this he became sensible, for the first time, of a slight improvement in his health and strength, and of a diminution of febrile excitement. Some weeks afterwards, he embarked for the Mediterranean, and encountered a succession of storms for the first four weeks, two of which were spent in the month of November, in the Bay of Biscay, in a very heavy sea. For more than three weeks he was generally very sick, and always in a state of nausea; and during the whole time, although his bed was repeatedly partially wetted by salt water, and the weather cold, the flow of blood towards the skin was so powerful as to keep it generally warm, always moist, and often wet with perspiration, forced out by retching and nausea. The result was, that, on entering the Mediterranean at the end of a month, and there meeting fine weather, he found himself, though still more reduced in flesh and very weak, in every other respect decidedly improved; and, on his arrival in Italy, at the end of seven weeks, recovery fairly commenced, after about ten months' illness; and, by great care, it went on with little interruption. till the summer of 1821, when he returned home.

To carry on what was so well begun, riding on horseback in the country was resorted to, and that exercise was found to excite the skin so beneficially as to keep it always pleasantly warm, and generally bedewed with moisture, even to the extremities of the toes: and in proportion to this effect was the advantage derived from it in relieving the chest, increasing the strength, and improving the appetite. A second winter was spent in the south with equal benefit: and in the summer of 1822, riding was resumed at home, and the health continued to improve. The excitement given to the skin by riding was sufficient to keep the feet warm, and to prevent even considerable changes of temperature from being felt, and rain was not more regarded, although special attention was of course paid to taking off damp or wet clothes the moment the ride was at an end. Strength increased so much under this plan, combined with sponging, friction, and other means, that it was persevered in through the very severe winter of 1822–3, with the best effects. For nine years thereafter the health continued good, under the usual exposure of pro-

fessional life; but in 1831 it again gave way, and pulmonary symptoms of a suspicious character once more made their appearance. The same system was pursued, and the same results have again followed the invigoration of the cutaneous functions and of the general health by a sea-voyage, horse-back exercise, and the regular use of the bath. These, as formerly, have proved beneficial in proportion to their influence in keeping up warmth and moisture of the surface and extremities.

In thus insisting upon the advantages of maintaining the healthy action of the skin, I must not be supposed to ascribe the whole benefit to that circumstance alone. So beautifully is the animal economy constituted, that, as I have already repeatedly had occasion to observe, it is impossible to use rational means for the invigoration of one organ or function, without good being done to all; and so closely are the various parts allied to each other, that, to describe fully the functions and sympathies of any one, we would require to make the circle of the whole. From this appears the fallacy of those who select the derangements of any one organ as the origin and source of all existing diseases. Some functions are no doubt more important, and their disorders exercise a wider influence over the general health, than others; but no one who knows the structure of the human body and the relations of its parts, or has carefully observed the phenomena of disease, can be satisfied with such exclusive reasoning. The stomach, the bowels, the liver, and the nervous system, have each had their patrons, and the derangement of each has been specially held out as the grand fountain of human misery. Each doctrine, too, has been demonstrated by cases and cures to be superior to all the rest, and each has proved successful in its turn, where the others have been tried and failed. Far, however, from proving the propriety of exclusiveness in favour of any one organ, such facts, rightly considered, demonstrate the reverse, and shew that successful practice requires views and remedies founded on a careful examination of *every* function; and afford a strong presumption that the man who traces every disease to the liver, the stomach, or the nerves, will be at least as often strikingly wrong as strikingly right.

In saying, therefore, that attention to the state of the skin is influential in preserving and restoring health, I wish to represent it as an important but by no means exclusive condition, and to ascribe to the means used for invigorating its functions their due share of action upon other organs and functions. Sailing, for example, is useful in pulmonary complaints, not only because its accompanying nausea causes a healthful flow of blood from the internal parts to the surface, but because the gentle and constant exercise, occasioned by the movement of the ship, is admirably adapted to a debilitated state of the system, when other exercise cannot be taken without hurrying the breathing or inducing fatigue—and because pure, fresh, bracing air is of infinite importance in all, and especially in pulmonary, affections. Attention to the skin, therefore, must never be considered for a moment as superseding attention to the other functions. That were a pernicious mistake. It must be regarded as a part only, though an important part, of a rational and consistent treatment; and its efficacy will often depend, in no small degree, on the care which is taken to support its effects by a scrupulous attention to the necessities of the rest of the system.

I have ofter had occasion to remark the powerful influence which free perspiration from natural causes has in relieving acidity in the stomach and promoting digestion, and also the fact that acidity is most prevalent when the skin is most inactive, and have thereby been led to prescribe with advantage the frequent use of the tepid and vapour bath in calculous and other complaints arising from excess of acid. In accordance with the same principle, Lord Byron is found noting in his Journal (28th March 1814), that after having, when previously very unwell, "sparred with Jackson *ad sudorem*," he felt "much better in health than for many days," and remarking that "the more violent the fatigue, *the better his spirits for the rest of the day*," and this, too, at a time when he was deriving little relief from his favourite remedies, abstinence and soda-water.

These results seem to corroborate the doctrine of M. Donné, that in the healthy state an acid humour is secreted from the whole surface of the skin, while the mucus secreted from the digestive canal is every where, except in the stomach, of an alkaline nature. I have often noticed that acidity in the stomach was much relieved by free action of the skin, particularly in gouty habits, after the use of the warm bath. On the other hand, the season of the year at which I have always heard most complaints of acidity was towards the end of autumn, when the colder weather was beginning to diminish perspiration, and change the balance of the circulation. These facts, if correctly observed, go far to corroborate the accuracy of M. Donné's views. The subject, however, still remains obscure, but its importance entitles it to the most careful examination.

Among the external agents which exert a beneficial influence on the health of the skin, there is one of much importance, which, in practice, is far too much lost sight of, and which must yet be obvious to every one on a moment's reflection: I allude to *the salutary stimulus of the solar light*. Those who live in the deep valleys of mountains (as in those of the Alps), in close narrow streets where the sun never shines, in mines or dark caves, and who are rarely exposed to the light of day, present a pale relaxed sallowness of skin, which contrasts with the ruddy freshness of country people and others living much in the sun and open air. The inhabitants of towns, accordingly, may generally be known by the light colour and delicacy of skin which confinement induces. Part of the effect is owing, no doubt, to the agency of the external air, in the constitution of which the skin seems to produce changes analogous to those which take place in the lungs during respiration; but much is also attributable to deprivation of the stimulus of light. Even vegetables become pale, watery, and feeble in the dark; and, in like manner, men who work during the night and sleep during the day, never present the vigorous look of health which distinguishes well-fed day-labourers. Hence the necessity which exists, particularly in a climate favoured with so little sunshine as ours, of endeavouring always to select a good exposure to light and air for our dwellings, and of resorting to some protective legislating measures to prevent that crowding together of low damp cellars and sunless and airless rooms, into which so many thousands of the poorer classes in all our large towns are compelled to dwell, to the utter sacrifice of every comfort worth living for, and to the positive ruin of both body and mind. In several of the English manufacturing towns, and in Liverpool, the working classes live wholly either in cellars or in courts, of which there are 2400 in Liverpool alone, which seem as if constructed on purpose to admit the smallest possible portion of air and light by which human existence can be sustained. In Edinburgh and Glasgow, thousands of the poor are as badly if not worse lodged, and it is appalling to think of an amount of misery constantly existing around us in this form, sufficient to goad on the minds of its victims almost to madness when they compare their own lot with that of the richer classes who take so little heed of their suffering, and are often in fact so little aware of its existence. It is fervently to be hoped that the public mind is becoming alive to the perception of the truth, and that the efforts now making by government will prove to be only the commencement of a series of measures calculated to im-

prove and elevate the condition of the working population, and thus tend to avert the dangerous expedient to which the latter have been for some years approaching, of rising in open violence to rectify their own wrongs, and seek by force the means of happiness which they saw no chance of being able to wrest from the sympathy of their fellow-creatures.

The last means of preserving the healthy activity of the cutaneous circulation and exhalation which requires to be noticed, is that of avoiding as much as possible the contact of noxious external agents which might otherwise be absorbed by virtue of the inhaling power of the skin, and thus produce disease.

The chief sources of external agencies of this kind are impurities in the air or locality in which we live; contagious or infectious matter temporarily in contact with the skin; and, lastly, poisonous or injurious substances, such as poisonous metallic vapours to which workmen are exposed in their various trades.

A damp locality or air is the most favourable to the absorption of hurtful external agents, because moisture affords a natural stimulus to the action of the absorbent vessels. Hence malaria is always most dangerous after sunset and during the night; and hence also, in some measure at least, the full watery lymphatic constitutions of the inhabitants of marshy and moist districts of country, and the prevalence of ague among them. On the same principle, the operation of dry heat in putting a stop to the diffusion of plague, fever, and dysentery, may be partly explained. The absence of moisture leaves the cutaneous absorbents inactive, while the heat increases the exhalation from the skin. For a similar reason, contagion is known to be more likely to take effect on a person who is fasting, than on one who is well fed; because in the former state, the system craves for a supply, and all the absorbents are ready to act; while in the latter the exhalants are more stimulated. In the navy, this principle is recognised and acted upon by never exposing the crews in the morning to the dews and damps of warm climates until after they have breakfasted. In like manner, the alleged immunity from plague of oilmen and others whose skins are more or less covered with oil or grease, may probably be accounted for by absorption being rendered more difficult.

When one is obliged to live in a damp, marshy, or malarious district, the means of protection to be used have a direct reference to the functions of the skin. Whatever keeps up a vigorous circulation and healthy perspiration on the surface, and affords least scope for the action of the absorbents, is most certain to prove efficacious. A good nourishing diet, ample exercise, cheerful activity of mind, flannel-clothing frequently changed, friction, and fires, are all ascertained to be beneficial, and all of them operate on this principle. The value of flannel as a protection has been already pointed out in the experience of Captain Murray in the West Indies, and of Sir George Ballingall, Dr Johnson, and others, in the East Indies; and practically the same confidence is shewn by the shepherds of the Campagna, and the marshy districts of Greece, clothing themselves in woolly sheep-skins even at midsummer.

From what we have said, it will be apparent that, when attending on friends who are ill of contagious or infectious diseases, the more we invigorate the other functions of the skin, and the less we stimulate the absorbents, the greater will be our own security. With regard to the protection of workmen from the noxious fumes of metals, dust, and other impurities, it would require a great extent of detail on matters foreign to my present design, to enter upon its discussion here. All that I can add is that, in adopting protective measures for them, scrupulous regard must be had to the constitution and functions of the skin, if we expect any positive advantage from their adoption.

CHAPTER V.

NATURE OF THE MUSCULAR SYSTEM.

Muscles.—Their structure, number, and uses.—Nature of muscular action.—Influence of nerve.—Muscles the servants of the mind and will—their importance to man.—Mode of action of muscular nerves.—Sense of the state of the muscle necessary to regulated motion.—Illustrations.—Muscles act by alternate contraction and relaxation.—Fatigue consequent on continuing the same attitude explained—Injuries of Spine from neglect of this law, and from sedentary occupations in school.—Effects of muscular exercise on the circulation—and on the bowels.—Consequences of deficient exercise on the organization.

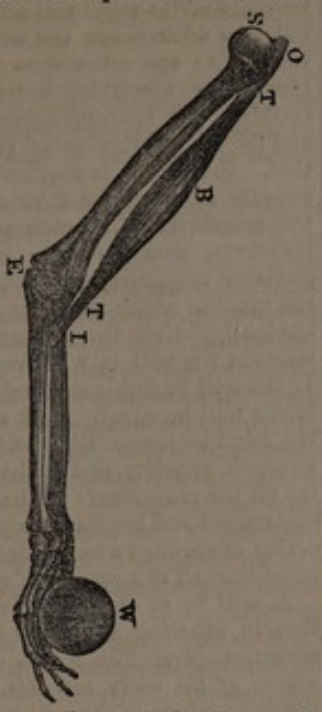
HAVING examined the nature and uses of the skin, we may next proceed to consider the important system of organs, lying almost immediately under it, viz. the MUSCLES, which, although in constant activity during our waking hours, and of indispensable necessity to man in every movement which he makes, are perhaps less familiarly known than almost any other part of the body. As the study of the muscular system involves an exposition of the principles which ought to regulate exercise, it can scarcely fail to excite the attention of the general reader, and especially of those who, as parents or teachers, are interested in the education of the young.

The muscles are those distinct and compact bundles of fleshy fibres which are found in animals immediately on removing the skin and subjacent fat; and which, although perhaps not known to all under their generic or scientific name, are familiar to every one as constituting the red fleshy part of meat.

Every muscle, or separate bundle of fleshy substance, is composed of innumerable small fibres or threads, each separated from, and at the same time loosely connected with, the others, by a sheath of cellular membrane enveloping it, but which is so thin as not to obscure the colour of the fibre, or attract notice unless specially looked for. Each muscle is in its turn separated from the neighbouring muscles by thicker layers or sheaths of the same membrane, in some of the cells of which fat is deposited, especially where the interval between the muscles is considerable; and hence the elegantly rounded form of the limbs, which, without this fat, would present the rigid, sharp, and prominent outline which we see occasionally in strong persons of a spare habit of body. From the loose texture of the connecting cellular membrane, the muscles enjoy perfect freedom of motion during life, and admit of being easily separated from each other after death, either by the knife, or by simply tearing the cellular tissue.

Muscles, speaking generally, may be divided into three parts, of which the middle fleshy portion, called the *belly*, is the most conspicuous and important. The other two are the opposite ends, commonly called the *origin* and *insertion* of the muscle. The belly is the bulky and fleshy part, by the contraction or shortening of the fibres of which the two ends are brought nearer to each other, while the belly itself swells out in a lateral direction. When we attempt to lift a heavy weight in the hand, or to overcome any resistance, the muscles which bend the arm may be seen and felt to start out rigid and well defined in their whole extent, while their extremities tend powerfully to approach each other, and of course to carry along with them the bones to which they are attached. In consequence of this tendency, if a weight be unexpectedly knocked out of the hand before we have time to obviate the result, the muscles, having then no resistance to overcome, will contract violently, and throw the hand up with a sudden jerk. Voluntary motion is, in fact, effected by the contraction of muscles acting upon and changing the re-

lative positions of the bones or solid support of the system, and therefore almost all muscles are attached to one bone by their *origin*, and to another by their *insertion*; the former being merely the fixed extremity, towards which the opposite and more moveable end, called the *insertion*, is carried by the shortening of the intervening belly of the muscle. These points will be readily understood by the inspection of the annexed figure, which represents the bones of the arm and hand, having all the soft parts dissected off except one muscle O B I, of which the function is to bend the arm. O indicates the origin of the muscle. B the belly. I the insertion. T T the tendons. S the shoulder-joint. E the elbow. When the belly contracts, the muscle becomes shorter, and as a consequence, the lower extremity of the muscle I is brought nearer to the origin or fixed point O, and, by thus bending the arm at the elbow-joint, raises up the weight W placed in the hand.



If the muscles are in general attached to bones, it may be asked,—How can the bones, which present comparatively so small a surface, afford space enough for the attachments of muscles which are so much larger, and which even appear in successive layers above each other? This difficulty is obviated in two ways. In the *first* place, the heads and other parts of bones to which muscles are attached, are enlarged so as to present a greater surface than the body of the bone, and form what are called *processes*, for the express purpose of affording greater room; and, *secondly*, instead of *all* the fleshy fibres of a muscle being prolonged to its point of attachment at the bone, they, with a few exceptions, terminate gradually, as they proceed from the belly, in a white shining *tendon*, of a much smaller size than the muscle, but of great strength, which is inserted into the bone. These tendons, or *sinews*, as they are occasionally named, conduce greatly to symmetry, elegance and freedom of motion; and may be traced under the skin on the back of the hand, and in the very powerful specimen at the heel, called the tendon of Achilles. The hamstrings are another obvious example, and may be easily felt becoming tight when an effort is made to bend the knee. There are a few muscles not attached to bones by either extremity, and also a few which have no tendons. Those which surround the eyebrows, the mouth, the gullet, and some of the other natural passages, are of the former description; as is also the heart. Some of the muscles of the trunk have no tendons, but these are few in number, and may at present be considered exceptions to the general rule.

In man, and in most of the animals with which we are familiar, the muscles are of a red colour. This, however, depends entirely on the blood which they contain; for so far is the colour from being essential to their constitution, that it may be destroyed by washing out the blood which produces it, the muscular substance remaining in other respects unchanged. Hence the colour of the muscles varies with that of the blood—is dark where it is dark, as in wild game, pale where it is pale, as in the domestic fowl, and white where it is white, as in most fishes. The true characteristic of muscular fibres is *contractility, or the power of shortening their substance on the application of stimuli, and again relaxing when the stimulus is withdrawn.*

The muscles of the human body exceed 400 in number, and form several layers lying over each other. That some conception may be formed of their arrangement and distribution, the superficial layer, or that which appears immediately on removing the skin, is represented in the annexed woodcut, taken from a little volume entitled "The Physician," published by the Society for the Diffusion of Useful Knowledge. To understand the uses of the various muscles, the reader has only to bear in mind that the object of muscular contraction is simply to bring the two ends of the muscle, and the parts to which they are attached, nearer to each other, the more moveable being always carried towards the more fixed point. Thus when the *sterno-mastoid* muscle *f g* contracts, its extremities approximate, and the head, being the moveable point, is pulled down and turned to one side. This may be easily seen in the living subject, the muscle being not less conspicuous than beautiful in its outline. Again, when the powerful *rectus* or *straight* muscle *b* on the front of the thigh contracts with force, as in the act of kicking, its lower end, attached to the knee-pan and leg, tends to approximate to the upper or more fixed point, and pulls the leg strongly forwards. This occurs in walking. But when the *sartorius* or tailor's muscle *c* is put in action, its course being oblique, the movement of the leg is no longer in a straight line, but in a cross direction, like that in which tailors sit, and hence the name *sartorius*.

Another variety of effect occurs, when, as in the *rectus* or straight muscle of the belly *i i*, sometimes one end and sometimes both are the fixed points. When the lower end is fixed, the muscle bends the body forward, and pulls down the bones of the chest. When, as more rarely happens, the lower end is the moveable point, the effect is to bring forward and raise the pelvis and inferior extremities; and, when both ends are rendered immoveable, the contraction of the muscle tends to compress and diminish the size of the cavity of the belly, and thus not only assists the natural evacuations, but co-operates in the function of respiration.

In contemplating this arrangement, it is impossible not to be struck with the consummate skill with which every act of every organ is turned to account. When the chest is expanded by a full inspiration, the bowels are pushed downwards and forwards to make way for the lungs; when the air is again expelled, and the cavity of the chest diminished, the very muscles, *i i i*, which effect this, by pulling down the ribs, contract upon the bowels also push them upwards and inwards, as can be

plainly perceived by any one who attends to his own breathing. By this contrivance, a gentle and constant impulse is given to the stomach and bowels, which is of great importance to them in contributing to digestion and in propelling their contents; and one cause of the costiveness with which sedentary people are so habitually annoyed, is the diminution of this natural motion in consequence of bodily inactivity.

From the preceding exposition, the action of the muscles *a*, *k*, *l*, which bend the arm and fore-arm, will be easily understood, and some notion may be formed of the innumerable combinations into which a system composed of upwards of 400 pieces may be thrown, in effecting all the movements required from the human frame. In some of the operations in which we engage, nearly the whole, and in others only a part, of the muscles are thrown into action at one time. The simultaneousness of action which obtains in such instances, and which occurs in almost every act of life, however simple, and without which no dictate of the will could be harmoniously and successfully obeyed, depends solely on the distribution and connections of the nerves which animate the muscles. Every individual fibre of every muscle is supplied with nervous filaments, and different fibres of the same muscle are indebted for the simultaneousness of their excitement to the connection established between each of them by these filaments. Wherever many muscles combine to execute an important movement, they are uniformly found to be provided with, and connected by, branches from the same system of nerves; as, without this means, simultaneousness of action could not be insured. Thus the muscles which cover the upper part of the chest co-operate in the voluntary movements of the arm, and at the same time in the respiratory movements of the chest; but these, being two distinct purposes, require different combinations of the muscles among themselves. To effect these combinations, two sets of nerves are provided, as has been shewn by Sir CHARLES BELL; the one regulating the respiratory, and the other the purely voluntary movements of the muscles. This is the true reason why the same muscle sometimes receives nerves from two or three different quarters; a circumstance which, before the principle was discovered, and when all nerves were considered alike, was altogether inexplicable, and seemed a work of mere supererogation.

From this peculiar constitution of the muscles, it will be already obvious to the reflective reader that their chief purpose is to enable us to carry into effect the various resolutions and designs—or *volitions*, as they are termed by philosophers,—which have been formed by the mind. The muscles, accordingly, form the grand instruments by which man acts and is acted upon by the external world. Whatever impression is made upon him by any other living creature is effected by the aid of muscular power. When the infant clings to its mother's bosom, it is by calling its little muscles into play. When its cries assail her ear and alarm her feelings, it is by muscular action they are produced. When she flies to its relief, or lulls it to sleep by some simple chant, her muscles are still the medium by which her sympathy and affection are expressed. Life itself is sustained by the constant exercise of muscular power; and were either the heart or the muscles of respiration to forget their part, even for a few minutes, existence would be at an end. Without the concurrence of the muscular power, man's grandest conceptions and most energetic resolutions would remain equally unknown and unfulfilled. Without muscular power wherewith to communicate with their fellow-men, Shakspeare and Milton would have remained mute as the statues which now represent their bodily form, and the immortal creations of their minds would have been lost to the world for ever. Mind is, no doubt, the high and directing power; but without obedient muscles, ready at a call to minister to its wants, mind would remain isolated in the midst of creation, and could neither speak, nor hear, nor touch. Amid the loss of children and friends, and even amid the wreck of worlds, mind, without muscles to express its feelings, would look on in apparent apathy, even when its affections were torn and its sufferings were most intense.

The muscles, then, are the indispensable agents and servants of the mind and will. But we have yet to inquire by what means the will exerts its influence over them. As the mind does not reside in the muscles themselves, something more is evidently required to establish and keep up a communication between them, and for the production of regulated or voluntary motion. Something is required at once to excite them to activity, and to direct their contractions. Without this, the muscle itself, though perfect in strength and in structure, would remain inert. This stimulus and guidance are conveyed to it by the *nerves*. As we write, the muscles which move the fingers and guide the pen obviously follow the commands of the will; and the moment the will is withdrawn, they cease to operate. If the will be feeble and undecided, the muscular movements will be equally weak and irresolute; whereas, if the mind be powerfully excited, and the will energetic, strength, rapidity, and decision, will equally characterize all the movements of the body. Under the intense excitement and headlong fury of madness, the muscular action of an otherwise feeble man acquires a force often exceeding all our powers of control.

It will be at once perceived from this description, that in effecting voluntary motion, we must have in operation, *first*, The brain, or organ of mind, as the *source of the will*; *secondly*, The nerves, which *convey* the intimations of the will to the muscles; and, *thirdly*, The muscles themselves, by whose contractile powers motion is *produced*. It will be understood, also, why the number and size of the nerves distributed to a muscle are in proportion, not simply to its volume, but to the variety, frequency, and vivacity of the movements required from it; and why some small muscles employed in many combinations, are therefore supplied with a greater variety of nerves than others double their size, but with more simple functions.

Other circumstances being equal, muscular power is proportioned to the size of the muscle; but it often happens that great power is required where bulk of muscle would be inconvenient or cumbersome. In such cases, the muscle is supplied with an increased endowment of nervous filaments, which compensate, by the strength of stimulus, for what it wants in bulk of fibre. Many birds, for example, require great muscular power to sustain them in their long and rapid flights through the air, and owe its possession chiefly to the strong stimulus imparted to moderate-sized muscles by large nerves, which add extremely little to their weight; whereas, had the greater power been obtainable only from an augmentation of fleshy fibres, the consequent addition of weight would, from the greatly increased difficulty the animal must have felt in raising and sustaining itself in the air, have gone far to counterbalance any advantage gained on the side of power. But in fishes, which float without effort in their own element, size produces no such inconvenience, and their strength, accordingly, is made to depend more on the volume of the muscle than on its nervous endowment,—shewing a beautiful adaptation to the mode of life and wants of the animal.

As voluntary motion depends as much on nervous stimulus as on muscular agency, it happens, that whatever interrupts the action of the nerves puts a stop to motion as effectually as if the muscular fibre itself were divided. Injuries and diseases of the brain, whence the will emanates, are well known to be accompanied with palsy, or want of power in the muscles, although in their own structure the latter remain sound. Sleep and narcotics, too, suspend voluntary motion, solely in con-

sequence of their action on the nervous system. Ardent spirits, in like manner, disturb the regularity of muscular action in no other way than by previously disordering the brain; and hence the unsteady gait and faltering elocution of a semi-intoxicated person are sometimes removed in an instant by some powerful mental impression being suddenly made, sufficient to restore the brain to its natural state, and thereby to give unity and steadiness to the nervous impulse proceeding from it to the muscles. For the same reason, although the brain and muscles be perfectly sound, yet if the communication between them be impaired or destroyed by the compression or division of the nerves, the muscles cease to act.

The influence of the nervous agency upon muscular contraction may be still farther illustrated. When the trunk of a muscular nerve is irritated by the contact of an external body, or by the electric spark, the muscles which it supplies instantly contract, but without either harmony or permanency of motion: the contraction is like the violent and ill-regulated start of convulsion. It is the influence of the brain and mind in the equal diffusion of the required stimulus to each muscle, in the exact proportion needful, that characterizes healthy and sustained voluntary motion, as opposed to the irregular convulsive start. Nothing can be more wonderful than the accuracy with which, in the most delicate movements, this stimulus is adjusted and apportioned to such a variety of parts, particularly where practice, or in other words *education*, has rendered the combination of powers easy and certain. Not to mention the more obvious and graceful movements of dancing, fencing, and riding, we discover, in the management of the hand and fingers by engravers, sculptors, watchmakers, jugglers, and other artists and mechanics, a minute accuracy of muscular adjustment to effect a given end, which is the more surprising the more we consider the complicated means by which it is effected.

In consequence of the co-operation of both nerve and muscular fibre being required to effect motion, excess of action in each is followed by results peculiar to itself. If the NERVES preponderate, either constitutionally or from over-exercise,—as they are apt to do in highly nervous temperaments,—their excessive irritability renders them liable to be unduly excited by ordinary stimuli; and hence, as in hysteric and nervous females, a proneness to sudden starts, cramps, and convulsions, from causes which would scarcely affect an individual differently constituted. Such persons have little muscular power, except under excitement; they then become capable of great efforts of short duration, but sink proportionally low when the stimulus is past. If, on the other hand, the MUSCLES predominate, as in athletic strong-built men, the nervous system is generally dull and little susceptible of excitement, and the muscles which it animates are consequently little prone to the rapid and vivacious action that accompanies the predominance of the nervous functions. Great strength and capability of bodily labour are then the characteristics.

Great muscular power and intense nervous action are rarely conjoined in the same individual; but, when they do happen to meet, they constitute a perfect genius for muscular exertion, and enable their possessor to perform feats of strength and agility, which appear marvellous to those who are deficient in either condition. The most successful wrestlers and gladiators among the ancients seem to have owed their superiority chiefly to the possession of both endowments in a high degree; and among the moderns, the most remarkable combination of the two qualities is exhibited by some of our harlequins, clowns, rope-dancers, and equestrian performers, and also by those who display their strength and power of equilibrium in balancing wheels, ladders, or other heavy bodies, on the chin; and whose performances require, from the small muscles of the jaw and neck, a force of contraction which, when reduced to calculation, almost exceeds belief. Belzoni combined both conditions in a high degree.

From the general resemblance which characterizes the different nerves, a similarity in function was long ascribed to them all, and no explanation could be given why one muscle sometimes received filaments from a variety of nervous trunks. Recently, however, the labours of Sir Charles Bell, Mayo, Magendie, and Bellingeri, have clearly established that in such cases each nerve serves a distinct purpose, in combining the movements of the particular muscles with those of others necessary to effect a given end,—and that without this additional nerve such a combination could not have been produced. The muscular nerves must not be confounded with those which we have seen ramified on the skin for the purposes of sensation. The former are provided for the purposes of motion and not of feeling, and hence muscles may be cut or injured with little pain, compared to what is felt by the skin. Weariness is the sensation recognised by one set of muscular nerves.

So uniformly is a separate instrument provided for every additional function, that there is strong reason to regard the muscular nerves, although running in one sheath, as in reality double, and performing distinct functions. Sir Charles Bell has the merit of this discovery, if such it shall ultimately prove to be. In his work on the Nervous System, he endeavours to shew, that one set of nervous fibres conveys the mandate from the brain to the muscle, and excites the contraction; and that another conveys from the muscle to the brain a peculiar sense of the state or degree of contraction of the muscle, by which we are enabled to judge of the amount of stimulus necessary to accomplish the end desired, and which is obviously an indispensable piece of information to the mind in regulating the movements of the body. Sir Charles has shewn that many of the sensations supposed to be derived from the sense of touch and the skin, arise from the muscular sense, and are wholly imperceptible to the skin, without the co-operation of muscular contraction.

"The muscles have two nerves," says Sir Charles, "which fact has not hitherto been noticed, because they are commonly bound up together. But whenever the nerves, as about the head, go in a separate course, we find that there is a sensitive nerve and a motor nerve distributed to the muscular fibre, and we have reason to conclude that those branches of the spinal nerves which go to the muscles, consist of a motor and a sensitive filament.

"It has been supposed hitherto, that the office of a muscular nerve is only to carry out the mandate of the will, and to excite the muscle to action, but this betrays a very inaccurate knowledge of the action of the muscular system; for, before the muscular system can be controlled under the influence of the will, there must be a consciousness or knowledge of the condition of the muscle.

"When we admit that the various conditions of the muscle must be estimated or perceived, in order to be under the due control of the will, the natural question arises, Is that nerve which carries out the mandate of the will capable of conveying, at the same moment, an impression retrograde to the course of that influence which is going from the brain to the muscle? If we had no facts in anatomy to proceed upon, still reason would declare to us that the same filament of a nerve could not convey a motion, of whatever nature that motion may be, whether vibration or motion of spirits, in opposite directions at the same moment of time.

"I find that, to the full operation of the muscular power, two distinct filaments of nerves are necessary, and that a circle is established between the sensorium and the muscle; that one filament or single nerve carries the influence of the will towards the muscle, which nerve has no power to convey an impression backwards to the brain; and that another nerve connects the muscle with

the brain, and, acting as a sentient nerve, conveys the impression of the condition of the muscle to the mind, but has no operation in a direction outwards from the brain towards the muscle, and does not therefore excite the muscle, however irritated."*

This consciousness of the state of the muscles, or muscular sense, as it may be truly called, is of great importance both to man and to animals, as it is necessarily by information thence derived, that every subsequent exertion is directed and apportioned in intensity to the effort required to be made. If we had no such sense, the delicate and well-directed touches of the engraver, painter, and sculptor, or of the ingenious mechanic, would be at the mercy of hazard; and a single disproportioned movement might ruin the successful labour of months, supposing success to be in reality compatible with chance. Without this sense man could not deliberately proportion the muscular efforts to his real wants; and, even in walking, his gait would be unsteady and insecure, because there would be no harmony between effort and resistance. The loss of equilibrium, and the concussion and disturbance of the system consequent on taking a false step, as it is called, are specimens of what we would always be subject to without the guidance of the muscular sense. When we imagine we have one step more of a stair to descend than really exists, we are placed nearly in the same circumstances as if we had no muscular sense to direct the extent of our intended movement; because, misled by an erroneous impression, we make an effort grievously unsuited to the occasion; and yet so habitually are we protected from this error by the assistance of the sense alluded to, and so little are we conscious of its operation, that it is only after mature reflection that we perceive the necessity of its existence.

In chewing our food, in turning the eye towards an object looked at, in raising the hand to the mouth, and, in fact, in every variety of muscular movement which we perform, we are guided by the muscular sense in proportioning the effort to the resistance to be overcome; and, where this harmony is destroyed by disease, the extent of the service rendered us becomes more apparent. The shake of the arm and hand which we see in drunkards, and their consequent incapability of carrying the morsel directly to the mouth, are examples of what would be of daily occurrence, unless we were directed and assisted by a muscular sense.†

Life and the nervous stimulus are essential to muscular power. Separated from the body, and deprived of both, the muscle which formerly contracted with a power equal to 100 pounds, would be torn asunder by a weight of ten. This fact is of itself sufficient to give a tolerable notion of the extent to which muscular contraction depends on other causes than the mere structure of the fleshy fibres; for that structure continues unaltered for some time after death, and after the nervous communication has been suspended—and yet how feeble is the power of resistance which the muscle then possesses!

The required movement having been once effected by the nervous impulse stimulating the muscular fibre to contraction, relaxation speedily follows, and is in its turn succeeded by a fresh contraction proportioned to the object in view. *Muscular action, therefore, consists properly in alternate contraction and relaxation of the fleshy fibres.* A state of permanent contraction is both unnatural and impossible; and, accordingly, the most fatiguing muscular employment to which a man can be subjected, is that of remaining immoveable in any given attitude. To an unreflecting person it may seem a very easy and pleasant service to stand for half a day in the attitude of an Apollo or a Gladiator, as a model to a statuary; but, on trying it, he will find, to his astonishment, that stone-breaking or the tread-mill are pastimes in comparison: in the one case, the muscles which preserve the attitude are kept incessantly on the strain; while in the other, they enjoy that play and variety of motion for which they were destined by nature. We may easily put the fact to the test, by attempting to hold the arm extended at a right angle to the body for the short space of ten minutes. He whose muscles, if indeed capable of the exertion, do not feel sore with fatigue at the end of that time, may think himself peculiarly fortunate in being blessed with a powerful constitution.

The principle just stated explains very obviously the weariness, debility, and injury to health, which invariably follow forced confinement to one position or to one limited variety of movement, as is often witnessed in the education of young females. Alternate contraction and relaxation, or, in other words, exercise, of the muscles which support the trunk of the body, are the only means which, according to the Creator's laws, can conduce to muscular development, and by which bodily strength and vigour can be secured. Instead of promoting such exercise, however, the prevailing system of female education places the muscles of the trunk, in particular, under the most unfavourable circumstances, and renders their exercise nearly impossible. Left to its own weight, the body would fall to the ground, in obedience to the ordinary law of gravitation; in sitting and standing, therefore, as well as in walking, the position is preserved only by active muscular exertion. But if we confine ourselves to one attitude, such as that of sitting erect upon a chair—or, what is still worse, on benches without backs, as is the common practice in schools,—it is obvious that we place the muscles which support the spine and trunk in the very disadvantageous position of *permanent* instead of *alternate* contraction; which we have seen to be in reality more fatiguing and debilitating to them than severe labour. Girls thus restrained daily for many successive hours, invariably suffer—being deprived of the sports and exercise after school-hours which strengthen the muscles of boys, and enable them to withstand the oppression. The muscles being thus enfeebled, the girls either lean over insensibly to one side, and thus contract curvature of the spine; or, their weakness being perceived, they are forthwith cased in stiffer and stronger stays—that support being sought for in steel and whalebone, which Nature intended they should obtain from the bones and muscles of their own bodies. The patient, finding the maintenance of an erect carriage (the grand object for which all the suffering is inflicted) thus rendered more easy, at first welcomes the stays, and, like her teacher, fancies them highly useful. Speedily, however, their effects shew them to be the reverse of beneficial. The same want of varied motion, which was the prime cause of the muscular weakness, is still farther aggravated by the tight pressure of the stays interrupting the play of the muscles, and rendering them in a few months more powerless than ever. In spite, however, of the weariness and mischief which result from it, the same system is persevered in; and, during the short time allotted to that nominal exercise, the formal walk, the body is left almost as motionless as before, and only the legs are called into activity. The natural consequences of this treatment are, debility of the body, curvature of the spine, impaired digestion, and, from the diminished tone of all the animal and vital functions, general ill health; —and yet, while we thus set Nature and her laws at defiance, we presume to express surprise at the prevalence of female deformity and disease!

It would be easy, were it required, to prove that the picture here drawn is not overcharged. A single instance, from a note appended by Dr Forbes to an excellent treatise on 'Physical Education," by Dr Bar-

* Bell's Anatomy, seventh edition, vol. ii. p. 372; and also his works on the nerves.

† The reader will find some very ingenious speculations on this subject by Mr James Simpson and others in the Phrenological Journal, vols. ix. x. xi. xii.

low of Bath, will suffice. After copying the programme of a boarding-school for young ladies, which exhibits only one hour's exercise, consisting of a walk, arm in arm, on the high road, *and that only when the weather is fine at the particular hour allotted to it*, in contrast with *nine* hours at school or tasks, and *three and a half* at optional studies or work,—Dr Forbes adds:—"That the practical results of such an astounding regimen are by no means overdrawn in the preceding pages, is sufficiently evinced by the following fact—a fact which, we will venture to say, may be verified by inspection of thousands of boarding-schools in this country. *We lately visited in a large town a boarding-school containing forty girls; and we learnt, on close and accurate inquiry, that there was not one of the girls who had been at the school two years (and the majority had been as long,) that was not more or less* CROOKED! Our patient was in this predicament; and we could perceive (what all may perceive who meet that most melancholy of all processions, —a boarding-school of young ladies in their walk) that *all* her companions were pallid, sallow, and listless. We can assert, *on the same authority of personal observation*, and on an extensive scale, that *scarcely a single girl (more especially of the middle classes) that has been at a boarding-school for two or three years returns home with unimpaired health*; and for the truth of the assertion, we may appeal to every candid *father* whose daughters have been placed in this situation."*

Dr Barlow justly remarks, that the superintendents of such schools cannot generally be blamed for indifference about the welfare of their pupils; that most of them are extremely anxious to do their utmost to improve those under their charge; and that it is *ignorance* alone which misleads them as to the proper means: he might have adverted also to the ignorance of *parents*, who insist on so many hours a-day being dedicated to the study of accomplishments for which their children have neither taste, capacity, nor use. From similar ignorance, the young girls in a public hospital in this country used to be *shut up in the hall and school-room during play-hours from November till March, and no romping or noise—in other words, no real play, relaxation, or exercise—allowed*; and in 1830-31, from fear of typhus fever, they were seldom if ever out of doors, except at church, from November to April—than which a more efficient method of infringing the laws of health could scarcely have been devised. Here, too, the object was unquestionably benevolent, but the method was radically bad; and, in consequence, a great deal of sickness prevailed.

The reality of the mischief done in this way was forcibly pointed out by Mr Carmichael of Dublin, in his excellent "Essay on the Nature of Scrofula," published so long ago as 1810, and which contains many valuable practical truths, which were then little known and coolly received, but to which great importance is now generally attached. In noticing the want of exercise as a cause of scrofula, Mr Carmichael mentions, that in St Thomas's Parochial School, *seven* out of *twenty-four* girls were affected with that disease during the preceding summer, owing to their exercise having been entirely interrupted, first, by the flooding of the playground by heavy rains, and subsequently by the mistress having received orders "*to keep the children perpetually within doors at their school-books.*" In a very short time after "this cruel and impolitic injunction" was acted upon, scrofula began to make its appearance, and afterwards affected nearly a third of their number; although none of them had the disease when admitted, and there was no fault of diet or other cause to which it could be ascribed. Mr Carmichael adds that, in the Bethesda School of the same city (Dublin), *six* out of *thirty* girls, fed in the best possible manner, and free from the disease on their admission, were *badly affected* with it during the same summer. In these cases it evidently arose from their having neither yard nor playground attached to the institution, in consequence of which "the children were necessitated to remain either in the school or bed-rooms during play-hours. On ascertaining this fact, Mr Carmichael remonstrated with the governors, and the evil no longer exists; but the circumstance itself affords an instructive example of the extent of misery which may arise, not from the institutions of Nature, as we are so apt to affirm, but from sheer ignorance on our own part of what these institutions are.

Mr Carmichael adduces other facts of a striking nature, for which I must refer to the work itself, to shew the needless suffering which is still inflicted on thousands by the sedentary and unvaried occupations which follow each other for hours in succession in many of our schools, and I agree with him that it is high time that a sound physiology should step in to root out all such erroneous and hurtful practices. Taken in connexion with the long confinement, the custom of causing the young to sit on benches without any support to the back, and without any variety of motion, cannot be too soon exploded. If the muscles of the spine were strengthened by the exercise which they require, but which is so generally denied,—and if the school employments were varied or interrupted at reasonable intervals, to admit of change of position and of motion,—nothing could be better adapted for giving an easy and erect carriage than seats without backs, because the play of the muscles necessary for preserving the erect position would give them activity and vigour;—and, accordingly, the want is scarcely, if at all, felt in infant-schools, for the very reason that such variety of motion is, in them, carefully provided for. But it is a gross misconception to suppose that the same good result will follow the absence of support, when the muscles are weakened by constant straining and want of play. The incessant and fidgetty restlessness observable after the second or third hour of common school confinement, shews the earnest call of Nature for a little wholesome exercise: and the quiet that ensues when it is granted, indicates clearly enough that the restlessness springs even more from bodily than from mental weariness. It is, in fact, a degree of what we all feel when kept long standing on our feet, or sitting at a desk. We become weary and uneasy from the continued strain on the same muscles, and feel at once relieved by a walk, a drive, or any change whatever. The same principle explains the fatigue so often complained of, as experienced in "shopping," or in an exhibition-room. We saunter about till the muscles become sore from the fatigue of being always in the same attitude, and we are refreshed by a walk or a dance, or anything which alters the position. The same languor of the muscles is felt after witnessing a pantomime, or other continuous spectacle, by which we are induced to keep the neck for a long time in a constrained and unvaried position. Children with thin bodies, weak muscles, and large heads, sometimes suffer much by being taken to church, and, that due respect may be shewn to the sanctity of the place, not allowed by their parents to lean their heads on the board, or on the arm of the person sitting next them, so as to support themselves more easily.

Man being intended for a life of activity, all his functions are constituted by Nature to fit him for this object, and they never go on so successfully as when his external situation is such as to demand the regular exercise of all his organs. It is, accordingly, curious to observe the admirable manner in which each is linked in its action and sympathies with the rest. When the muscular system, for example, is duly exercised, increased action in its vessels and nerves takes place, but the effect is not by any means limited to the mere organs of motion. The principal bloodvessels in all parts of the body lie imbedded among muscles, both for

* Cyclopædia of Practical Medicine, article Physical Education, vol. i. p. 698.

the protection and for the aid which the latter afford them. Every contraction of the muscles compresses and lessens the diameter of the vessels; and as the blood contained in them cannot retrograde in its course, it is propelled in the arteries from the heart *towards* the extreme parts, and in the veins *from* the latter towards the heart with greater force and velocity than before. This will be better understood on examining the annexed engraving of the bloodvessels of the arm, copied from Fyfe's Anatomy. The letters A, B, C, D, E, represent the principal muscles of the arm, and F, G, H, I, K, L, M, N, those of the forearm; though, as the preparation is dried, and the muscles consequently much shrunk, they do not appear in their natural situation. The letters in italics point out the *humeral* artery, which is seen dividing at the elbow into two branches. The one called the *radial* artery passes on the outer side of the forearm towards the thumb, and is the branch in which the pulse is generally felt; the other called the *ulnar*, passes along the inner side of the forearm.

In the natural state, these bloodvessels are covered and protected in almost their whole course by the adjacent muscles. In consequence of this position, the muscles cannot contract without, at the same time, compressing the bloodvessels, and propelling their contents; for, as we saw in a former chapter, the muscles swell out laterally at every contraction. The assistance afforded to the circulation of the blood by this arrangement is familiarly exemplified in the operation of bloodletting from the arm. When the blood stops or flows slowly, it is customary to put a ball or other hard body into the hand of the patient, and desire him to squeeze and turn it round. The utility of this depends simply on the muscles of the arm compressing the interjacent bloodvessels and forcing onwards the current of the contained blood by their successive contractions. Muscular action is, indeed, one of the powers provided for effecting a regular circulation; and hence when its assistance is neglected, as it is by those who take no active exercise, the blood begins to flow less freely, till at last it finds some difficulty in returning against the law of gravitation from the lower extremities, which then gradually swell. People engaged for years in sedentary professions, are thus very subject to *varicose* or dilated veins, and swelled feet.

The chain of connection among all the living functions is nowhere more visible than in this relation between muscular exercise and the circulation of the blood. Action requires the presence of arterial blood, and in the case of the muscles, the very circumstance of their being active favours the circulation and increases the supply. This increase, in its turn, enables the parts to which it is sent to act with greater energy and effect, and the augmented action is attended by corresponding waste and exhalation, and proportionate nutrition of the parts. To replenish the blood thus exhausted of its nutritive principle, a greater quantity of food is required; and, to prompt us to attend to this condition, the appetite becomes keener and more imperative, and the power of digestion proportionally vigorous. The food taken is more speedily converted into chyle, and its absorption from the surface of the intestines and transmission into the circulating current more rapid. That the blood so improved may be properly and quickly animalised in the laboratory of the lungs, respiration becomes deeper and more frequent, thus admitting a larger quantity of air and freer circulation through them than before; and the blood in this way renewed and re-endowed with the pabulum of life, imparts fresh nutriment and vigour to all the organs of the body, and fits them for that active exertion which the proper discharge of his duties imperatively requires from every member of the human race.

Considered in this point of view, the hurried breathing and quickened circulation, of which we are so apt to complain when engaged in muscular exercise, instead of being evils, are, in fact, the beneficent means by which we become fitted to continue the exertion. Without a more than usually rapid flow of blood to the part in use, the necessary stimulus to its vessels and nerves could not take place, and its action could not be sustained. But were the bloodvessels not so situate among the muscles as to have their contents propelled more quickly by the compression to which every muscular contraction necessarily subjects them, it is obvious that no increase of circulation could take place. And if respiration, on the other hand, were not to be accelerated, so as to oxygenate the venous blood more quickly as it arrived at the lungs, it is obvious that the requisite stimulus must again have failed; as, in that case, the blood must either have accumulated in the lungs and caused death, or have passed through them imperfectly prepared, and extinguished life more slowly, but not less certainly.

It is from this effect of muscular compression in promoting the flow of blood through the arteries and veins, that *shampooing*, which consists in a kind of kneading of the flesh, is so successfully resorted to in the warm climates of the East, and among the richer class of invalids in our own country, as a substitute for active exercise. Shampooing furnishes from without that impulse to the circulation which the Creator has destined it to receive from active muscular exertion; and the principle of its action being the same, we cannot wonder that it should prove indisputably useful in promoting circulation, strength, and nutrition, in cases where active exercise cannot be enjoyed. Hence also its utility in dispersing indolent swellings, in restoring tone to weakened joints, and in the cure of rheumatism.

It is a common observation, that sedentary persons are habitually subject to costiveness and its attendant evils. The reason is the same. In the natural state, the contents of the bowels are propelled partly by the successive contractions of the muscles which form the walls of the belly and separate that cavity from the chest, and partly by the contraction of the muscular fibres which constitute an important part of the structure of the intestines themselves. If, however, exercise be refrained from, and the same position be preserved for many hours a-day, as in sitting at a desk, the bowels are necessarily deprived of one important source of power; and, thus weakened, they are unable to act upon and propel their contents with the same regularity as when assisted by exercise. A slowness of action ensues, which no course of medicine, and scarcely any modification of diet, can overcome so long as sedentary habits are indulged in; but which also may often be relieved by daily pressing over the region of the abdomen with a kind of kneading motion, imitating, though feebly, the effects of muscular action. Females suffer much from intestinal debility caused by sedentary habits.

The evils arising from *deficiency* of exercise to all the functions of the mind and body will now be equally evident and intelligible, for they are the converse of what we have seen to be the advantages of adequate exercise. The circulation, from want of stimulus, becomes languid, especially in the extreme vessels; the feebleness of action occasions little waste of materials, and little demand for a new supply; the appetite and digestion consequently become weak; respiration heavy and

imperfect; and the blood so ill conditioned that, when distributed through the body, it proves inadequate to communicate the stimulus requisite for healthy and vigorous action. The concatenation of causes and consequences thus exhibited, cannot fail, when the principle connecting them is perceived, to interest and instruct every thinking mind.

CHAPTER VI.

RULES FOR MUSCULAR EXERCISE.

The laws and conditions of healthy muscular action having now been sufficiently explained, I shall next endeavour to shew how usefully our acquaintance with them may be applied to the proper regulation of exercise in the ordinary conduct of life.

In attempting to lay down rules for exercise, our aim should be always to act in accordance with the physiological constitution of the muscular system. With this principle to guide us, and keeping in view the conditions of muscular action as explained in the preceding chapter, we can have no difficulty in perceiving, that, to derive proper advantage from exercise, it is necessary, *first*, that it should spring from, and be continued under, the influence of an active nervous or mental stimulus; *secondly*, that it should always involve as much variety of movement as possible; *thirdly*, that it should be proportioned to the age, strength, and constitution; *fourthly*, that it should be taken at the most favourable times of the day; and, *lastly*, that it should be of a kind calculated to ensure all the good effects which well-conducted exercise is capable of affording.

That *exercise should always spring from, and be continued under, the influence of an active and harmonious nervous and mental stimulus*, will scarcely require any additional evidence; but as the principle is not sufficiently appreciated or acted upon, a few remarks seem still to be called for to enforce its observance. The simple fact that the muscles are expressly constructed for the purpose of fulfilling the commands of the will, might of itself lead to the inference that a healthy mental stimulus ought to be considered an essential condition or accompaniment of exercise; and, accordingly, we have already seen how easy and pleasant muscular action becomes under the influence of mental excitement, and how useful a vigorous nervous impulse is in sustaining and directing it. We have seen also how difficult, wearisome, and inefficient, muscular contraction becomes, when the mind, which directs it, is languid or absorbed by other employments. Hence the superiority, as exercises for the young, of social and inspiriting games which, by their joyous and boisterous mirth, call forth the requisite nervous stimulus to put the muscles into vigorous and varied action; and hence the utter inefficiency of the dull and monotonous daily walk which sets all physiological conditions at defiance, and which, in so many schools, is made to supersede the exercise which it only counterfeits. Even the playful gamboling and varied movements which are so characteristic of the young of all animals, man not excepted, and which are at once so pleasing and attractive, might have taught us that activity of feeling and affection, and sprightliness of mind, are intended by Nature to be the sources and accompaniments of healthful and invigorating muscular exercise; and that the system of bodily confinement and mental cultivation now so much in vogue, is calculated to inflict lasting injury on all who are subjected to its restraints. The buoyancy of spirit and comparative independence enjoyed by boys when out of school prevent them from suffering under it so much as girls do; but the mischief done to both is the more unpardonable when it does occur, because it might so easily have been entirely avoided. Even in some infant schools, where properly conducted exercise ought to be considered as a necessary of life, the principle on which I am insisting is so little understood or valued that no play-grounds have been provided, and the very best means of moral as well as physical training—play with companions—has, to the great injury of the poor children, been wholly omitted. Under judicious direction, the play-ground affords the most valuable and effective aid to the parent and teacher, not only in eliciting the highest degree of physical health, but in developing the general character by the practical inculcation of moral principle, kindness, and affection, in the daily and hourly conduct of the children committed to their charge. A double evil is thus incurred in its neglect or omission.

Facts illustrative of the beneficial influence of a mental stimulus as the only legitimate source of muscular activity abound everywhere, and must be familiar to every reflecting mind; but as the practical inferences deducible from them have, to a great extent, escaped the notice of parents and teachers, I shall add a few remarks in their farther elucidation.

Every body knows how wearisome and disagreeable it is to saunter along, without having some object to attain; and how listless and unprofitable a walk taken against the inclination and merely for exercise is, compared to the same exertion made in pursuit of an object on which we are intent. The difference is simply, that, in the former case, the muscles are obliged to work without that full nervous impulse which nature has decreed to be essential to their healthy and energetic action; and that, in the latter, the nervous impulse is in full and harmonious operation. The great superiority of active sports, botanical and geological excursions, gardening and turning, as means of exercise, over mere monotonous movements, is referable to the same principle. Every kind of youthful play and mechanical operation interests and excites the mind, as well as occupies the body; and by thus placing the muscles in the best position for wholesome and beneficial exertion, enables them to act without fatigue, for a length of time which, if occupied in mere walking for exercise, would utterly exhaust their powers.

The elastic spring, bright eye, and cheerful glow of beings thus excited, form a perfect contrast to the spiritless and inanimate aspect of many of our boarding-school processions; and the results in point of health and activity are not less different. So influential, indeed, is the nervous stimulus, that examples have occurred of strong mental emotions having instantaneously given life and vigour to paralytic limbs. This has happened in cases of shipwrecks, fires, and sea-fights, and shews how indispensable it is to have the mind engaged and interested along with the muscles. Many a person

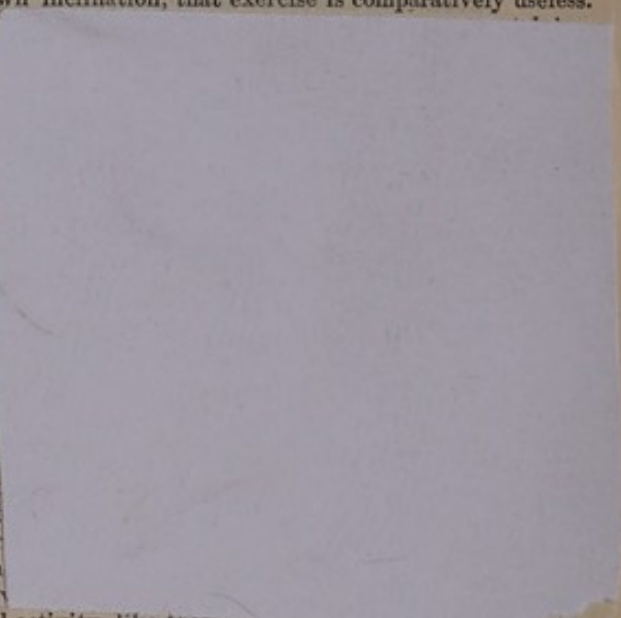
who feels ready to drop from fatigue, after a merely mechanical walk, would have no difficulty in subsequently undergoing much continuous exertion in active play or in dancing; and it is absurd, therefore, to say that exercise is not beneficial, when in reality proper exercise has not been tried.

The amount of bodily exertion of which soldiers are capable, is well known to be prodigiously increased by the mental stimulus of pursuit, of fighting, or of victory. In the retreat of the French from Moscow, for example, when no enemy was near, the soldiers became depressed in courage and enfeebled in body, and nearly sank to the earth through exhaustion and cold; but no sooner did the report of the Russian guns sound in their ears, or the gleam of hostile bayonets flash in their eyes, than new life seemed to pervade them, and they wielded powerfully the arms which, a few moments before, they could scarcely drag along the ground. No sooner, however, was the enemy repulsed, and the nervous stimulus which animated their muscles withdrawn, than their feebleness returned. Dr Sparrman, in like manner, after describing the fatigue and exhaustion which he and his party endured in their travels at the Cape, adds,—"yet, what even now appears to me a matter of wonder is, that *as soon as we got a glimpse of the game, all this languor left us in an instant.*" On the principle already mentioned, this result is perfectly natural, and in strict harmony with what we observe in sportsmen, cricketers, golfers, skaters, and others, who, moved by a mental aim, are able to undergo a much greater amount of bodily labour than men of stronger muscular frames, actuated by no excitement of mind or vigorous nervous impulse. I have heard an intelligent engineer remark the astonishment often felt by country people, at finding him and his town companions, although more slightly made, withstand the fatigues and exposure of a day's surveying better than themselves; but, said he, they overlooked the fact that our employment gives to the mind, as well as to the body, a stimulus which they were entirely without, as their only object was to afford us bodily aid, when required, in dragging the chains or carrying our instruments.—The conversation of a friend is, in the same way, a powerful alleviator of the fatigue of walking.

The same important principle was implied in the advice which the Spectator tells us was given by a physician to one of the eastern kings, when he brought him a racket, and told him that the remedy was concealed in the handle, and could act upon him only by passing into the palms of his hands when engaged in playing with it —and that as soon as perspiration was induced, he might desist for the time, as that would be a proof of the medicine being received into the general system. The effect, we are told, was marvellous; and, looking to the principle just stated, to the cheerful nervous stimulus arising from the confident expectation of a cure, and to the consequent advantages of exercise thus judiciously managed, we have no reason to doubt that the fable is in perfect accordance with nature.

The story of an Englishman who conceived himself so ill as to be unable to stir, but who was prevailed upon by his medical advisers to go down from London to consult an eminent physician at Inverness who did not exist, may serve as another illustration. The stimulus of expecting the means of cure from the northern luminary, was sufficient to enable the patient not only to bear, but to reap benefit from, the exertion of making the journey down; and his wrath at finding no such person at Inverness, and perceiving that he had been tricked, sustained him in returning, so that on his arrival at home he was nearly cured. Hence also the superiority of battledoor and shuttlecock, and similar games, which require society and some mental stimulus, over listless exercise. It is in fact a positive misnomer to call a solemn procession *exercise*. Nature will not be cheated; and the healthful results of complete cheerful exertion will never be obtained where the nervous impulse which animates the muscles is denied.

It must not, however, be supposed, that a walk simply for the sake of exercise can never be beneficial. If a person be thoroughly satisfied that exercise is requisite, and perfectly *willing*, or rather desirous, to obey the call which demands it, he is from that very circumstance in a fit state for deriving benefit from it, because the *desire* then becomes a sufficient nervous impulse, and one in perfect harmony with the muscular action. It is only where a person goes to walk, either from a sense of duty or at the command of another, but against his own inclination, that exercise is comparatively useless.



tal activity, like that which accompanies conversation with a friend, is indeed beneficial by diffusing a gentle stimulus over the nervous system; and it may be laid down as a general rule that any agreeable employment of an inspiriting and active kind, and which does not absorb the mind, adds to the advantages of muscular exercise; but wherever the mind is engaged in reading or in abstract speculation, the muscles are drained as it were of their nervous energy by reason of the great exhaustion of it by the brain; the active will to set them in motion is proportionally weakened, and their action is reduced to that inanimate kind I have already condemned as almost useless. From this exposition, the reader will be able to appreciate the hurtfulness of the practice in many boarding-schools, of sending out the girls to walk with a book in their hands, and even obliging them to learn by heart while in the act of walking. It would be difficult, indeed, to invent a method by which the ends in view could be more completely defeated as regards both mind and body. The very effort of fixing the eye on the printed page when in motion, strains the attention, impedes the act of breathing, distracts the nervous influence, and thus deprives the exercise of all its advantages. For true and beneficial exercise, there must, in cases where the mind is seriously occupied, be *harmony of action between the mind which impels, and the part which obeys and acts. The will and the muscles must be both directed to the same end and at the same time*, otherwise the effect will be imperfect. But in reading during exercise, this can never be the case. The force exerted by strong muscles, animated by strong nervous impulse or will, is prodigiously greater than when the impulse is weak or discordant; and as man was made not to do two things at once, but to direct his whole powers to one thing at a time, he has ever excelled most when he has followed this law of his nature.

The second rule for the management of exercise is, that *it should involve as much variety of movement as possible*, for the double purpose of calling into play the greatest possible number of the muscles, and of fulfil-

ing the law which requires their alternate contraction and relaxation as the condition of their well-being. The absolute necessity of attention to this rule will be apparent when we consider that the sphere of action of each muscle is strictly local, and that it is only by calling them all into play that a *general* effect can be produced. Thus, by much walking, we may greatly develope the muscles of the legs, and yet leave those of the arms and chest comparatively feeble; or, by wielding a ponderous hammer, or rowing a boat, we may greatly develope those of the chest and arms, and leave the legs weak, and their circulation languid. For the same reason, a slow formal walk, with demure look and motionless arms, is much less useful than a smart walk or run, in which we cannot refrain from exercising the arms and chest also. In the former case, the influence is entirely confined to the legs, and is small even on them; while, from the trunk and arms remaining rigid and inactive, no *general* advantage is obtained.

Another reason for varied movements in exercise is, that the constitution of the muscles requires their frequent contraction and relaxation; and if this is neglected, and they are kept long in the same state of tension, they become wearied and weakened by exhaustion. Let this physiological law be kept in view, and then let the reader consider the motionless attitudes required of the young for hours together in schools and at home, and say whether any plan more opposed to the intentions of the Creator could be devised for their management! When we thus sow the seeds of bad health and physical deformity, have we any right to be surprised and grieved when the crop which we have cherished arrives at maturity? God has kindly laid the conditions of our welfare before us without mystery and without obscurity. If we prefer our own way to that which He in his wisdom has marked out for our guidance, can we, without presumption, complain of the consequences? The path of duty is obvious as the sun at noonday. The human body is composed of bones and muscles in addition to other organs. These bones and muscles, exceeding together upwards of 600 in number, were made expressly for active use; and their health and that of the body depend on this condition being fulfilled by all of them being called into play by varied and vigorous movements, with proper intervals of repose. But if we reject this variety, and restrict the body to the constrained observance of certain attitudes and motions, a few of the muscles will suffer from being overstrained, but the great majority of them and the bones will become weakened from inactivity, and impaired health and debility necessarily follow.

The principle of varied exercise is often transgressed to an injurious extent among the manufacturing classes, and its results are seen in their impaired physical condition. We are constantly told that the working of young children in factories for eight or ten hours a-day is not hurtful in any degree, because the labour is so light as not to fatigue them. But a statuary might, on nearly the same grounds, assure his living model, when requested to stand for hours in the same attitude, that his doing so cannot fatigue him, as no active exertion is required of him. But when we recollect that to preserve the same attitude, the same muscles must be in a constant state of tension, and the remainder in a constant state of relaxation, and that all of them are thus denied that *alternate contraction and relaxation*, and those intervals of repose, which are so essential to their well-being; the case of the factory-children assumes a far more serious aspect. And, accordingly, we know, from indisputable evidence, that the factory system has, notwithstanding the boasted lightness of the labour, produced a large amount of impaired health and physical deformity. In England there are no statistical data of a sufficiently precise or trustworthy character to be adduced as evidence; but it is otherwise in France, where the system of examining the yearly levy of conscripts affords an excellent test, as it shews the exact proportions found unfit for the army, from physical deformity, in every part of the country. All the young men above twenty years of age, liable to serve, are examined one by one with the greatest care by a council composed one-half of military men, and the other half of civilians; and the following are the results of a comparison made between ten departments which are principally agricultural, with ten which are principally engaged in manufactures. "In 10,000 young men capable of supporting the fatigues of military service, the ten agricultural departments give only 4029 infirm or deformed persons; while the ten departments which are chiefly manufacturing give 9930 (more than double the number) of infirm or deformed persons. These numbers are the *averages* of the ten departments." But this is not the worst of the picture. In the department of the Eure, the proportion of infirm and deformed persons rises so high as 14,451; and according to Baron Charles Dupin, in a speech reported in the Moniteur of March 7. 1840, "the fearful consequences that arise from excessive labour in childhood and youth may be judged of from the following facts. In Normandy, for every 100 men strong enough to be passed as recruits for the army, there were rejected 170 young men of twenty years of age at Rouen, 200 at Elbeuf, and 500 at Bolbec, all manufacturing towns!!"* Well may it be added in the report, that "such immense disproportions ought not to be looked upon with indifference by the legislature; they are proofs of deep and grievous wounds; they shew that there must be individual suffering of the most afflicting kind. . . . . *We should blush for the state of our agriculture if we could only rear for its operations so small a proportion of oxen and horses able to work, in comparison of so large a number of weak and misshapen animals.*"

I am quite aware that the wholesome regulations already in force in this country, prevent the production of an equal extent of deformity and bad health in our factories; and that in many mills the most active measures are employed to diminish the evils of the system; but it is nevertheless certain that in the best of them the mischief is only mitigated and not extinguished, while in by far the greater number the amount of injury inflicted is still very great. A humane and active spirit of inquiry has, however, been excited, and the general sympathy which it has called forth gives a promise that much more will yet be done to improve the physical and moral wellbeing of our large manufacturing population. But it would be foreign to my present purpose to pursue the subject here, and I have already said enough to shew the necessity which exists of consulting variety in the exercise and employments of the young.

To render exercise as beneficial as possible, particularly in educating the young, it ought always to be taken in the open air, and to be of a nature to occupy the mind as well as the body. Gardening, hoeing, social play, and active sports of every kind, cricket, bowls, shuttlecock, the ball, archery, quoits, hide and seek, and similar occupations and recreations well known to the young, are infinitely preferable to regular and unmeaning walks, and tend in a much higher degree to develope and strengthen the bodily frame, and to secure a straight spine and an erect and firm but easy and graceful carriage. A formal walk is odious and useless to many girls who would be delighted and benefited by spending three or four hours a-day in spirited exercise and useful employment.

Let those mothers, who are *afraid* to trust to Nature for strengthening and developing the limbs and spines of their daughters, attend to FACTS, and their fears will vanish. It is notorious that a majority of those girls who, in opposition to the laws of Nature, are encased

* Leonard Horner on the Employment of Children in Factories and other works. Longman and Co., 1840, p. 51-2.

in stays, and get insufficient exercise, become deformed, an occurrence which is, on the other hand, comparatively rare in boys, who are left, in conformity with the designs of Nature, to acquire strength and symmetry from free and unrestricted muscular action. In a seminary for young ladies, for example, containing forty pupils, it was discovered on examination, by Dr FORBES, that *only two* out of those who had been resident in it for two years had straight spines; while out of an equal number of boys, imperfect as their exercise often is, it would be difficult to discover as many whose spines were not straight. Here, then, is ample proof, that stays and absence of exercise, so far from contributing to an elegant carriage, are directly opposed to its acquisition; and that the absence of stays and indulgence in exercise, even when not carried so far as the wants of the system require, instead of being hurtful to the spine, contribute powerfully to its strength and security. Yet such is the dominion of prejudice and habit, that, with these results meeting our observation in every quarter, we continue to make as great a distinction in the physical education of the two sexes in early life, as if they belonged to different orders of beings, and were constructed on such opposite principles that what was to benefit the one must necessarily hurt the other. It is true that there are cases *of disease* in which the use of stays may be beneficially resorted to; but so far from sanctioning their general employment, such cases are sufficient to prove that, like every other remedy, they ought to be used only under the direction of the medical attendant.

I make this earnest appeal to mothers, because, in truth, *it is they who are responsible* to both God and man for any suffering entailed upon their children from this cause. They are the guides to whom their daughters look up with deference and respect, and if they neglect their trust evil cannot fail to result. To mothers, I would say, Listen to the clear-sighted evidence of one of your own sex, whose worth and talents entitle her opinions and judgment to have weight with you, and who writes only to do good. "We are now so much accustomed to see delicate women," remarks Madame Necker de Saussure, "that, from want of good models, the ideal of a good figure has altogether disappeared from the imaginations of many. What features do we boast of in romance? Is it a dazzling freshness, or the graceful elasticity and vivacity of youth? No, it is a fragile and airy form, a sylph-like figure, an interesting paleness occasionally relieved by a tinge of carnation; it is an expressive look softly shaded by melancholy. But *the most of these indications are precisely those of feeble health.* Extreme delicacy of form, a colour which comes and goes, and a languor of expression forbode nothing good for the future mother or wife called upon perhaps to aid her husband in adversity. And yet, in the mean time, pictures of this kind fascinate the imagination of a young girl and even of a mother, and make them afraid of injuring charms so seductive. One young person will not eat from the fear of becoming too stout, another will not walk lest her foot should become too large. What miserable folly!"

"We have no wish to form Clorindas or stately Amazons; assuredly not; but the opposite extreme into which women have lately fallen, shews that the sex has degenerated. This complaint is heard every where, in England, in Switzerland, and even in America, more than any where else. The victims of maternity multiply daily, youthful widowers often afflict our sight. Physicians often forbid mothers from nursing, so much would it weaken both them and their nurslings. Numerous orthopedic (or deformity-correcting) establishments, sad and uncertain remedies for a defective education, are evidences of its fatal consequences. How does it happen that in an age remarkable for the progress of medical science, the application of hygiène to woman should be so much in arrear,—to that half of the human family on whom the health of the whole race essentially depends? To her will be due the existence of a healthy, active, and vigorous generation, or of one soft, vacillating, enervated, and subjected to the empire of excessive nervous susceptibility, such as characterizes so many women of the present day."

"In towns, especially, physical inaction and inability have deplorable effects. Much is believed to be done when the young girls are taken out to walk in fine weather. But what elasticity, I ask, can a monotonous march give them when they are compelled to keep themselves erect, to keep a guard on their expression, to take care of their clothes, and to speak very low? The blood is scarcely sufficiently accelerated by it to diffuse any heat through their limbs. The muscles of the arms, the shoulders, and the loins, remain inactive; those muscles which are so necessary in uniting the bones together, and preventing them from yielding, and which, by their free play, support and maintain the spinal column in its proper position; these very muscles receive no increase of strength from exercise; the spine, left to its natural flexibility, yields under the weight of the hand and arms, and becomes curved in its weakest part."*

Were there any real difficulty in determining the best means of developing the body and preventing deformity, even the comparison of savage with civilized man would at once remove it. Mr Henry Marshall, in his late excellent work "*On the Enlisting, the Discharging, and the Pensioning of Soldiers*," states, that "lateral curvature of the spine is intimately connected with civilized life. In the male sex, it occurs more frequently among boys who study very closely, clerks, and persons who exercise sedentary trades. The agricultural peasant is seldom affected with it, and *the tribes of people commonly denominated savage perhaps never.* I have had good opportunities of observing the form of the natives of India, and of the Malay islands, and I do not recollect having seen a single case of this deformity among them." P. 21. Mr Marshall's testimony is strongly supported by an intelligent old author, who, in describing the Caribs 170 years ago, says, in a tone of regret, "They do not swaddle their infants, but leave them to tumble about at liberty in their little hammocks, or on beds of leaves spread on the earth in a corner of their huts; and NEVERTHELESS *their limbs do not become crooked, and their whole body is perfectly well made!*" And, again, "ALTHOUGH *the little creatures are left to roll about on the ground in a state of nudity, they* NEVERTHELESS *grow marvellously well*, and most of them become so robust as to be able to walk without support at six months old."†

The naiveté of this expression of surprise at the little Caribs growing *marvellously well* with the assistance of Nature alone, and without the use of stays and bandages imported from Europe, is extremely amusing, and shews to what extent prejudice and custom, once established, will continue to prevail, even where we have before our eyes the strongest evidence of their being hurtful. Our excellent author seems never to have allowed the thought to enter his head, that the Europeans *produced* the deformity by means of swaddling and bandages, and that the Caribs *escaped* it, simply by avoiding its causes, and giving liberty to both limbs and trunk of the body.

It is mentioned of the Araucanian Indians, also, in Stevenson's narrative of a Twenty Years' Residence in South America, that "the children are never swaddled nor their bodies confined by any tight clothing." "They are allowed to crawl about nearly naked until they can walk." "To the loose clothing," adds Mr Stevenson, "which the children wear from their infancy, may doubtless be attributed the total absence of deformity among the Indians." Vol. i. p. 9, 10.

* Madame Necker de Saussure sur l'Education Progressive, &c. Paris, 1838. Vol. iii. p. 168.

† Histoire Naturelle et Morale des Isles Antilles. Rotterdam, 1658.

But there is another important consequence of excessive tasking of the mind, and confinement within doors, and neglect of proper exercise in the open air, to which the attention of all mothers ought to be earnestly directed. I allude to the delicacy and lowered tone of the general health, so graphically described by Madame Necker de Saussure, and which frequently assumes so many of the features of increased refinement as to be considered and hailed by the unreflecting mother as a new charm added to her daughter's former attractions. But too often this "interesting paleness," "sylph-like form," and "expression tinged with melancholy," are only the harbingers of a deep-seated and insidious disease, which is destined to destroy the mother's fondest hopes when excited to the utmost. The same indications are often the first clear evidences of an infirmity of constitution which becomes, in its turn, the source of many evils, and which Mr Hare has shewn to precede, in most cases, the actual occurrence of spinal deformity in youth. In this sense, Mr Hare justly enough *considers the impaired health as the first stage of the spinal disease*, and affirms that the same amount of physical confinement would not be sufficient to produce the deformity if the general health remained unbroken.* In this view I entirely concur; and it affords a double reason for putting an end to the present system of excessive confinement and mental cultivation; and there can be no doubt that in numerous instances it induces that form of impaired health which Sir James Clark has shewn to be so favourable to the production of tuberculous consumption, and which, when confirmed, is scarcely susceptible of cure.†

The next rule for the regulation of exercise is, that *it should always be proportioned in amount to the age, strength, state of the constitution, and former habits of the individual.* From overlooking this condition, it is usual for persons of an indolent or sedentary habit to tell the physician, when he urges upon them the necessity of exercise, that even a short walk fatigues them so much as to render them unfit for every thing for some days afterwards, and that they are never so well as when allowed to remain in the house. But if, in perfect reliance on the regularity of the Creator's laws, we seek out the cause of this apparent exception, we shall almost uniformly find, that, instead of beginning with a degree of exertion proportioned to the weakened state of the system, such persons have (under the notion that it was not worth while to go out for a short time) forced their muscles, already weakened by inactivity and confinement, to perform a walk to which only regularly exercised muscles were adequate. The amount of exertion which is always followed by exhaustion is thus, through mere impatience and ignorance, substituted for that lesser degree which always gives strength; and because the former is followed by headach and debility, it is argued that the latter also must be prejudicial! Many sensible people delude themselves by such puerile plausibilities as this; and it is only by the diffusion of a knowledge of the laws of exercise as part of a useful education, that individuals can be enabled to avoid such mistakes. This, however, will be made more clear by the following considerations.

When any living part is called into activity, the processes of waste and renovation, which are incessantly going on in every part of the body, proceed with greater rapidity, and in due proportion to each other. At the same time the vessels and nerves become excited to higher action, and the supply of arterial or nutritive blood and of nervous energy becomes greater. When the active exercise ceases, the excitement thus given to the vital functions subsides, and the vessels and nerves return at length to their original state.

If the exercise be resumed frequently, and at moderate intervals, the increased action of the bloodvessels and nerves becomes more permanent, and does not sink to the same low degree as formerly; NUTRITION *rather exceeds waste, and the part* GAINS *consequently in size, vigour, and activity.* But if the exercise be resumed too often, or be carried too far, so as to fatigue and exhaust the vital powers of the part, the results become reversed: WASTE *then exceeds nutrition, and a* LOSS of volume and of power takes place, accompanied with a painful sense of exhaustion and fatigue. When, on the other hand, exercise is altogether refrained from, the vital functions decay from the want of their requisite stimulus; little blood is sent to the part, and nutrition and strength fail in equal proportion. A limb which has been long in disuse becomes weak and shrivelled from this cause, and its muscles present an unusual paleness and flabbiness, strongly contrasting with the florid redness and rigid fulness of the muscles of a well-exercised limb.

Even sensation gives faithful notice of these changes, and therefore serves as a guide to the amount of exercise. When muscular employment is neglected, the body becomes weak, dull, and unfit for powerful efforts, and all the functions languish. When exercise is taken regularly and in due proportion, a grateful sense of activity and comfort prevails, and we feel ourselves fit for every duty, both mental and bodily. Lastly, when we are subjected to excessive exertion, a painful sense of weariness and exhaustion ensues, which is not relieved by rest, and which for a long time prevents sleep. A person who has greatly over-fatigued himself in walking, for example, is feeble and restless; and, on lying down, either cannot sleep at all, and rises in the morning weak in body and languid in mind, or has uneasy and disturbed sleep till the exhaustion is partially recovered from, after which he may enjoy sound and refreshing repose.

From this exposition of the effects of exercise in its different stages, it becomes easy to deduce rules applicable to all, for promoting the healthy development of the muscular system, and to trace the errors by which indolent people are accustomed to maintain that exercise is hurtful to their constitutions. *The second stage of exercise, or that in which, by its frequency, moderation, and regularity, nutrition and vigour are preserved at their highest pitch, is of course to be aimed at;* but the quantity of exercise which corresponds to it, must vary according to the constitution and previous habits of the individual, as is well exemplified in training for pedestrian feats, for the ring, and for racing. *The assertion made by many, that exercise hurts them, arises entirely from overlooking this circumstance.*

A person, accustomed to daily activity, will feel invigorated by a walk of four or five miles in the open air, whereas the same distance will weaken another who has not been in the habit of walking at all. But, instead of inferring from this, as is often done, that exercise in the open air is positively hurtful to the latter, reason and experience coincide in telling us, that he has erred only in over-tasking the powers of his system, and that to acquire strength and activity, he ought to have begun with one mile, and to have gradually extended his walk in proportion as the muscles became invigorated by the increased nutrition consequent on well regulated exercise. A person recovering from fever begins by walking across his room perhaps ten times in a day, and gradually extends to twenty or thirty times, till he gains strength to go into the open air. On going out, a walk of ten minutes proves sufficient for him at first; but by degrees his strength and flesh increase, and his exercise is prolonged till he arrives at his usual standard. Such is the order of Nature; but many sedentary people have no patience for such slow progress, and when urged to take exercise, they grudge the trouble of going out for a short time, and think that, if a walk of half a mile does them good,

* Hare on Spinal Diseases. London, 1838.

† Sir James Clark on Consumption and Scrofula.

one of a whole mile will do more; and when they suffer from the error, they shelter their ignorance under the general assumption that exercise does not agree with them! And the same persons who argue thus would think themselves entitled to laugh at the Irishman, who, finding himself relieved by five pills taken at night, inferred that he would necessarily be cured if he took the whole boxful at once, and on doing so narrowly escaped with his life.

From these principles it follows, *first*, that, to be beneficial, exercise ought always to be proportioned to the strength and constitution, and not carried beyond the point, easily discoverable by experience, at which waste begins to succeed nutrition, and exhaustion to take the place of strength; *secondly*, that it ought to be regularly resumed after a sufficient interval of rest, in order to ensure the permanence of the healthy impulse given to the vital powers of the muscular system; and, *lastly*, that it is of the utmost consequence to join with it a mental and nervous stimulus. Those who go out only once in four or five days, are always at work, but never advancing; for the increased action induced by the previous exercise, has fully subsided long before the succeeding effort is begun; and so far as increased nutrition, strength, and greater aptitude for exertion are concerned, no progress whatever is made.

From the influence which muscular activity exercises upon the general circulation, and also in increasing the waste from the system, it is evident that the supply of nourishment ought at all ages to hold a direct relation to the activity of the mode of life, particularly in youth, when fresh materials are required for growth, as well as to repair the waste caused by exercise. In strict conformity with this principle, the first effect of exercise, if properly regulated, is always to increase the appetite; and hence in youth a quantity of food is both required and digested, which, at a more inactive period of life, would speedily oppress the system and disorder the health. If this full supply of nourishment be denied, the development of the bodily organs often receives a check which no subsequent treatment can remedy, and a foundation is laid for diseases of debility which afterwards embitter and endanger life. From pretty extensive inquiry, I am satisfied that in boarding-schools, especially for females, this important principle is occasionally disregarded; while the conductors are at the same time without the least suspicion of the evil they are producing, and even take credit to themselves for only checking sensual appetites, and promoting temperance in eating as well as in drinking. Youth requires the best and most nutritious food, and such ought regularly to be provided, and the infringement of this condition entails much misery upon our young manufacturing population. Wasted by excessive labour, long confinement, and miserable diet, the muscular system is stinted in growth and weakened in structure; and the blood, impoverished by insufficiency of nourishing food and by a vitiated atmosphere, is no longer capable of repairing the waste consequent upon exercise, or of affording a healthy stimulus to the vessels and nerves which animate the muscles. Languor, debility, and exhaustion of mind, necessarily follow; and the individual is left susceptible of no stimulus but that of ardent spirits or of excited and reckless passion. In health, consequently, activity and appetite are generally proportioned to each other, and those suffer most who attempt to combine the pleasures of appetite with bodily indolence.

The next subject for consideration is *the times at which exercise ought to be taken*. Those who are in perfect health may engage in exercise at almost any hour, except immediately after a full meal; but those who are not robust, ought to confine themselves within narrower limits. To a person in full vigour, a good walk in the country before breakfast may be highly beneficial and exhilarating; while to most invalids and delicate persons, it will prove more detrimental than useful, and will induce a sense of weariness which will spoil the pleasure of the whole day. To some, however, who have no appetite on rising, a short walk in the open air before breakfast proves very beneficial. All that is required is, that we should not prescribe morning exercise indiscriminately, but only in the class of cases for which it is adapted. From losing sight of this precaution many persons, deceived by the current poetical praises of the freshness of morning, hurt themselves in summer by seeking health in untimely promenades.

In order to prove beneficial, exercise must be resorted to only when the system is sufficiently vigorous to be able to meet it. In delicate constitutions, this is the case after a lapse of from two to four hours after a moderate meal, and consequently the forenoon is the best time for them. If exercise be delayed till some degree of exhaustion from the want of food has occurred, it speedily dissipates instead of increasing the strength which remains, and impairs rather than promotes digestion. The result is quite natural; for exercise of every kind causes increased action and waste in the organ, and, if there be not materials and vigour enough in the general system to keep up that action and supply the waste, nothing but increased debility can reasonably be expected.

For the same reason, exercise *immediately before meals*, unless of a very gentle description, is injurious, and an interval of rest ought always to intervene. Muscular action causes an afflux of blood and nervous energy to the surface and extremities, and if food be swallowed whenever the activity ceases, and before time has been allowed for a different distribution of the vital powers to take place, the stomach is taken at disadvantage, and from want of the necessary action in its vessels and nerves, is unable to carry on digestion with success. This is very obviously the case where the exercise has been severe or protracted, and the consequence is so well known, that it is an invariable rule in the management of horses, never to feed them immediately after work, but always to allow them an interval of rest proportioned to the previous labour. "*Eat not*," therefore, "until you be fully reduced to that temper and *moderate heat* as when you began, and when the spirits are retired to their proper stations."* Even instinct would lead to this conduct, for appetite revives after repose.

Active exercise ought to be equally avoided *immediately after* a heavy meal. In such circumstances, the functions of the digestive organs are in the highest state of activity; and if the muscular system be then called into considerable action, the withdrawal of the vital stimuli of the blood and nervous influence from the stomach to the extremities, is sufficient almost to stop the digestive process. This is no supposition, but demonstrated fact; and accordingly, there is a natural and marked aversion to active pursuits after a full meal. In a dog, which had hunted for an hour or two directly after eating, digestion was found on dissection to have scarcely begun; while in another dog, fed at the same time, and left at home, digestion was nearly completed.

A mere stroll which requires no exertion, and does not fatigue, will not be injurious before or after eating; but exercise beyond this limit is at such times hurtful. All, therefore, whose object is to improve or preserve health, and whose occupations are in their own power, ought to arrange these, so as to observe faithfully this important law, for they will otherwise deprive themselves of most of the benefits resulting from exercise.

When we know that we shall be forced to exertion soon after eating, we ought to make a very moderate meal, in order to avoid setting the stomach and muscles

* Maynwaringe, p. 14

after dinner sit a

at variance with each other, and exciting feverish disturbance. In travelling by a stage-coach, where no repose is allowed, this precaution is invaluable. If we eat heartily as appetite suggests, and then enter the coach, restlessness, flushing, and fatigue, are inevitable; whereas, by eating sparingly, the journey may be continued for two or three days and nights, with less weariness than is felt during one-fourth of the time under full feeding. I observed this when travelling as an invalid on rather low diet, and was surprised to find myself less fatigued at the end of seventy-two hours, than I had previously been, when in health and living fully, with half the journey; and I have heard the same remark made by others, also from experience. But for full information on this and other practical questions connected with diet and digestion, I must refer the reader to my separate work in which they are discussed in detail.*

It is the custom in many families and schools, apparently for the purpose of saving time, to take young people out to walk about the close of the day, because there is not light enough to do any thing in the house. Nothing can be more injudicious than this plan—for, in the *first* place, *exercise once a-day is very insufficient for the young*, and even supposing that it were enough, the air is then more loaded with moisture, colder, and proportionably more unhealthy, than at any other time; and, *secondly*, the absence of the beneficial stimulus of the solar light, diminishes not a little its invigorating influence. For those, consequently, who are so little out of doors as the inmates of boarding-schools and children living in towns, and who are all at the period of growth, *the very best times of the day ought to be chosen for exercise*, particularly as in-door occupations are, after nightfall, more in accordance with the order of nature.

By devoting part of the forenoon to exercise, another obvious advantage is gained. If the weather prove unfavourable at an early hour, it may clear up in time to admit of going out later in the day; whereas, if the afternoon alone be allotted to exercise, and the weather then proves bad, the day is altogether lost. In winter, indeed, it is not unusual for girls to be thus confined from Sunday to Sunday, simply because the weather is rainy at the regular hour of going out. When the muscular system is duly exercised in the open air early in the day, the power of mental application is considerably increased; while, by delaying till late, the efficiency of the whole previous mental labour is diminished by the restless craving for motion which is evinced by the young of all animals, and which, when unsatisfied, distracts attention, and leads to idleness in school. It would be well to copy in this respect the practice adopted in the infant schools, where the children are turned out to play for a few minutes, as soon as the wandering of mind and restlessness of body indicate that the one has been too much and the other too little exerted. After such an interval, work goes on briskly again, and every one is alive. For these reasons I cannot too strongly condemn the system still pursued even in our best schools, of confining the young during the whole day at lessons, or preparations for lessons, with the exception of only one hour, or an hour and a half, of intermission. I am acquainted with an excellent and very large school of this kind where the boys are allowed only an hour and a half for play, and in this the dinner time is included! By way of making the most of every moment, the boys are led out to play at football the instant dinner is swallowed. This is well meant, as is proved by the masters sharing in the play; but a more irrational method could not be devised. *Three* hours at least ought to be spent in the open air daily, and five hours would be still better, joined, of course, to useful occupation.

* The Physiology of Digestion considered with reference to the Principles of Dietetics. 1 vol. post 8vo. Simpkin & Co., London; Maclachlan & Co., Edinburgh.

The *different kinds of exercise* fall now to be considered. The object being to employ all the muscles of the body, exercise ought to be often varied, and always adapted to the peculiarities of individuals. Speaking generally, *walking* agrees well with every body; but as it brings into play chiefly the lower limbs and the muscles of the loins, and affords little scope for the play of the arms and muscles of the chest, it is insufficient of itself to constitute adequate exercise; and hence the advantage of combining with it movements performed by the upper half of the body, as in rowing a boat, fencing, shuttlecock, and many other useful sports. Such exercises have the additional advantage of animating the mind, and by increasing the nervous stimulus, making exertion easy, pleasant, and invigorating. Nature, indeed, has shewn her intention that the upper part of the body should always partake in the exercise of the lower, by rendering it impossible for us even to walk gracefully without the arms keeping time, as it were, with the movements of the legs.

Active play, running, leap-frog, foot-ball, cricket, gardening, pedestrian, botanical, and geological excursions, combine in their results all the advantages which well-conducted exercise is capable of yielding; and the latter are much resorted to in the German seminaries, for the purpose of developing the mental and bodily powers. On the Continent generally, more attention is paid to physical health and development in the education of the young than with us; and in many institutions a regular system of useful manual occupation is substituted for mere play, and with decided advantage. For not only is the physical organization thereby strengthened and developed, but the mental energy and dignity of character are increased, and the mind becomes better fitted for independent action. Among the ancients the training and invigoration of the body formed a leading object in education; but physical strength having become of less importance in war since the invention of gunpowder, the moderns have too generally restricted their attention to the direct improvement of the mind.

In summer, walking excursions to the Highlands of Scotland are common among the youth of our cities, and when proportioned in extent to the constitution and previous habits of the individual, nothing can be more advantageous and delightful. But not a season passes in which health is not sacrificed and life lost by young men imprudently exceeding their natural powers, and undertaking journeys for which they are totally unfit. It is no unusual thing for youths, still weak from rapid growth, and perhaps accustomed to the desk, to set out in high spirits at the rate of twenty-five or thirty miles a-day, on a walking excursion, and (in consequence of carrying exercise, for days in succession, to the third degree, or that in which *waste exceeds nutrition*) to come home so much worn out and debilitated that they never recover. Young soldiers, whose growth is scarcely finished, are well known to die in great numbers, when exposed to long and heavy marches, particularly when food is at the same time scanty. Violent exercise is not less pernicious, and, as well remarked by Dr Johnson, "it did great harm even when nations were more in a state of nature than they now are. Galen, in his discourse on Thrasibulus, inveighs against the athletic practices of the gymnasium. A smart walk of a mile is to a valetudinarian what a furious wrestle would be to an athletic. If we trace those dreadful aneurismal affections of the heart and arteries in early life, we shall find their origins in violent exercise or sudden overexertion, in nine cases out of ten, where age and ossification are not concerned."* Even a single day of excessive fatigue will sometimes suffice to interrupt growth and produce permanent bad health; and I know one instance of a strong young man, who brought on a severe illness and permanent debility, by sudden return

* Johnson on Derangement of the Liver, &c. p. 129.

to hard exercise for a single day, although some years before he had been accustomed to every species of muscular exertion in running, leaping, and swimming. Many young men hurry on the premature development of consumption by excessive fatigue during the shooting season in cases where, by prudent management, they might have escaped it for years, if not altogether. The principle already laid down, of not exceeding the point at which *exercise promotes nutrition and increases strength*, will serve as a safe guide on all occasions, and indicate the rate at which it may be extended. Old sportsmen know the rule by experience, and generally prepare themselves for the moors by several weeks of previous training. The science and judgment which fox-hunters display in preparing their horses for their future exertions in coursing are well known, and might be still more usefully applied by their riders to the training of their own families.

Since the above remarks appeared in the third edition of this volume, I have had occasion to examine carefully two young gentlemen, who, during their attendance at Cambridge, were in the habit of using very violent and continued exertion in rowing. In the one the muscles of the arm and upper part of the chest were of an almost unnatural size and hardness from excess of nutrition, while the rest of the body was only moderately developed. In the other there was no such disproportion, but there was a liability to palpitations and severe pain in the region of the heart, which, he said, were first brought on by excessive exertion. On cautioning him against the probable consequences of continuing such trials of strength as occurred during their frequent boat-races, he told me, that in looking back to his own companions at college, he could name several dead within the last four years whose lives were distinctly ascertained to have been sacrificed in this way, —a fact strikingly corroborating Dr Johnson's testimony, and which certainly ought to make a salutary impression on the minds of those who, in the pursuit of pleasure, rush so thoughtlessly into danger.

As the subject is one of much practical importance, I may add another melancholy but instructive example, with which a friend has furnished me, of the operation of the principles just inculcated. He says, " A young gentleman, whom I knew, was employed as a clerk in one of the banks in Edinburgh. He was closely confined to his desk during the summer, and, towards the end of July, had become weak and emaciated from deficient exercise in the open air. His strength continued to decline till Friday the 12th of August, when he went to shoot on Falkirk Moor. On Friday and Saturday he was much fatigued by excessive and unusual exertion, and on Sunday evening was feverish and heated, and perspired very much during the night. In this condition, he rose about three or four o'clock on Monday morning, and returned to Edinburgh on the top of a coach. When he reached home he felt very unwell, but went to the bank. At two o'clock he became so sick as to be unable to sit at his desk. He was then bled by a medical gentleman, but without much effect; and after passing three months in a feverish and sleepless condition, he died in the beginning of November. He was previously of a healthy constitution." It is more than probable that this young man's life became a sacrifice to his ignorance of the structure and functions of the human body.

Riding is a most salubrious exercise, and, where the lungs are weak, possesses a great advantage over walking, as it does not hurry the breathing. It calls into more equal play all the muscles of the body, and, at the same time, engages the mind in the management of the animal, and exhilarates by the free contact of the air and more rapid change of scene. Even at a walking pace, a gentle but universal and constant action of the muscles is required to preserve the seat, and adapt the rider's position to the movements of the horse; and this kind of muscular action is extremely favourable to the proper and equal circulation of the blood through the extreme vessels, and to the prevention of its undue accumulation in the central organs. The gentleness of the action admits of its being kept up without accelerating respiration, and enables a delicate person to reap the combined advantages of the open air and proper exercise, for a much longer period than would otherwise be possible.

From the tendency of riding to equalize the circulation, stimulate the skin, and promote the action of the bowels, it is also excellently adapted as an exercise for dyspeptic and nervous invalids.

Dancing is a cheerful and useful exercise, but has the disadvantage of being used within doors, in confined air, and often in dusty rooms and at most unseasonable hours. Practised in the open air, and in the day-time, as is common in France, dancing is certainly an invigorating pastime; but in heated rooms, and at late hours, it is the reverse, as these drawbacks do more harm than can be compensated by the healthful exercise of the dance.

Gymnastic and calisthenic exercises have been in vogue for some years, for the purpose of promoting muscular and general growth and strength, but they are now rather sinking in public estimation; partly, I believe, from absurdly making them supersede instead of aiding exercise in the open air, and partly from overlooking the necessity of adapting the kind and extent of them not only to the individual constitution, but to the natural structure of the body; the consequence of which has been, that some of the more weakly pupils have been injured by exertions beyond their strength, and discredit has thus been brought upon the system. It is certain, indeed, that some of the common gymnastic exercises are altogether unnatural and at variance with the design of the bodily organization; and that others are fit only for robust and healthy boys, and not at all for improving those who are delicately constituted, and who stand most in need of a well-planned training. It is impossible to enter minutely into this subject at present, but the best guide we can have is to follow the footsteps of Nature, and, before adopting any exercise, to consider whether it is in harmony with the mode of action assigned by the Creator to the parts which are to perform it. If it be so, we may proceed with perfect confidence that it will not only improve the health, but add to the freedom, elegance, precision, and strength of our movements; whereas, if it be opposed to the obvious intention of the Creator, we may rest assured that no good can accrue from it.

If, for example, we examine the various attitudes and motions of the body which occur in fencing, dancing, swimming, shuttlecock-playing, and some of the better class of gymnastic exercises, we find that they are not less graceful and beneficial to the young who engage in them, than pleasing to those by whom they are witnessed,—just because they are in perfect harmony with Nature, or, in other words, with the structure and mode of action of the joints, ligaments, and muscles by which they are executed. But it is far otherwise with some of the anomalous exercises which were at one time so fashionable, and which are not yet extinct in schools and gymnasia, and seem to have for their chief object the conversion of future men and women into foresters, firemen, or savages, rather than into beings who are to continue to have the use of stairs, ladders, carriages, steam-boats, and the other conveniencies of civilized life. It is no doubt a good thing for a boy to be able to climb up a perpendicular pole or a slippery rope, when no other means present themselves of attaining an important object at its upper end; and it is an equally good thing for a young lady to be able to sustain her own weight hanging by one or both hands, when there is no possibility of resting her feet on *terra firma*; and where boys and girls are strong enough to take pleasure

in such amusements, there is no great reason to hinder them, provided they are impelled to them, not by emulation or any secondary motive which may lead to over-exertion, but by the pure love of the exercise itself. In all ordinary circumstances, those only who are vigorously constituted will attempt them, and, if left to themselves, will be sure to desist before any harm can be done. But the case is entirely altered when such extraordinary evolutions are not only encouraged but taught to all indiscriminately, whether they be strong or weak, resolute or timid. We have only to reflect for a moment on the structure of the shoulder-joint, and on the sphere of action of the muscles surrounding it, to perceive at once that the position of the one and the strain upon the other, caused by the exercises alluded to, are so *forced* and *unnatural* as to exclude the possibility of the Creator having intended either to be practised except upon occasions of urgent necessity, and to discover how preposterous it is, therefore, to make them a subject of general instruction. Nay, the very violence of the effort required to sustain the body when hanging by the hands is far beyond that moderate exertion which adds to nutrition and to strength; and in delicate subjects it may even induce relaxation and stretching of the ligaments and bloodvessels, and thus, as in the case of the young men at Cambridge, lay the foundation for future and fatal disease. The same remarks apply to a common practice of making the pupils slide down an inclined plane resting on the hands alone, by which unnatural effort the shoulders are pushed halfway up the neck, and the wrists, arms, and chest severely tried. But in these and other similar evolutions, it requires only to look at the dragging and distortion which they produce, and which form such a painful contrast to the ease and grace of all natural motions and attitudes, to perceive that they are *out of the order of Nature*, and that neither health nor elegance can result from them.

I am aware that these exercises are said to stretch the spine and to remedy its deformities; but it would be quite as sound logic to maintain that, because a *broken* leg requires to be tied up with splints and bandages, therefore the best way to strengthen a *sound* leg must be to bandage it also, as to infer that, because a few *diseased* spines require to be stretched, therefore all *healthy* spines must also derive benefit from the same process,—although, in the latter case, it is obvious to reason that the stretching will be much likelier to put the bones out of their places than to fix them more firmly in those which they already occupy. It is not by such extravagant means that a soldier-like carriage is obtained in the army, and yet there the uniformity of result—the erect and steady gait—is scarcely less remarkable than the discordant materials and variety of slouching and awkward attitudes out of which it is formed by perseverance in a rational system of drilling.

In the selection of exercises for the young, then, we should not be misled by a vain desire of surmounting difficulties and performing feats at the serious risk of inducing aneurism or rupture, but rather endeavour to strengthen the body by active amusements, which shall call the social and moral feelings and intellect into play at the same time, and by the practice of such gymnastic evolutions only as tend to improve and give tone to the *natural action* of the moving powers. And, in endeavouring to attain this object, we should be always careful to avoid great fatigue, and to modify the kind, degree, and duration of the exercise, so as to produce the desired results of *increased nutrition and strength*; and to remember that the point at which these results are to be obtained, is not the same in any two individuals, and can be discovered only by experience and careful observation.

For giving strength to the chest, *fencing* is a good exercise for boys, and what is called the *club exercise* for females; but the above limit ought never to be exceeded, as it often is, by measuring the length of a lesson by the hour-hand of a clock, instead of its effects on the constitution. *Shuttlecock*, as an exercise which calls into play the muscles of the chest, trunk, and arms, is also very beneficial, and would be still more so, were it transferred to the open air. After a little practice, it can be played with the left as easily as with the right hand, and is, therefore, very useful in preventing curvature and giving vigour to the spine in females. It is an excellent plan to play with a battledoor in each hand, and to strike with them alternately. The play called the *graces* is also well adapted for expanding the chest, and giving strength to the muscles of the back, and has the advantage of being practicable in the open air.

Dumb-bells are less in repute than they were some years ago, but when they are not too heavy, and the various movements gone through are not too eccentric or difficult, they are very useful. They do harm occasionally from their weight being disproportioned to the weak frames which use them; in which case they pull down the shoulders by dint of mere dragging. When this or any other exercise is resorted to in the house, the windows ought to be thrown open, so as to make the nearest possible approach to the external air.

Reading aloud, recitation, and singing, are more useful and invigorating muscular exercises than is generally imagined, and are extremely useful in promoting the development of the lungs and chest, at least when managed with due regard to the natural powers of the individual, so as to avoid effort and fatigue. They all require the varied activity of most of the muscles of the trunk to a degree of which few are conscious, till their attention is turned to it. In forming and modulating the voice, not only the chest but also the diaphragm and abdominal muscles are in constant action, and communicate to the stomach and bowels a healthy and agreeable stimulus; and consequently, where the voice is raised and elocution rapid, as in many kinds of public speaking, the muscular effort comes to be even more fatiguing than the mental, especially to those who are unaccustomed to it, and hence the copious perspiration and bodily exhaustion of popular orators and preachers. When care is taken, however, not to carry reading aloud or reciting so far at one time as to excite the least sensation of soreness or fatigue in the chest, and it is duly repeated, it is extremely useful in developing and giving tone to the organs of respiration, and to the general system. To the invigorating effects of this kind of exercise, the celebrated and lamented Cuvier was in the habit of ascribing his own exemption from consumption, to which, at the time of his appointment to a professorship, it was believed he would otherwise have fallen a sacrifice. The exercise of lecturing gradually strengthened his lungs and improved his health so much that he was never afterwards threatened with any serious pulmonary disease. But of course this happy result followed only because the exertion of lecturing was not too great for the then existing condition of his lungs. Had the delicacy of which he complained been farther advanced, the fatigue of lecturing would only have accelerated his fate; and this must never be lost sight of in practically applying the rules of exercise.

It appears, then, from the foregoing remarks, that the most perfect of all exercises are those sports which combine free play of all the muscles of the body, mental excitement, and the unrestrained use of the voice; and to such sports, accordingly, are the young so instinctively addicted, that nothing but the strictest vigilance and fear of punishment can deter them from engaging in them the moment the restraint of school is at an end. Many parents, absorbed in their own pursuits, forgetful of their own former experience, and ignorant that such are the benevolent dictates of Nature, abhor these wholesome outpourings of the juvenile voice, and lay restric-

tions upon their children, which, by preventing the full development of the lungs and muscles, inflict permanent injury upon them in the very point where in this climate parents are most anxious to protect them. In accordance with this, we find that what are called wild romping boys or girls, or those who break through all such restrictions, often turn out the strongest and healthiest; while those who submit generally become more delicate as they grow older.

Enough has, I trust, been said to enable any rational parent or teacher to determine the fitness of the different kinds of muscular exercise, and to adapt the time, manner, and degree of each to every individual under his care; but, before taking leave of the subject, and with a view to impress the more deeply upon the mind of the reader the practical importance of the principles inculcated in the preceding pages, I cannot refrain from subjoining a case which affords an extremely apposite illustration of almost every one of them. The particulars were furnished to me by a young friend who was allowed to peruse the manuscript of these pages, and who, as himself the subject of the case, was struck with the perfect accordance between his own experience and the doctrines here expounded. It is proper to keep in view, that at the time of his experiment, my friend was about seventeen years of age, and growing rapidly. I shall use nearly his own words.

After having passed the winter closely engaged in a sedentary profession, and unaccustomed to much exercise, he was induced by the beauty of returning spring to dedicate a day to seeking enjoyment in a country excursion; and for that purpose set off one morning in the month of May, without previous preparation, to walk to Haddington by way of North Berwick,—a distance of 34 miles. Being at the time entirely unacquainted with physiology, he was not aware that the power of exerting the muscles depended in any degree upon the previous mode of life, but thought that if a man were once able to walk thirty miles, he must necessarily continue to possess the same power, under all circumstances, while youth and health remained. The nervous stimulus arising from his escape from the desk, and from the expected delights of the excursion, carried him briskly and pleasantly over the ground for the first twelve miles, but then naturally began to decrease. Unfortunately, the next part of the road lay through a dull, monotonous, and sandy tract, presenting no object of interest to the mind, and no variety of any description; so that the mental stimulus, already greatly impaired in intensity, became still weaker. Being *alone*, his intellect and feelings could not be excited by the pleasure of companionship and conversation; weariness consequently increased at every step; and long before his arrival at North Berwick (25 miles), "every vestige of enjoyment had disappeared, time seemed to move at a marvellously tardy pace, and every mile appeared doubled in length."

Not being aware that excessive exercise without a succeeding period of repose is unfavourable to digestion, and having a lively recollection of the pleasure and refreshment consequent upon eating a good dinner with an appetite whetted by a *proper* degree of bodily labour in the open air, he looked forward with confidence to some recompence and consolation for his toils when dinner should make its appearance. In this, however, he was doubly disappointed; for, from having started with too light a breakfast, and walked so far, his digestive organs were, in common with every part of his system, so much impaired, that he looked upon the viands placed before him almost without appetite; and as they were in themselves not remarkably nutritive or digestible, he infringed still further that condition of muscular action which consists in a full supply of nourishing arterial blood, made from plenty of nutritious food, —a condition which I have stated to be essential, especially in youth and during growth.

After a rest of two hours, and taking a moderate allowance of wine, which, however, he says, "seemed to have lost its ancient virtue of imparting cheerfulness to the human heart," he set out to complete the remaining nine miles to Haddington. The country was more beautiful and varied, but the charms of nature had, by this time, lost all attractions, for our pedestrian was "now wholly occupied in counting the tedious miles yet to be traversed, and in making a pious vow that this *pleasure excursion*, though not the first, should certainly be the *last* in his life." Being reduced to the utmost degree of exhaustion, it required an extraordinary effort to persevere; but at last he arrived at Haddington, in a state of exquisite misery. Unable to read from fatigue, and having no body to converse with, he sought refuge in bed at an early hour, in the expectation that "tired Nature's sweet restorer, balmy sleep," would visit his couch and bring him relief. But in accordance with what is mentioned on page 41, he tossed and tumbled incessantly till four in the morning, a period of seven hours, after which sleep came on. Next day my youthful friend returned home in the stage-coach, wiser at least, if not happier, for his pleasure excursion; and now makes the observation, that if he had been instructed in the least degree in the nature of the human constitution, he would never for a moment have entertained an expectation of enjoyment from a proceeding so utterly in defiance of all the laws of exercise, as that of which he reaped the unpalatable fruits. He adds justly, that the number of young men who suffer in a similar way is by no means small, and that he has reason to be thankful that he has not, like some of his companions, carried his transgression so far as permanently to injure health, or even sacrifice life.

My aim being practical utility, I have said nothing in this place on the subject of what are called the *Involuntary* Muscles, or those over which the will has no power, in contradistinction to the *Voluntary*, or those which obey the direction of the will. Most of the involuntary muscles are the agents of important vital functions, which are carried on by them unconsciously to ourselves, and which it would have been dangerous to leave under our control. The chief of them is the heart, which goes on in one unvarying round of alternate contraction and relaxation, from the commencement till the close of existence. The next in importance are those connected with respiration, which, like the heart, continue to act by night and by day for the whole period of a long life, without weariness and without interruption. The muscular fibres of the stomach, bowels, and other viscera, are excellent examples of the same class; and the beneficence of Providence in withdrawing them from our control cannot be sufficiently admired. Had the action of the heart and respiratory muscles depended on the will, as that of the muscles of locomotion does, the circulation of the blood and the process of breathing would both have ceased whenever sleep or any other cause overcame the power of attention, and life would in consequence have been extinguished.

From the different constitution of the voluntary and involuntary muscles, it is clear that the former were designed for alternate activity and repose. Had it so pleased the Creator, He could as easily have rendered the one set of muscles incapable of fatigue, as he has actually rendered the other; but then the powers of man would not have been in harmony with the purpose of his existence. Incessant muscular activity would not only have been incompatible with the highest human enjoyment,—that arising from the gratification of the moral and intellectual faculties,—but it would have lacked objects on which to expend itself usefully, and, unguided by intellect, would only have served to overturn and destroy the best provisions of Nature for our happiness.

CHAPTER VII.

THE BONES, THEIR STRUCTURE, USES, AND CONDITIONS OF HEALTH.

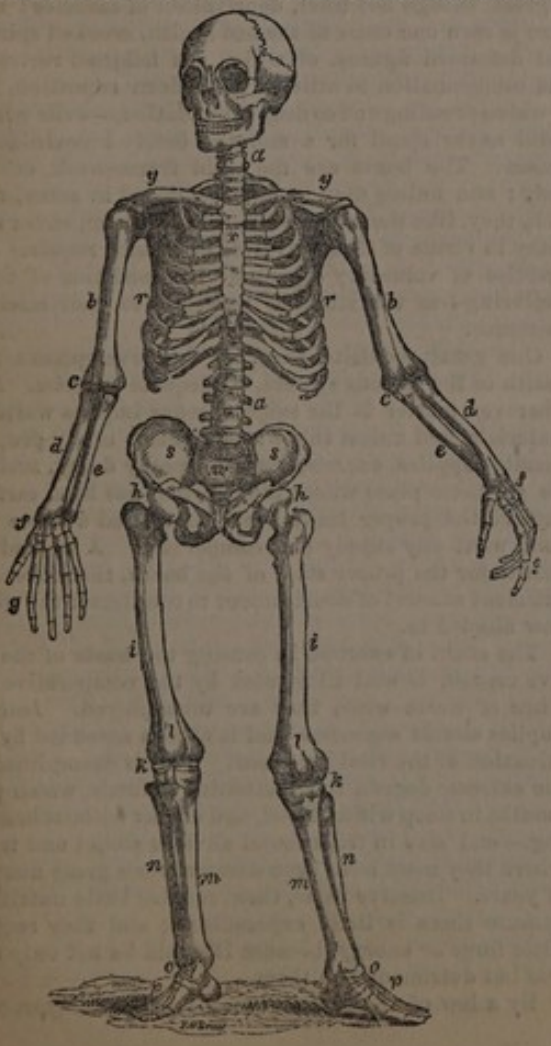
The bones essential to motion, and to the security of the vital organs.—The Skeleton.—Bones are composed of animal and of earthy matter.—The animal part the seat of their vitality.—The proportions between these vary at different periods of life.—Vessels, nerves, life, growth, and decay of bones.—Advantages of their vitality and insensibility.—Their adaptation to contained parts.—Conditions of health.—Necessity of exercise.

THE hardness, strength, and insensibility, which form the distinguishing properties of healthy bones, fit them in a remarkable degree for serving as a basis of support to the softer and more active textures of the body. By their means, the human frame is enabled to unite the most finished symmetry of form, with the most perfect freedom of motion and security to life.

Some of the bones, such as those which compose the skull and the socket for the eye, are designed exclusively for the protection of important organs contained within them. But by far the greater number are constructed with a direct reference to voluntary motion, and serve only incidentally the purposes of protection.

In proportion to the variety of movements which any piece of mechanism is required to perform, its component parts must be numerous and varied. Considered in this light, the animal frame is the most wonderful of all combinations of machinery. No production of art can be compared with it for the multiplicity and nicety of its evolutions; and yet all these are executed simply by muscular power, acting upon the bones or other parts, and changing their relative positions.

The incalculable variety of movements required from man, is the reason why the bones composing the skeleton are so numerous (as may be seen from the annexed figure), and each so admirably connected with the others by articulations, constructed so as to admit of precisely that kind of motion which the animal requires from it, and of no other. The advantages of this arrangement are not less obvious than admirable. Had the osseous frame-work consisted of one entire piece, not only would man and animals have been incapable of motion, but every external shock would have been communicated undiminished to the whole system. Whereas, by the division of its parts, and by the interposition of elastic cartilages and ligaments at the joints, free and extensive motion is secured, and the impetus of every external shock is deadened in its force and diffused over the body, in the same way as, to a person riding in a carriage, the jolt of the wheel passing over a stone is diminished by being equally diffused over the whole vehicle, in consequence of the elasticity of the springs. The safety imparted by this arrangement to the delicate and important vital organs, is apt to be lost sight of, from the very smoothness with which it enables us to move along, but it will be perceived if we reflect on the shock given to the whole system by taking a single false step in going up or down stairs. The parts have then no time to adapt themselves to the exigencies of the moment, and to put the proper springs in play for the equal distribution of the impetus. Death has been occasioned by accidents of this kind.



Bones consist of two kinds of substances, viz. those of an animal and those of an earthy nature. To the former belongs every thing connected with the life and growth of bones, and to the latter the hardness and power of resistance by which they are characterized. At birth, many of the bones are, properly speaking, of a cartilaginous nature. As ossification advances, the cartilage is removed by the absorbents, and its place supplied by a kind of cellular membrane, in the interstices of which the earthy particles are deposited, the two forming, by their union, the homogeneous whole called Bone. Although, therefore, it is to the softer material alone that vital properties essentially belong, it is usual to speak of the life, the vessels, and the nerves of bones, as if life belonged equally to the earthy and animal portions. This is correct enough in reality, because the union between the earthy and animal tissues is always the product of life; and the parts thus united are, to all intents and purposes, living parts. Insensible as they may seem, the bones thus possess all the attributes of living and organized parts. They are all provided with bloodvessels, with nerves, and with exhaling and absorbing vessels; and they are constantly undergoing the same process of decay and renovation to which all other living parts are subjected.

Bones, being in their very nature so hard and durable, may be thought not to require any such supply of nourishment or undergo any such change of parts, as we have just alluded to. But if we look for a moment to the advantages consequent upon this order of things, we shall see abundant reason for their being subjected in this respect to the general laws of animated nature.

It is only by means of the processes of growth and renewal that the bones can adapt themselves to the wants and state of the system. If the bones were not endowed with the principle of life, the stature of the infant must have been that of the future man. Or even supposing the osseous system to have grown to maturity, and then remained unchanged, the withered form of old age would necessarily have been oppressed and overcome by the large and massive bones which the vigorous muscles of manhood alone can easily put in motion. Had the bones been created unsusceptible of internal change and unendowed with life, it is obvious that, when broken by accident, they must have remained for ever disunited, and therefore an incumbrance instead of an assistance to the animal. But, from possessing bloodvessels of their own to supply them with

nourishment, and nerves to give power of action to those bloodvessels, the very irritation of the broken end is made to serve the purpose of increasing the vital powers of the injured parts, and producing that excitement which is necessary for the formation of a new bond of union, and for filling up the gap that would otherwise have remained.

In a state of health, the bones are insensible to pain; and here also the most provident benevolence appears. For, surrounded as they are by the softer and more sensitive parts, these afford them ample protection, while their insensibility enables them to act, for any length of time, without weariness or pain. But when a severe accident occurs to break them asunder, or destroy their texture, pain then becomes their kindest guardian, and the surest promoter of their recovery. In such circumstances, indeed, nothing can be more truly benevolent than pain. It accompanies that inflammation and vascular activity, without which the work of reunion of the broken part cannot be accomplished; and is the means of securing the repose and quietude which are essential to the exact adaptation of the parts to each other, and which can be effected only by causing great pain to follow even the slightest motion. Of such utility is inflammation on these occasions, that when, as sometimes happens, the requisite degree of it, from want of nervous sensibility in the part, does not take place, and the bone remains un-united for many weeks, surgeons are in the habit of using violence to produce the necessary stimulus. In this case, they either rub the broken ends rudely against each other, or introduce an instrument between them, by which pain and irritation may be excited; and then reunion is accomplished. On the other hand, if pain did not guard the limb from motion when the process of recovery is going on, the union would be incessantly disturbed by every heedless and unavoidable start altering the relative position of the parts. This, also, is occasionally exemplified in practice. Looking at these facts, it is impossible not to admire the wisdom and the benevolence manifested in the adaptation of the structure of bones in every particular to the circumstances and occurrences of life.

I have already stated, that, besides a large proportion of earthy matter, which gives to them dryness and hardness, bones contain a large quantity of animal matter, which is essential to their constitution. In early life, this cartilaginous matter preponderates, and the bones are consequently less heavy, more pliable and elastic, and possessed of greater vitality. In old age, again, the earthy parts predominate, and with them fragility, insensibility, and a lower degree of life. It is from this difference that bones broken in youth reunite in one-third of the time necessary for their reunion in advanced life.

In some unhealthy states of the system, the proportion of earthy matter is greatly diminished, and in some parts it is even altogether removed. The bones become soft, compressible, and incapable of affording protection or support to the other parts, to such a degree, that instances have occurred, in which the lower extremities could be twisted behind as if made of wire. A slighter degree of the same affection is common in weak, rickety children; and hence the deformity of limbs, so often occurring from absolute insufficiency of the bones to support the weight of the body.

The practical application to be made of our knowledge of the constitution of the bones, as parts of our animal frame, and as governed by the ordinary organic laws, will now be obvious. Their health we have seen to depend on the regular supply of nourishment by the bloodvessels, on a due supply of nervous energy by the nerves, and on a due balance between the action of the nutrient and absorbent or removing vessels. To the steady fulfilment of these conditions, therefore, we are bound to attend.

It is a common fault to consider the study of an organ or function complete, when we have viewed it on all sides as an isolated part, without regarding its external relations as constituting an essential portion of its history. Thus, in the case of the bones, we are apt to describe their hardness, their mobility, and other qualities, without sufficiently adverting to the fact, that, being organs of support and resistance, the frequent and regular performance of a full but not excessive amount of their duties, is as essential to their wellbeing as blood is to the heart, air to the lungs, or light to the eyes. And, accordingly, when that condition is not fulfilled, the bones become feeble, diseased, and unfit for their functions, just as the softer parts of the body do. In practice, it is of the utmost importance to be fully aware of this fact.

It is familiar to the professional mind, that a part deprived of that exercise or action which nature destined it to fulfil, becomes weakened, diminishes in size, and at last shrivels and alters so much in appearance, as not to be recognizable. Thus, if an artery—the large artery which supplies the arm with blood, for example—be tied, and the flow of blood obstructed, a change of structure immediately begins, and goes on progressively, till, at the end of a few weeks, what was formerly a hollow elastic tube, presents the appearance of a ligamentous inelastic cord. A muscle condemned to inaction, is speedily reduced to half its original bulk; and if long unexercised, at last loses entirely its power of contraction and muscular appearance. The same rule holds with all other parts of the system, and, in an especial manner, even with the hard and apparently unalterable fabric of the bones. It is ascertained by extensive experience, that complete inaction, besides diminishing the size of the bone, injures its structure so much as to deprive it of hardness, and render it susceptible of being cut with a knife. Now, what is strongly marked in the extreme case is not less active, although it may be less palpably apparent, in cases where there is great, though not total, deprivation of exercise; and here is seen one cause of the bad health, crooked spines, and deformed figures, of which the habitual restraint and condemnation to attitude in modern education, lay so wide-spreading and so deep a foundation,—evils which could never stand for a moment before knowledge or reason. The bones are the solid frame-work of the body; and unless they be duly exercised in actual motion, they, like the muscles which move them, suffer and decay in virtue of that universal law which requires the exercise of voluntary organs as the condition of their wellbeing—as the stimulus necessary to their efficient existence.

One great requisite, then, for the development and health of the osseous system, is adequate exercise. But wherever matter is the subject, *action* implies waste of materials, and unless this waste be made up by proportionate supplies, exercise leads to speedy decay, such as we see takes place where the exertion has been carried beyond the proper limits, and occasioned a waste beyond what any supply can compensate. A second requisite for the proper state of the bones, therefore, is a sufficient amount of nourishment to counteract the waste now alluded to.

The effect of exercise in causing the waste of the active organs, is well illustrated by the comparative absence of waste when they are unemployed. *Inaction* implies almost *stagnation*, and is always attended by diminution of the vital functions. This is exemplified in the extreme degree, in hybernating animals, which pass months in sleep without food, and almost without breathing,—and also in frogs found alive in stones and trees, where they must have been dormant for a great number of years. Inactive parts, then, require little nutrition, because there is little expenditure; and they require little force or energy, because it would be not only useless but detrimental to them.

By a law of the constitution already more than once

alluded to, and manifestly arranged with relation to this principle, when any part of the system is active, it attracts to itself, by the simple stimulus of that activity, an increased supply of blood and nervous energy. The former repairs the waste of substance which action produces, and the latter gives an increased tone in harmony with the greater call made on its powers. If the exercise is momentary and is not repeated, the extraordinary flow of blood soon disappears, and the nervous power falls to the usual standard: But if it is continued for a time, and is recurred to at regular intervals, a more active nutrition is established; a permanently greater supply of blood enters the vessels, even during the intervals of inaction; and an increase of development takes place, attended with increased facility and vigour of function.

If, again, any part is not duly exercised, there is no local stimulus to attract a large supply of blood or abundant flow of the nervous fluid; there is no activity of nutrition, no perfection of development, and no vigour of function. And hence, in partial exercise, there is always predominance of some part over others; the one too strong, the other too feeble. In the muscular system, the arms of a blacksmith contrasted with those of a dancing-master, are a sufficient illustration.

This law of increased afflux of fluids and increased nutrition to exercised parts, and of diminished afflux and nutrition to inactive parts, is not only highly important in its practical consequences, but is in exact and obvious accordance with the plainest principles of reason. By this benevolent arrangement, parts acting strongly receive large supplies, and parts doing nothing are left in the state of weakness befitting the demands made upon them. To every one who sees the principle, it must appear the height of folly to expect great nutrition and great energy to follow inaction, and *vice versa*; and yet this is what is, in ignorance, daily looked for by mankind at large.

This law of exercise, as influencing nutrition and function, is universal in its application, and applies to the osseous as much as to any other system. If the bones are duly exercised, then active nutrition goes on, and they acquire dimensions, strength, and solidity. If they are not exercised, the stimulus required for the supply of blood to them becomes insufficient; imperfect nutrition takes place; and debility, softness, and unfitness for duty follow in the train. This cause of defective formation is most active and most commonly seen in the bones of the spine in growing girls, who are denied free exercise in that part; and the consequent weakness in the bones and cartilages, as well as in the muscles, is a very frequent cause of the swollen joints and curvature in the bones of the limbs in young people, which no subsequent care can ever remove.

The beneficial effects of exercise and diet in imparting solidity to the bones, have not escaped the observation of trainers and veterinary surgeons. Sir John Sinclair expressly mentions that the bones of persons trained become, in a remarkable degree, *harder* and *tougher*, and less liable to be injured by blows or accidents.* Delabere Blaine also, in speaking of the deposit of earthy matter and the consequent consolidation of the bones of the horse being hastened by anything that permanently quickens the circulation through them, adds that Nature gives to young animals a playful disposition for the purpose of "increasing the flow of blood, and occasioning a more free deposit of the earthy particles."—"The earthy deposit," he continues, "is usually proportioned to the wants of the animal; it is thus most perfect in those whose exertions are most considerable; in the full-bred horse, therefore, the bones will be found more solid than in the bulky lower-bred varieties." But from this very circumstance, when the animal is subjected to premature exertion, the consolidation of the bones becomes complete before their softer portion has increased to its full dimensions, and hence "horses early and hard worked never arrive at their full size."* Testimony of this kind ought to be of great weight, as based, not on theory, but on the broad and well-marked experience of practical men.

It must be observed, however, that defective nutrition, may arise from other causes than inadequate exercise; but even then the consequences attending it are analogous in their nature. Among the poor it often arises from deficiency of wholesome food, and from damp dark habitations; among the rich, from feeble digestive and assimilating powers, and pampering in diet; and also from errors in clothing, and neglect of sufficient ventilation, and due exposure to the open air. Rickets, softness of the bones, and white swelling, are accordingly observed to be almost confined to children belonging to one or other of these classes.

To understand more clearly the relative uses of bones and muscles, we may be allowed to use a comparison, although, like all other comparisons, it presents many points of difference. The bones are to the body what the masts and spars are to a ship; they give support and the power of resistance; and the muscles are to the bones what the ropes are to the masts and spars. It is to the muscles that the bones are indebted for the preservation or change of their relative position. If the bones or masts are too feeble in proportion to the weight which they are required to sustain, then a deviation from their shape or position takes place; and, on the other hand, if the muscles or ropes are not sufficiently strong and well braced, then insufficiency of support must necessarily result. Early infancy affords an instance of both imperfections; the bones being infirm, and the muscles small and destitute of true fleshy fibres. The diseased state, called *mollities ossium*, or softness of the bones, is an instance of what may be called a weak mast of the body, which must yield if its muscles be strongly drawn. The state of muscular debility consequent on fever and many acute diseases, or even on sudden fright, is, on the other hand, an instance of the inability of the bones alone to preserve an attitude, or execute motion when the muscular system is weakened by disease. These differences merit attention.

A knowledge of the condition of the bones at different periods of life, is not without its practical uses,—particularly in regulating our treatment of children. In my *Treatise on the Management of Infancy*, I have already shewn that many parents, disregarding the fact that the bones are comparatively soft and pliable in infancy, and in their haste to see the little objects walk without support, are continually soliciting attempts at standing or walking, long before the bones have acquired sufficient power of resistance, and the muscles sufficient power of contraction, to cope with the laws of gravitation. The natural consequence is a curvature of the bone, which yields just like an elastic stick bending under a weight. The two ends approach nearer to each other than they ought to do; and to accommodate themselves to the change, the muscles become shorter on one side, and perhaps longer on the other, each losing part of its efficiency in the unnatural change which it undergoes.

From this view, it will be seen how hurtful leading-strings must be. In the first place, by their mechanical force, they compress the chest and impede respiration; and, in the second, by preventing the body from falling to the ground, or rather by preserving an upright position, they cause more of the weight to fall on the bones of the spine and lower extremities, than these parts are fitted to carry. From this noxious practice, flatness of the chest, confined lungs, distorted spine, and deformed legs, too often originate.

The impropriety of an indiscriminate use of dumb-

* Code of Health, 5th edit. Appendix, p. 35.

* Blaine's Outlines of the Veterinary Art. Third edition, p. 93.

bells in early life, will also be easily understood. If the weight of these be disproportioned to the strength of the *bones*, it is obvious that we must produce the same kind of evil as by premature attempts to walk, viz. yielding of the bones, and stretching and relaxation of their connecting ligaments. If, again, they be disproportionate to the *muscular* power, their effect will be to exhaust instead of increasing the strength of the body.

From the exposition I have given of the laws of exercise, as affecting the muscular and osseous systems, the absurdity of expecting to *strengthen* either the one or the other by the use of stays, or by lying for hours on a horizontal or inclined plane, will be abundantly manifest. There is no royal road to health and strength, and no method by which, while exercise is dispensed with, its advantages can be obtained. *In the intervals between exercise*, reclining on a plane is very useful in delicate fast-growing girls; but it should be resorted to, only when the feeling of fatigue exists, either from previous exercise or from mere sitting up. As soon, however, as this feeling is entirely recovered from, it ought to be discontinued, and never employed for hours and days in succession, without reference to previous weariness, as it often is, on the false notion of its being conducive to strength.

In this chapter, as well as that on the muscles, I have dwelt perhaps too long on the principles by which exercise ought to be regulated; but as the subject is little understood by those who have the direction of youth, and is of paramount importance, I am inclined to hope that the tediousness of repetition may be forgiven, if clearness and conviction are obtained.

CHAPTER VIII.

ON THE BLOOD AND THE ORGANS OF CIRCULATION.

The blood the source of life and nourishment.—Its supply to all parts proportioned to their importance and activity.—Health depends on its proper quality and quantity.—The blood also the source of the secretions and excretions,—and its supply bears a direct relation to their amount.—Example in the kidneys and tears.—The arterial or red blood alone is capable of supporting life, and loses its properties in the act of doing so, and becomes dark or venous. The arteries and capillaries described.—The general or systemic circulation and its uses.—Digestion and respiration the chief sources of arterial blood.—The veins and their course described and illustrated.—The pulmonic or lesser circulation and its uses in converting the venous into arterial blood.—The blood peculiarly the vital fluid.—Causes affecting its quality and their influence on health.—exemplified in all classes of society—in scurvy, cholera, and the effects of transfusion of blood.—All the organs of the body and the mind itself affected by the quality of the blood.—Importance of respiration in its formation.

In the former editions of this work, the next subject discussed was the important function of respiration; but as the chief object of that process is to effect a change in the properties of the blood, it will be useful to give a brief account of the latter before entering upon the consideration of the changes produced in it, in its passage through the lungs.

The blood is the fluid by which the vitality of all other parts of the system is supported, and from which they all derive their nourishment. It is also the source from which all the secretions and excretions are derived, and consequently the medium through which the waste or effete materials are thrown out of the system. Before the food, which is taken into the stomach, can become a part of the living structure, the chyle, which is formed from it by the organs of digestion, must be converted into blood and distributed throughout the body. It is only when thus converted into blood that the nutriment becomes organized or endowed with living properties, and it is only then that it becomes capable of supporting the life and action of the parts to which it is sent.

Within the limits of health, organic activity and the supply of nourishing blood are always proportioned to each other. When a part is sufficiently but not too much exercised, a more vigorous circulation takes place through its vessels, and it increases in size and in power. When it is left inactive, it receives a diminished supply of blood, and becomes comparatively enfeebled. In like manner, when the natural supply of blood to an organ is cut off or diminished, as sometimes happens from tumours pressing upon the principal bloodvessels going to it, its nutrition and its functional power immediately become impaired. As might be expected, similar consequences ensue when the blood itself is imperfectly constituted and inadequate to supply the proper stimulus and the requisite nourishment. This frequently happens among the poor from deficiency of wholesome food; among the rich from an impaired state of the digestive organs; in the consumptive from defective respiration; and in many trades from the impurity of the surrounding atmosphere. An opposite condition of the blood may also exist and equally endanger health. From too full living, aided by a good deal of exercise in the open air, which gives keenness to the appetite and vigour to the digestive powers, blood may be formed in so large a quantity, and of so rich a quality, as to keep the system habitually in a state of excitement bordering on, and easily convertible into, active disease by the application of any accidental cause. Many young men, in what may be termed a florid state of health, are thus cut off after a few days' illness, by some acute disease, often to the great surprise of all around them, although obvious signs of danger may have been long present, if the sufferers had only been sufficiently instructed to be able to understand them.

From these considerations, it follows that a due supply and proper quality of blood, are indispensable to the life, nutrition, and activity, of every organ of the body; and that, for the continued preservation of health, both the supply and the quality of the blood ought to bear a constant relation to the age, constitution, and mode of life of the individual. In youth, when growth is rapid, and the mode of life characterized by activity, a full supply of well-constituted blood is much more essential than in old age when growth is at an end, and the bodily energies have become impaired. In youth, accordingly, the effects of impoverished diet are felt much sooner than in maturity; and hence, in cases of shipwreck and starvation, the young are generally the first to perish.

But the blood, as already hinted, serves other purposes besides those of supporting life and nutrition. It supplies the materials of all the various *secretions and excretions*, and consequently, every secreting and excreting organ receives a supply of blood proportioned to its own size, and to the importance and extent of its function. Thus, the urine is separated or secreted from the blood by the kidneys, and these are, in consequence, provided with arteries of a size corresponding to the average copiousness of their secretion. In like manner, the perspiration is derived from the blood, and we have already seen in what profusion its vessels are distributed to the skin. The excretion from the bowels is another example of a similar correspondence. The bland and oily fluids which lubricate the joints, the mucus which moistens the air-passages, and the tears which bedim the eye, are all instances of *secretions* derived more or less directly from the blood, and they cease to be formed if the supply of blood to their respective organs be arrested. In the case of the tears, indeed, we can often see this direct relation between the secretion and

the activity of the circulation in the vessels which furnish it. In the natural state of the eye, no bloodvessels are visible on its surface, and the tears are secreted only in sufficient quantity to moisten that organ. But when a particle of dust or lime comes into contact with, and irritates, the eyeball, an instantaneous redness is observed to ensue, and innumerable vessels appear as if just called into existence. This redness arises from the increased afflux of blood, produced by the irritation, forcing its way into vessels previously too small to admit its red particles; and the immediate consequence is, an increase of the secreting function to so great an extent that the natural channel becomes insufficient to convey the tears fast enough into the nose, and hence they overflow the cheek sometimes with considerable rapidity.

This increased activity under an additional supply of blood, is an exact type of what happens in every organ when it is stimulated to a *moderate* extent. Its vessels then enlarge and receive more blood, and its function becomes more energetic. If, however, the stimulus be carried too far, *diseased* action will follow, and the regular or physiological order of events become interrupted, so that the function may be even altogether arrested.

The greatly increased quantity of blood which is thus directed towards a secreting organ when in full activity, may be easily conceived from what happens in the case of the kidney, when its function is highly excited. It is a matter of common remark, what a copious discharge of urine often follows within a few minutes after drinking a pint or two of mineral water in a cold morning, or on going into the open air in winter after leaving a convivial party in a warm room. But as every drop of the urine thus rapidly thrown out is secreted *from the blood sent to the kidneys*, it is obvious that the whole quantity of blood circulating through them at that time, must have been very large; otherwise no such extensive secretion could have taken place.

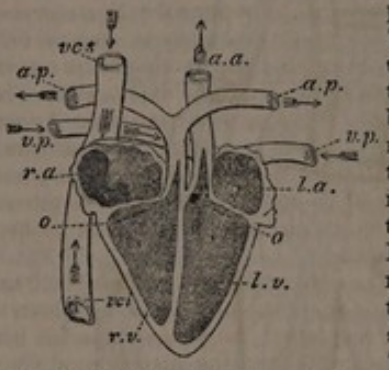
The blood which thus supports life, imparts nourishment, and furnishes the materials of the secretions and excretions, is called the *vital*, *red*, or *arterial* blood. The first name is derived from its exclusive property of *sustaining life*; the second from *its florid red colour*; and the third from the vessels or *arteries* in which it is contained. It is this blood we have now to speak.

In man and the higher classes of animals, the *arterial* or *vital* blood is of a florid red hue, but in many invertebrate animals it is entirely colourless. As already mentioned, it is the arterial blood alone which is capable of supporting life and yielding nourishment to the different parts of the organization, and from the moment that it ceases to be supplied to any part, that part begins to decay and die. By the very act, however, of thus supporting life and carrying on nutrition, the arterial blood itself undergoes a change. It loses its bright red colour, assumes a darker hue, and is found to be no longer available for its former purposes. These changes do not take place to any visible extent in the larger arteries, which may therefore be regarded, in a general sense, as serving only for the *conveyance* of the blood. It is in the very minute subdivisions or branches by which the nutrient particles are deposited in the tissue of all living parts, that the change from the arterial to the venous character is first observed.

From the arterial blood being indispensable to the continuance of life and nutrition, it follows that it must, by some means or other, be distributed in due quantity *to every part* of the living body. The solid parts being fixed and immoveable in their respective places, they cannot go in quest of blood, and thus the only alternative is that the blood be brought to them. But it is not sufficient that arterial blood be sent *once* to every organ of the body. By the very act of supporting life and imparting nourishment, the arterial blood itself undergoes a change, and loses its characteristic properties. Hence the supply must be *continuous* and proportioned to the nature and activity of the part. Such accordingly is the fact. The current of vital blood *is* continuous, and ceases only with the extinction of life; and our next step is to investigate the means by which that supply is effected with the required regularity and constancy.

Putting all other questions out of sight for the present, I may mention that the arterial blood is sent as fast as it is prepared to the *left side of the heart*, as the fountainhead from which it is distributed throughout the body. At this point, therefore, we shall take it up.

In the annexed woodcut representing a section of the heart, the two sides are seen separated by a white perpendicular line. The letters *v c s*, and *v c i*, indicate the two *venæ cavæ* by which the venous blood is returned from the rest of the body to the *right auricle r.a.* From the right auricle it passes by the hole *o*, into the *right ventricle r.v.* The venous blood next enters the *pulmonary arteries a.p.*, *a.p*, to go to the lungs, whence it returns *arterialized* by the *pulmonary* veins *v.p.*, *v.p.*, to the *left auricle l.a.* The arterial blood next passes through the orifice *o*, into the *left ventricle l.v.*, to be distributed through the body by the *aorta a.a.* The right auricle and ventricle constitute the *right side* of the heart, and contain *venous* blood. The left auricle and ventricle constitute the *left side*, and contain *arterial* blood. For the sake of simplicity we shall, at present, confine ourselves to the distribution of the arterial blood.

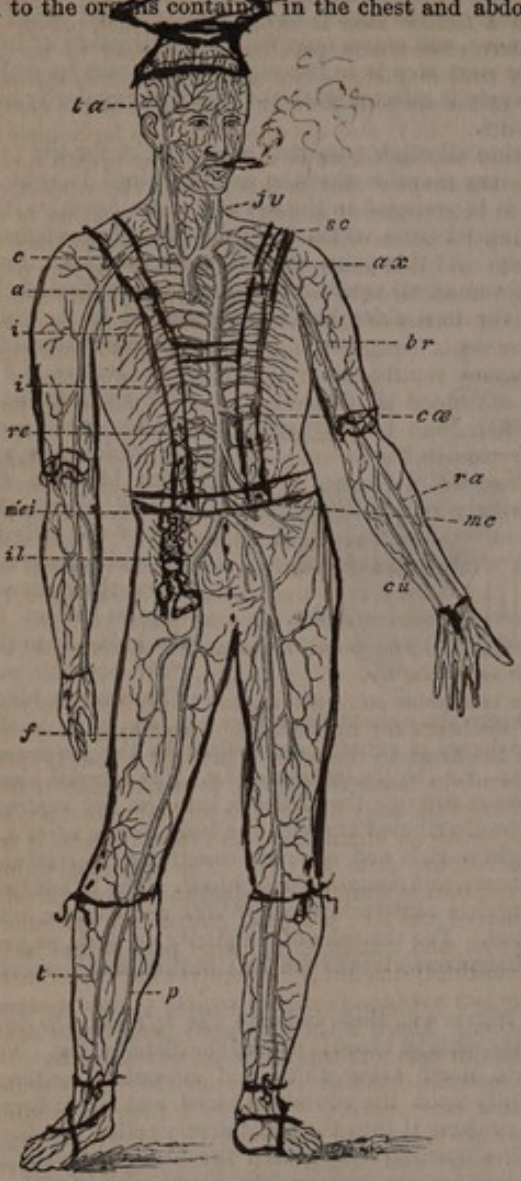


The letters *l.v.*, then, indicate the *left ventricle* into which the arterial blood is poured for distribution. The ventricle itself being thick and muscular, contracts powerfully upon the contained blood, and like a force-pump, projects it into the great artery called the *aorta*, *a.a.* The opening *o*, by which the blood entered the ventricle from the left auricle, being now shut by a valve which admits of the current flowing only in one direction, the blood cannot retrograde in its course; and as another valve at the beginning of the aorta prevents its return into the ventricle from which it has been expelled, the only channel left open to it is that which it actually follows along the aorta.

By every successive contraction of the ventricle, a fresh quantity of blood is projected into the aorta, and it in its turn impels that which preceded it; just as happens with the successive quantities of water raised or propelled by a pump. It is chiefly by this contraction of the left ventricle that the blood is circulated in the arteries, and what is called *the pulse* is merely the successive dilatation and contraction of the arteries as they receive and contract upon every successive quantity discharged by the heart. Hence, in the healthy state, the pulse and the beating of the heart always correspond and preserve the same relation to each other.

The course of the arterial blood after it has entered the *aorta*, and its gradual distribution through its smaller and smaller branches, will be easily understood from the figure on the next page, representing the aorta *a*, just where it leaves the heart, and its various subdivisions as they spread over the whole body. At *a*, just after leaving the heart, the aorta forms a kind of semicircle, which is thence called the *arch of the aorta*. From the upper part of this arch, the arteries supplying the head, shoulders, and arms, are seen to arise and branch into *c* the *carotid*, *s c* the *subclavian*, *a x* the

axillary, *t a* the *temporal* arteries. At the termination of the arch, the aorta passes downwards along the spine, and gives off branches to the parts lying on each side and to the organs contained in the chest and abdomen,



such as *i i* the intercostals running between the ribs, *cœ* the *cœliac* going to the digestive organs, *re* the *renal* going to the kidneys. At the lower part of the spine it divides in two great branches called the *iliac* arteries, *il*, which pass down and subdivide to supply the lower extremities and lower parts of the trunk. The other letters refer to the names of arteries which need not now be particularized.

As the arteries continue, in the manner above represented, to divide and subdivide into smaller and smaller branches, like the branches of a tree from the parent stem, they ultimately reach a size in the intimate tissues of the organization which renders them almost invisible, and they become proportionally numerous. To appearance they are even smaller than hairs, and hence they are often called *capillary (hair-like) vessels*, or branches of the arteries. So minute are they in size and innumerable in quantity, that the point of the finest needle cannot penetrate the skin without piercing them and drawing blood. When, therefore, the expression *capillary vessels* or *branches*, or simply the *capillaries*, occurs, the reader ought to keep in mind that all of these are merely different names for the continuous and minute subdivisions of the larger bloodvessels; and when the *capillary circulation* is spoken of, it is not a distinct entity which is meant, but merely that part of the general circulation which is carried on by the minute branches of the larger bloodvessels. Strictly speaking, the capillaries form a kind of network of almost microscopic vessels between what are considered the terminations of the arteries and the commencement of the veins, and are consequently common to both. But in a general sense, the capillary vessels and circulation bear much the same relation to the larger bloodvessels and circulation, which the small gas or water pipes distributed through a private house do to the main pipes and larger subdivisions extending along the streets and alleys. They are all parts of the same great whole, and the venous capillaries are merely those branches by which the now venous blood is transmitted from the arterial capillaries to the extremities of the veins.

As it is in the capillaries that the changes incident to nutrition and the support of life take place, and that the arterial blood loses its florid colour and characteristic properties, it follows that if the now exhausted blood were not sent away, and its place supplied by fresh arterial blood, the part would speedily die. We have, therefore, next to shew what becomes of the blood after it has given out the nutrient particles and the various secretions and excretions already referred to, and thereby lost its vital power.

The principal means which the Creator has appointed for renewing and restoring the lost properties of the arterial blood, are the digestion of food and the process of respiration. By the former, fresh materials of nutrition are supplied in the form of chyle, as fully explained in my work on Digestion and Diet; and by the latter, the now dark blood absorbs a portion of oxygen, and gives out the excess of carbon, the presence of which is the chief cause of its being no longer capable of supporting life. But before the chyle can be converted into vital blood, it also must be subjected to the process of respiration; and hence in man and the more perfect animals, the dark blood and the chyle must be made to pass together through the lungs or organs of respiration before arterial blood can be formed from them. The next step in the circulation, therefore, is, *to trace the blood from the remote capillary branches of the arteries where we left it to the lungs or organs of respiration.*

On carefully observing with a microscope the circulation in the thin membranous web of the foot of a frog, the red blood is seen to pass from the minute arterial capillaries into other vessels equally minute and numerous which gradually coalesce into larger and larger branches, and these again into others still larger, just as the fine roots of a tree gradually unite and at last terminate in one common stem. These minute vessels are also termed capillaries, but, from their containing dark blood, they are named *venous*, to distinguish them from the others as *arterial* capillaries. In point of fact, however, the two are continuous, and analogous in structure and appearance. The only differences are, that the blood which they contain is *dark* or *venous*, and that the course which it follows is exactly *the opposite* of that in the arteries. Thus the venous blood proceeds from all parts of the body *towards the heart*; while the arterial, as we have seen, proceeds *from the heart* towards all other parts. The two thus form a current and counter-current, and these two currents constitute what is called the *general*, *systemic*, or *larger* circulation, the capillaries being merely the small vessels intermediate between the larger branches of the arteries and veins.

Of the course of the veins no particular description need be given, as it is nearly the same as that of the arteries. In most instances, indeed, the deeper seated veins and arteries lie side by side; but frequently there are two veins where there is only one artery. The more superficial veins, such as those seen on the back of the hand, on the arm, and legs, do not accompany arteries. The branches of the veins, in common with those of the arteries, every where communicate freely with each other by what are called *anastomosing* or cross branches;

and by this arrangement, when the current is for a time accidentally stopped in one vessel, the blood can always find a passage by another.

From the blood running in opposite directions in the arteries and veins, it follows that when a wound is inflicted, a different method must be employed to arrest the loss of blood according as it proceeds from an artery or a vein. If an artery is laid open and red blood is flowing, the pressure or ligature ought to be applied on the side *nearest the heart*; whereas if a vein is wounded and dark blood escapes, the pressure should be applied on the side *farthest from the heart* or beyond the wound. We see this principle exemplified in common bloodletting. The object being then *to cause the blood to flow*, the ligature is always placed nearer the heart than the intended puncture, so as to intercept the current upwards from the hand and fore-arm. When it is wished to stop the flow of blood, the ligature is removed. To those unacquainted with anatomy, the florid or dark colour of the blood which escapes from a wounded vessel will indicate whether it proceeds from an artery or a vein, and whether the chief pressure should be applied above or below the wound.

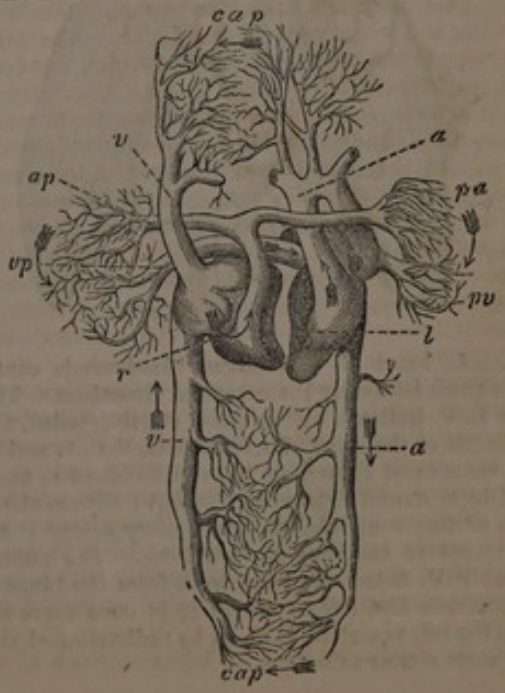
The object of the dark blood being thus returned to the heart by the veins is, that, after receiving the nutriment prepared from the food in the form of chyle, it may then be *transmitted through the lungs, there to undergo the changes required for imparting vital properties to the chyle, and re-converting the venous into vital blood.* This transmission is effected in the following manner.

We have already stated that the vital blood is transmitted by the *left* side of the heart into the aorta *a* for general distribution. By the veins, however, it is returned to the *right side of the heart.* From the head, arms, and upper part of the body, the dark blood returns by a variety of veins, which ultimately terminate in one large trunk called the *vena cava superior*, or *descendens* (the superior or *descending* hollow vein), *v c s*, in the figure of the heart on p. 51. From the inferior extremities and lower part of the body, the venous blood is returned by a great number of veins which, in like manner, ultimately coalesce into one trunk, called the *vena cava inferior*, or *ascendens* (the inferior or *ascending* hollow vein), *v c i*, in the figure. These two great veins are seen to terminate at one common point, where their two currents accordingly meet, as indicated by the arrows, in the cavity termed the *right auricle of the heart*, *r a.* The venous blood being the proper stimulus of the auricle, causes it immediately to contract, and the necessary result is to propel its contained blood, in the direction of the arrow, through the opening *o*, into the triangular-looking cavity called the *right ventricle r.v.* The right ventricle is now in its turn stimulated to powerful contraction, and, as a valve at *o* prevents the return of the blood into the auricle, the current must once more flow, in the direction of the arrow, into the large vessel seen at its upper corner, and called the *pulmonary* or *lung artery.* This artery divides into two branches, *a.p.*, *a.p.*, one going to each of the two lungs, and spreads through their substance in endless ramifications, of infinite minuteness, resembling the capillary vessels already described. These minute capillaries are ramified extensively upon the delicate lining membrane of the innumerable air-cells of the lungs; and it is while circulating through them that the dark blood, by absorbing oxygen from the inhaled air and giving out its carbon in the form of carbonic acid, becomes converted into arterial blood.

To an uninformed person, it may seem impossible that any chemical action should take place between the blood and the external air when the membranous structure of the air-cells is interposed between them. This, however, forms no obstacle to the requisite changes taking place, for it is found by experiment that venous blood is acted upon by the air even through the thick and firm texture of bladder. Of late years, too, it has been discovered, that both living and dead tissues give passage to gases and fluids by a peculiar interchange of particles, termed *endosmosis* and *exosmosis*, processes which I cannot stop to explain, but which play a part in many phenomena previously supposed to be of a purely vital character. Not only, indeed, does the membrane of the air-cells present no obstacle to the changes alluded to, but it also gives passage to a large quantity of watery vapour which is visible in the breath thrown out by the lungs. But as this part of the subject will come to be considered more fully when treating of respiration, I shall now leave it, and proceed to trace the course of the blood onwards to our original starting point.

The venous blood being thus reconverted into arterial in the capillaries of the air-cells, proceeds onwards into another set of equally minute vessels, corresponding to the venous capillaries of the general circulation. In these the blood is observed to have resumed its florid red colour, and to have changed its direction. It is now transmitted from very minute to larger and larger branches, till the latter at last coalesce, and form the large venous trunks called the *pulmonary veins v.p.*, *v.p.*, in the woodcut of the heart on page 51. These veins collect all the newly arterialized blood from the two lungs, and convey it to the *left auricle of the heart*, *l.a.*, by the contraction of which the vital blood is once more transmitted to the point from which we started, viz. the *left ventricle*, *l.v.*

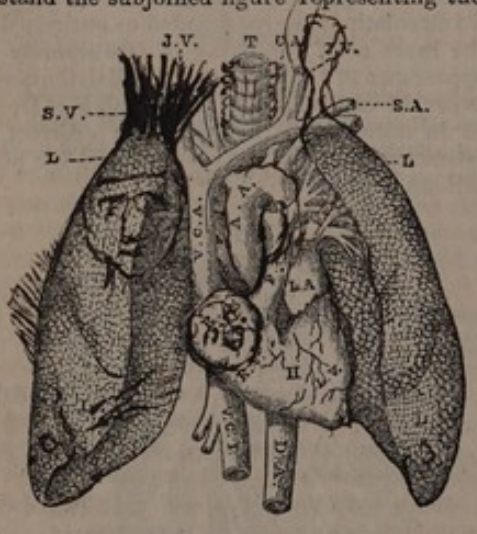
This transmission of the venous blood from the right side of the heart through the lungs, and back to the left side of the heart in the form of arterial blood, is called *the pulmonic* or *lesser circulation*, to distinguish it from that through the body formerly described as the general, *systemic*, or *larger* circulation; and their objects, it will be observed, are quite distinct. The use of the pulmonic circulation is simply to subject the venous blood to the action of the air; whereas, that of the systemic is the support and nutrition of every part of the body; and accordingly the lungs themselves receive branches *for their own nutrition* from the vessels of the systemic circulation. There is thus, properly speaking, *a double circulation* in man and the more perfect animals. But as it is essential that the reader should clearly understand this arrangement, I subjoin a diagram in which the two circulations are represented as entirely distinct, and the heart as if consisting of two *separate* halves. The appearance of the heart and the distribution of the vessels are, of course, artificial and different from what is seen in nature, but they will give a correct idea of the distinction between the systemic and the pulmonic circulations.



Starting as before from the *left ventricle*, *l*, the vital blood passes into the aorta at *a*, and is thence distributed by the arteries, *a*, *a*, which branch out as already described till they terminate in the very minute capillary ramifications, *c a p*. These arterial capillaries are seen to join with the equally minute venous capillaries, which coalesce into larger and larger branches of veins, till at length they form the two ascending and descending *venæ cavæ*, *v v*, which terminate at the *right auricle* of the heart. This includes the whole of the systemic circulation. In the diagram, it is represented by the *upward* and *downward* vessels, and the course of the blood is indicated by the direction of the arrows.

Arrived at the *right auricle*, the venous blood passes into the *right ventricle*, *v*, from which, as indicated by the bent arrow, it is propelled into the *pulmonary artery*, *a p* and *p a*, to be distributed to the two lungs. In one sense it is a misnomer to call it an *artery*, as it contains venous blood; but it has received that name partly from its structure, and partly from its bearing the same relation to the right ventricle which the aorta does to the left, and from its branching out into smaller and smaller ramifications just as an artery does. On arriving at the *pulmonary capillaries*, the venous blood regains its florid colour and life-supporting properties, and is thence collected by the venous capillaries which coalesce into larger and larger branches, and ultimately unite to form the pulmonary veins, *v p* and *p v*, which, as formerly mentioned, return the now arterial blood into the left auricle of the heart, and thence into the left ventricle, *l*, from which we started. This shorter course is called the *pulmonic* or *lesser* circulation, and in the diagram it is represented by the vessels branching out *horizontally* to the right and left where the lungs are supposed to be. The sole object of this circulation is the aëration of the venous blood, and consequently it varies in the different classes of animals, according to the mode in which the aëration is effected. Here also it is, however, necessary to explain, that the pulmonary veins, although containing *arterial* blood, take the name of veins from their structure and mode of distribution.

Having now explained the course of the blood throughout both circulations, the reader will be able easily to understand the subjoined figure representing the lungs



L L L L, heart H, and larger bloodvessels connected with them in nearly their natural situations. The letters L. V. indicate our original starting-point, the left ventricle of the heart, A.A. the aorta, V.C.A. and V.C.I. the venæ cavæ returning the venous blood to the right auricle R.A. and right ventricle R.V. From the upper part of this ventricle, the pulmonary artery P.A. may be traced to the root of each lung. The pulmonary veins P.V. bring the blood back from the lungs to the left auricle L.A., from which it is once more thrown into the left ventricle, L.V., to be redistributed and run the same course as before.

On the present occasion. it would be entirely foreign to my purpose to enter upon a detailed or scientific investigation of the properties, sources, and uses of the blood. My principal object is to consider it only as connected with the subject of respiration treated of in the following chapter; and the few remarks which I shall now make will therefore be of a very general nature.

If the term vital can be justly applied to one part of the animal economy more than another, the blood may be said to be peculiarly the *vital fluid* of the body. It is not only the direct support of life in all other organized parts, but it is the medium by which the external and inanimate matter contained in the food becomes organized and endowed with life. On the proper qualities and due renewal of the blood, therefore, the health and welfare of every living part, and of the system at large, must essentially depend. If, from defective food or bad digestion, the blood be insufficiently supplied with nourishing chyle to replace its waste, the general health must necessarily suffer, because every organ will then be partially deprived of its healthy support and stimulus. If, from excessive labour, the waste from the system be also rendered excessive, and the food be of merely the usual quantity and quality, a gradual deterioration of health will again ensue, because the proper constitution of the blood will be altered. In like manner, if the food be innutritious or unwholesome in quality, the formation of well-constituted blood will cease, and that which is supplied will prove insufficient for the continued preservation of health and life. And, again, if the air which we breathe be impure or of an unusual temperature, the proper aëration of the blood in the lungs will be prevented, and the blood, consequently, be rendered partially unfit for its destined purposes in the animal economy, and the health become impaired.

In society, examples of all these departures from the physiological or healthy standard unfortunately abound. Among the poor, how many thousands constantly suffer from their blood being impoverished by insufficient food, joined to excess of labour and impurity of air! How many also, even among the rich, have ill-constituted blood flowing in their veins owing to impaired digestion or excess in regimen! Of the influence of innutritious food on the qualities of the blood, we have familiar examples in the effects of salt provisions in producing scurvy and altering the state of all the circulating fluids. The influence of a scanty diet also is visible in the unhealthy condition of the inmates of some of our workhouses. Not to speak vaguely, I may refer to the condition of the children in the West Church Charity-Workhouse at Edinburgh in 1838. Fifty of them, being one-fourth of the whole number, were then afflicted with scrofulous ophthalmia; seventeen died consumptive within seven months, and there were thirty-six cases of fever. An inquiry into the causes of this unusual sickness and mortality took place, and proved them to proceed from inadequate diet and clothing, and an immediate improvement followed a more liberal allowance of food.* A similar instance is mentioned by Mr Combe in his "Notes on the United States of America" (vol. ii. p. 253), when describing the asylum for coloured orphans at New York. Out of between 50 and 60 inmates, no fewer than fifteen died within eighteen months, while many more suffered from disease. On examination, these results were found to be chiefly owing to a defective diet, and on this cause being removed, a year passed without the occurrence of a single death! But for the farther elucidation of this subject, I must refer the reader to my work on "Digestion and Diet" already alluded to.

Of the deteriorating influence of impure air upon the healthy constitution of the blood, proofs everywhere

* Chambers's Edinburgh Journal, 2d and 19th February 1839.

abound, but as these will be fully considered in the next chapter, when treating of the function of respiration, it will be needless to enumerate them here.

Aided by these remarks, the reflecting reader will be able to appreciate the powerful and direct influence which the good or bad condition of the blood exercises upon the general health and vigour. Where, from neglect of the organic laws, the constitution of the blood has become impaired, bad health will never be far distant; and, on the contrary, where all the conditions for the formation of good blood are fulfilled, the greatest facilities which the system can still afford for the recovery of health will undoubtedly be enjoyed. Let those who are not aware of the extent of this influence, consider what occasionally occurs in disease, and they will obtain a more correct idea of the fact. Cases are not wanting, for example, in which women in childbed, apparently at the gates of death from loss of blood, have been resuscitated, and ultimately restored to health by having blood from a healthy person transfused into their veins. In cholera also, in which the blood almost ceases to circulate and undergoes a greater change than in perhaps any other disease, being dark and thick even in the arteries, an extraordinary and instantaneous resuscitation has been observed to follow the injection of a largely diluted solution of soda into the veins. In many cases in which this remedy was tried by the late Dr Mackintosh, the patients lay without perceptible sense or motion, almost as if already dead; and yet before the whole of the fluid was injected, they were sitting up in bed talking and apparently well. The effect, unfortunately, was not permanent, for in most of them the fluid was drained off by the bowels in a short time, and collapse again ensued. But it was nevertheless sufficient to shew, in a striking manner, how much the whole animal machine is under the influence of the blood, and how directly it is affected by any change in its qualities.

The original formation of well-constituted nourishing blood, and the proper reconversion of venous into life-sustaining blood, thus become most important processes, not only in the preservation and restoration of health, but in enabling all the organs of the body to work with efficiency and vigour. Even the mind, the affections, and the dispositions are directly influenced by the good or bad quality of the blood, because the co-operation of the nervous system is indispensable to the action of the mental faculties, and consequently, when the brain is imperfectly sustained by the blood, their tone and activity also become reduced. We have, therefore, the greatest interest in making ourselves acquainted with, and fulfilling all the conditions required for the restoration of the lost properties of the venous blood; and having already in my other work fully discussed all of those connected with the reception and digestion of the food, it now only remains for me to explain the conditions connected with the important function of respiration. This I shall attempt to do in the following chapter.

CHAPTER IX.

THE LUNGS, THEIR STRUCTURE AND FUNCTIONS.—RESPIRATION AND ITS USES.

Respiration defined—nearly analogous with sanguification and aëration of the blood.—The lungs the organs of respiration in man—the gills in fishes—and air-holes in insects.—The structure of the lungs—the air-cells—the vessels and tissue of the lungs.—The changes in the air and blood during respiration.—Quantity of air inhaled—constitution of air required for breathing.—Air as indispensable to fishes, insects, and plants, as to man.—Quantity of blood subjected to the action of the air in the lungs—changes produced in it.—Pure atmospheric air alone adapted for respiration.—The production of animal heat depends on respiration.—Analogy between combustion and respiration.—Important practical results.

The word *respiration*, as employed in ordinary conversation, signifies the mere act of breathing or of inhaling and expelling air from the lungs. But, as often used physiologically, it designates not only the act of breathing, but the whole series of phenomena connected with the conversion of venous into arterial blood. In this latter sense, however, the terms *sanguification* and *aëration of the blood*, also in general use, are more appropriate in themselves; because, while they apply with equal accuracy to all classes of animals, the term respiration is almost irrevocably associated in the public mind *with the existence of lungs*—a condition which is so far from being indispensable to the process, that in fishes and many of the less perfect animals, which have no lungs, the aëration of the blood, nevertheless, goes on with the same regularity as in man.

When we consider the variety of circumstances under which the different classes of animals exist, it becomes obvious that the same kind of apparatus could not possibly serve for the aëration of the blood in them all. Lungs, for example, are admirably suited for man, quadrupeds, and birds, which live and breathe in the atmospheric air, and die when immersed in water; but they would be very ill adapted for fishes which live in water and perish in the open air. Fishes, therefore, have no lungs; but what is a great deal better for them, they are supplied with *gills*, so constructed as to present a prodigious extent of surface for the necessary ramification of the bloodvessels and capillaries, and for the exposure of the blood contained in them to the contact of the air which is intimately mixed in greater or less quantity with the water in which they live. By this arrangement, the same changes are effected in the venous blood passing through the gills of fishes, as in the venous blood circulating through the lungs in the higher classes of animals.

In worms, again, and other animals of a similar structure, no single organ is set apart for the conversion of venous into arterial blood. The requisite changes take place in small sacs or vesicles commonly placed in pairs along the back and opening upon the surface of the body, by means of pores in the skin, called *spiracula*, specially adapted to this end, and which cannot be shut up or obstructed any more than the real lungs or gills, without inducing death. "In the common earthworm there are no less than 120 of these minute air-vesicles, each of which is provided with an opening placed between the segments of the body. In the leech, the number is reduced to sixteen on each side, which open externally by the same number of minute orifices."* So necessary, indeed, is atmospheric air to the vitality of the blood, in all classes of animals, and even to plants, that its abstraction inevitably induces death: and a fish can no more live in water deprived of air, than a man can do in an atmosphere devoid of oxygen. And thus the fish requires a renewal of air, and perishes when it is denied, or when the air is expelled from the water by boiling, exactly as man would do under a similar deprivation.

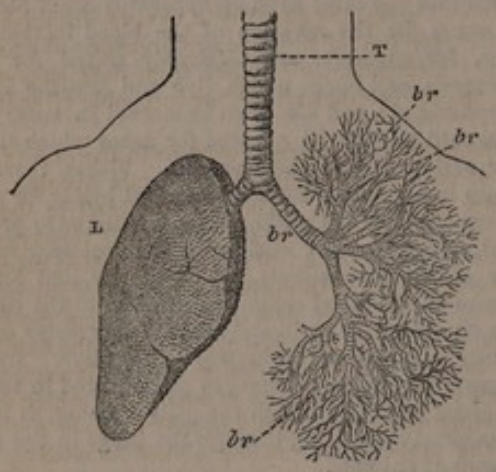
In man, *the lungs* are those large, light, elastic, and spongy bodies, which, along with the heart, completely fill the two lateral cavities of the chest. They vary much in size in different persons, and, as the chest is framed for their protection, and moulded on their form, we find it either large and capacious, or the reverse, according to the size which the lungs have attained. In women and in youth, the lungs are less developed than in men and in mature age, and hence the smaller

* Smith's Philosophy of Health, vol. ii. p. 29.

breadth of shoulder and greater narrowness of chest by which the former are characterized.

In the figure on page 54 we have already seen the external appearance of both lungs, and the position which they occupy relatively to the heart and large bloodvessels. The substance of which they are composed, consists of *bronchial tubes, air-cells, bloodvessels, nerves, exhaling* or *excreting* vessels, *absorbents*, and the cellular membrane or *parenchyma* which binds all these parts together.

The appearance and distribution of the *bronchial tubes*, or *bronchi*, will be understood from the subjoined figure, in which the right lung L is represented in its natural situation in the right cavity of the chest; while on the left side the substance of the lung is supposed to be removed, leaving only the *bronchi*, *br*, *br*, *br*, *br*. On following the windpipe or trachea T downwards from the neck, we find it first dividing into two large branches, one going to each lung, and then subdividing into the innumerable ramifications *br*, called the bronchi. The bronchial tubes, then, are merely the minute subdivisions of the windpipe; and their purpose is to convey the air from it into the air-cells of the lungs.



The *air-cells* are very minute rounded vesicles or shut bags, smaller in size than pin-heads, in which all the minute ramifications of the bronchial tubes terminate. They are so very numerous, that, when fully distended by air, they seem to constitute the chief part of the pulmonary tissue. Keil estimates their entire number at 174,000,000, and calculates the surface they present to the air as equal to 21,900 square inches. Lieberkuhn rates the latter at 150 cubic feet; and Monro, again, at thirty times the surface of the human body.* The diameter of each air-cell is stated by Hales and other physiologists at the 100th part of an inch. It is very probable that these estimates are not entirely correct; but the very magnitude of even the lowest of them will give the reader an idea how great the number, and how vast the extent of surface, of the air-cells must really be to warrant such calculations being seriously founded upon them.

Numerous, however, and closely compacted as the air-cells are, they have no direct communication with each other; but, according to Reissessen, a small artery, with its accompanying vein, goes to each of them, and, by its ramifications upon the fine, thin, and continuous membrane with which they are lined, forms upon it a kind of network of capillary vessels; and it is while circulating through these capillaries, and exposed in them to direct contact with the air in the air-cells, that the blood undergoes the change from the venous to the arterial state.

Bloodvessels necessarily form a large constituent portion of the substance of the lungs. Besides the arteries and veins which the lungs possess in common with other parts for the purposes of nutrition, they have, as we have seen, the large pulmonary arteries and veins, dividing everywhere through their substance into innumerable branches, conveying *the whole blood of the body* to and from the capillaries of the air-cells. Indeed, from the rapidity with which the blood performs its circuit through the body, in rather less than 2½ minutes, and the quantity which consequently passes through the lungs in a given time (being, according to Müller, not less than *ten pounds in a minute*), it is clear that the vessels of these organs *must* be so large as to constitute no small portion of their tissue; otherwise such a mass of blood could not flow through them so quickly.

The lungs, it need hardly be said, are provided with *nerves*. The sobbing attendant on grief and the hurried breathing which accompanies excitement, are clear proofs of the powerful and direct action of the nervous system in respiration; and it is certain that, without the constant influence of the nervous stimulus, both their life and special function would speedily cease.

When treating of the skin as the seat of a copious exhalation of waste matter from the system, I mentioned that in this respect the lungs were somewhat analogous to it, as they also are the seat of an abundant exhalation, and consequently are provided with *exhaling* or *excreting vessels*. Every one who has observed the clouds of vapour issuing from a horse's nostrils in a cold day, must be aware of the existence of this exhalation. Even when invisible it still goes on, the proof of which is the familiar test of holding a cool mirror near the mouth of a person apparently dead, to ascertain whether breathing has entirely ceased. The quantity of watery vapour thus exhaled by an adult in 24 hours, has been estimated by Müller, from the average of many experiments, at 7963 grains, or *nearly seventeen ounces*. The pulmonary exhalation is in fact one of the outlets of waste matter from the system; and the air, which we expel from the lungs in breathing, is thus vitiated, not only by the subtraction of its oxygen and the addition of carbonic acid, but also by watery vapour and animal effluvia derived from the exhalants. In some individuals whose bowels are habitually disordered, this last source of impurity is so powerful as to render their breath offensive, and even insupportable to the bystanders. The presence of this effluvia in a concentrated form, is, in common with perspiration, one of the chief sources of the disagreeable sickening smell which prevails in crowded rooms.

That the lungs are also provided with *absorbents*, is proved by the fact that absorption takes place from the lining membrane of the air-cells more easily and rapidly than it does by the skin. When a person breathes an atmosphere loaded with fumes of spirits, of tobacco, of turpentine, or of any other volatile substance, a portion of the fumes is taken up by the absorbing vessels of the lungs and carried into the system, and there produces precisely the same effects as if introduced into the stomach: dogs, for example, have been killed by being made to inhale the fumes of prussic acid for a few minutes. The lungs thus become a ready inlet to contagion, miasmata, and other poisonous influences diffused through the air which we breathe. Hence typhus fever is much more easily communicated by breathing the confined and loaded air near the body of the patient, than even by touch. Hence, also, the general safety of the attendants where ventilation is sufficiently observed. The frequent renewal of the air dilutes and carries off the poison.

The *parenchyma* of the lungs is merely the substance which connects all their other tissues and vessels together. It may thus be more intelligibly described negatively than positively. That part of the pulmonary structure which does not belong to the bronchial tubes, air-cells, bloodvessels, nerves, glands, exhalants, or absorbents, is *parenchyma*. Hence we have parenchyma in the liver, in the kidneys, and in other organs where it designates a similar connecting substance.

* Smith's Philosophy of Health, vol. ii. p. 48.

Having now given a general idea of the structure of the lungs, let us next examine the changes which occur in the constitution of the air and of the blood during the process of respiration, and the conditions upon which these changes depend.

Atmospheric air consists of 79 parts of nitrogen gas, 21 parts of oxygen, and a very small quantity of carbonic acid, not amounting, according to Saussure, to more than 4.15 in 10,000 parts. The proportion of carbonic acid varies, however, in different situations, and is larger in towns than in the open country, but nowhere is it found to exceed perhaps one-fifth, or at most one-half per cent.

The *quantity* of air taken into the lungs at each inspiration varies according to the age, constitution, and circumstances at the time. It has been variously estimated at from 15 to 40 cubic inches. Sir Humphrey Davy valued it so low as from 13 to 17 cubic inches. Herbst again states, that adults of large stature breathing tranquilly, inspire from 20 to 25 cubic inches; and persons of smaller stature from 16 to 18.* Menzies, on the other hand, who also experimented with great care, estimates the amount at 40 cubic inches. Southwood Smith states, that the largest quantity ever inhaled at one inspiration is nine pints and a quarter. He adds, that the quantity received at an ordinary inspiration without any effort at all, is about one pint Winchester measure; while at an easy inspiration, *free from any great effort*, it amounts to 2½ pints (vol. ii. p. 8). Females take in a smaller quantity than males.

The popular notion that the whole of the air is expelled from the lungs at each expiration, is entirely erroneous. Even after forcing out as much as we can, it is calculated that at least 40 cubic inches remain in the air-cells; while, after an ordinary expiration, about 120 inches remain behind. According to Sir H. Davy, the whole quantity of air in the lungs after a natural inspiration, amounts to 135 cubic inches; so that, taking an ordinary inspiration and expiration at 20 inches, the quantity of air remaining in the chest is at least *five times greater* than that expired. Dr Smith estimates the quantity of air remaining at eleven pints. It is by this continuance of the air in the lungs that its requisite action on the blood is rendered continuous, and has time to take place, and also that we are enabled for a time to "hold the breath," as it is called, when under water, as in diving. Without this stock to continue the oxygenation of the blood, diving would be immediately fatal. The average number of respirations varies in health from fourteen to twenty in a minute. In disease, it is often much greater, and sometimes also considerably less.

With these data to guide us, we can now form a correct conception of the extent to which a constant renewal of the air we breathe is required for the support of human and animal life. Taking the consumpt of air at each inspiration at even the moderate rate of 20 cubic inches, and rating the number of respirations at only 15 per minute, it appears that, in that short space of time, no less than 300 cubic inches of air are required for the respiration of a single person. But to place this in a still more striking light to the general reader, I shall extract from the excellent work of Dr Southwood Smith (vol. ii. p. 84), the results of some very careful and elaborate calculations made for him by Mr Finlaison, the celebrated actuary, from data communicated to him for the purpose.

Mr Finlaison estimates the fresh air inspired in one minute of time at 616 cubic inches, or, "as nearly as may be, eighteen pints." In one hour, it amounts "to 1066⅔ pints, or 2 hogsheads, 20 gallons, and 10⅔ pints!" In one day, it amounts "*to* 57 *hogsheads*, 1 *gallon, and* 7¼ *pints!*"

To this quantity of air are presented for aëration in one minute of time 144 ounces of blood, being 259½ cubic inches, or nearly an imperial gallon. In one hour, 540 pounds avoirdupois, or 1 hogshead, and 1½ pints; and in twenty-four hours, 12,960 pounds, or 10,782½ pints, or 24 hogsheads and 4 gallons. Or, in other words, "there flow to the human lungs every minute nearly 18 pints of air, and nearly 8 pints of blood;" and "*in twenty-four hours, upwards of* 57 *hogsheads of air*" *are inhaled to oxygenate* "24 *hogsheads of blood!*"

Before entering the lungs, the atmospheric air consists, as we have seen, of twenty-one parts of oxygen and seventy-nine of nitrogen, with a very small trace of carbonic acid. When it is expelled, however, it is found to be greatly altered. The bulk of the air expired continues to be nearly equal to that inspired, but, on analyzing its composition, we now find that rather more than eight out of the twenty-one parts, or nearly two-fifths of the oxygen, have disappeared; that their place has been supplied by an equal volume of carbonic acid. The nitrogen is the only constituent which remains almost unaltered. Along with this expired air, a large quantity of watery vapour and some animal matter are also thrown out. If the same air is breathed again and again, the quantity of oxygen diminishes still further, and that of carbonic acid increases at every successive respiration, till at last, from deficiency of oxygen, the air becomes altogether incapable of sustaining life.

Precisely the same changes occur in the case of fishes, and of animals breathing by spiracula opening on the surface of the body. The air contained in the water passing through the gills of fishes, loses its oxygen and acquires carbonic acid. The same alteration takes place in the air expelled from the air vesicles of the worm or the leech. In every class of animals, from the highest to the lowest, the presence of oxygen in the fluid which they breathe is thus essential to the continuance of life. Hence is derived the name of *vital air*, by which oxygen is distinguished from carbonic acid or *fixed air*, which has the property of causing almost immediate death when inhaled into the lungs.

It may be thought that if oxygen be really the life-sustaining part of the atmospheric air, life should go on better by increasing the proportion of it in the air we breathe, and that invalids might therefore be restored to health by causing them to inhale a highly oxygenated air. To a certain extent the inference is just; and accordingly we find that an animal placed in a vessel full of pure oxygen breathes with greater energy and lives longer than in the same bulk of common air, in the proportion of fourteen minutes to six minutes (Smith, p. 86). But as the function of respiration and all the processes connected with it were originally instituted by the Creator with relation to an atmosphere containing only one-fifth part of oxygen, the excitement in the animal economy, caused by breathing the latter gas in its pure state, is far too great to admit of its being continued for any length of time without inducing disease and the ultimate extinction of life. Similar results follow, although more slowly, even when the proportion of oxygen in common air is only partially increased.

The only kind of air, then, which is calculated to sustain animal life in permanent health and vigour, is that containing the precise ingredients in the precise proportions ascertained to exist in the atmosphere. If the relative quantity of any ingredient be increased or diminished, the proper constitution of the blood will be immediately changed, and the general health endangered. If, for instance, the air contain more carbonic acid than the minute trace of it which exists in pure air, it will be to that extent unfit for the purposes of respiration, and act deleteriously upon the blood and general system. This effect is exemplified in the feebleness, headach, and other symptoms produced by breathing air vitiated by the carbonic acid poured out from several hundred pairs

* Müller's Elements of Physiology, second edition, vol. i. p. 312.

of lungs in a crowded room or church. When the quantity of carbonic acid in the air amounts to ten per cent., it acts as a poison, and renders the air incapable of supporting life. Hence the fatal accidents so common in breweries and other places, from the workmen rashly entering fermenting vats filled with fixed air. Hence also the immediate insensibility of dogs and other animals thrown into the stratum of fixed air, which occupies the lower part of the celebrated Grotto del Cane, near Naples.

If, on the other hand, the quantity of oxygen in the air we breathe be artificially increased, a feeling of active energy is felt at first, which soon passes into morbid excitement; and the more narrowly we observe what is passing around us, we shall become only the more satisfied that the proportion of the ingredients in the air, as determined by the Creator, is the only one conducive to our permanent comfort and welfare, and is consequently that which we should, in all circumstances, and at all times, endeavour to secure as an indispensable condition of really healthy respiration.

Experiments have been made to determine whether respiration could be carried on by means of any other gas, or mixture of gases, than common air. Some which contain oxygen support life for a shorter or longer time in proportion to its quantity; and those which contain none do not sustain it at all. Nitrous oxide, in which oxygen abounds, may be breathed for a few minutes with comparative impunity, and its intensely exciting effects are well known. Other gases seem to act as direct poisons. Thus, air containing $\frac{1}{150}$ of sulphuretted hydrogen destroys a bird, and $\frac{1}{250}$ suffices to kill a horse. Carbonic acid is also poisonous, and acts by producing narcotism and fatal stupor.

The changes effected by respiration in the appearance and constitution of *the blood*, are not less remarkable than those produced on the air. From being of a dark purple hue, it passes immediately to a bright red colour. This change is caused by the action of the oxygen on the red particles of the blood; and it takes place even out of the body when venous blood is exposed to the contact of oxygen. In effecting this change, the oxygen is absorbed, and carbonic acid is exhaled. Arterial blood, accordingly, is stated by Müller to contain more oxygen and less carbon than venous blood. From the experiments of Mayer, Müller, and others, the arterial blood seems to contain more fibrin than venous blood, in the proportion of 29 to 24; and its temperature is also believed to be from 1° to 1½° higher.

During respiration, the properties of the blood undergo as great a change as its composition. The venous blood, from being incapable of supporting life or affording nourishment, and acting even like a poison when again distributed through the body, becomes, by its conversion into arterial blood, the source of vital energy and health to every organized part.

It is not easy to offer a perfectly satisfactory explanation of the various changes described as occurring during respiration. But the probabilities seem to me decidedly in favour of the recent theory of Lagrange and Hassenfratz, who think that the combination of the absorbed oxygen with the carbon of the venous blood takes place not in the lungs but in the course of the circulation, and that the carbonic acid thus formed is only set free on reaching the lungs. According to this view, the formation of carbonic acid takes place in the capillaries of every part, because it is only there that arterial blood loses its bright colour and becomes venous. But, whatever may be the true theory, all physiologists agree as to the fact that the arterialization of the blood in the lungs is essentially dependent on the supply of oxygen contained in the air which we breathe, and that air is fit or unfit for respiration in exact proportion as its quantity of oxygen approaches to, or differs from, that contained in pure air. If, consequently, we attempt to breathe nitrogen, hydrogen, or any other gas not containing oxygen, the result will be speedy suffocation; while, if we breathe air containing a too high proportion of oxygen, the vital powers will speedily suffer from excess of stimulus. All agree, farther, that oxygen is absorbed and carbon given out, and that the process essentially resembles the slow combustion of other inflammable bodies. Hence, the venous blood is sometimes said to be *oxygenated*, and, at other times, to be *decarbonised*, during respiration.

The restoration of the vital properties of the venous blood, is not the only change which is effected during its passage through the lungs. The *development of animal heat* is another and very important result of its oxygenation, and one scarcely less essential to the continuance of life. If the human body did not possess within itself the power of generating heat, so as to maintain nearly an equality of temperature in all climates, it could not long exist. In winter, and especially in the northern regions, the blood would speedily be converted into a solid mass, and life be extinguished, if no provision existed for replacing the caloric withdrawn from the system by the cold air surrounding it. In most parts of the globe, the heat of the atmosphere is, even in summer, inferior to that of the human body, and consequently a loss of caloric is always going on which must be made up in some way, otherwise, disease and death would speedily ensue.

During the ordinary combustion of carbon or pure charcoal in the open air, the carbon combines with the oxygen of the atmosphere, and forms carbonic acid. During this process, heat is evolved with a rapidity proportioned to the intensity of the combustion. The very same changes occur during respiration, and the relation between the production of animal heat and the condition of the respiratory functions in all classes of animals is so direct and remarkable as to be admitted by every one, however divergent the theories may be by which the explanation of the phenomena is attempted. In general, other conditions being alike, the quantity of heat generated is in proportion to the size and vigour of the lungs; and when these are impaired, its production is diminished. Hence many persons with imperfectly developed lungs, and a predisposition to consumption, complain habitually of coldness of the surface and feet; and many who were previously in good health, become more and more sensible to cold, in proportion as the approach of disease weakens the functions of the lungs. I have noticed this increased sensibility to cold, as a precursor of chronic pulmonary disease, both in myself and in others, before any other very obvious symptom had appeared, and I think I have seen its farther progress arrested by the timely use of proper means, where much greater difficulty would have been experienced, had the warning not been attended to.

The generation of heat in the living system being so immediately connected with the lungs, we find the temperature highest in those animals which possess them in the greatest perfection, namely birds. In many species, the internal heat exceeds that of man by twenty or thirty degrees; while that of man exceeds, to as great an extent, the heat of such of the inferior animals as are remarkable for imperfect organs of respiration, till we arrive at last at the cold-blooded animals in which the respiratory functions are very feebly performed. Animal heat, then, is really the produce of a physiological combustion, and bears a direct relation to the intensity with which the carbon and oxygen are brought into combination.

There is still another point of analogy between the processes of combustion and respiration, to which, from its important practical consequences, I am anxious to direct the particular attention of the reader. On burning a given quantity of carbon or pure charcoal in a given quantity of air, *they invariably combine in the same proportions and form precisely the same amount of carbonic*

acid. For the combustion of 12.7 grains of carbon, for example, 100 cubic inches of oxygen are required, and the result is always 100 inches of carbonic acid. If the portion of air in which the charcoal is burned contain only 75 cubic inches of oxygen, combustion will cease, and 3.2 grains of the carbon will remain unconsumed. If, again, the oxygen exceed 100 cubic inches, the whole of the carbon will be consumed, and the excess of oxygen remain behind. The relative quantities, in short, are fixed and definite, and the results depend directly on the proportions in which they are presented to each other.

In respiration, precisely the same law holds. *Other conditions being alike, a given quantity of atmospheric air can oxygenate only a certain and invariable quantity of similarly constituted venous blood.* When the proportion of air is too small, it is unable to furnish the requisite amount of oxygen, and consequently, a portion of the venous blood remains unchanged, and becoming mixed with the portion which has been oxygenated, it circulates with it, and proportionately impairs its powers of sustaining life and nutrition. When, again, the proportion of oxygen in the inhaled air is artificially made to exceed its due relation to the quantity of blood passing through the lungs, the amount of carbon required to combine with it is wanting, and the excess of oxygen thus absorbed proves so highly stimulating as speedily to disturb the general health. Dr Southwood Smith calculates that each contraction of the heart propels to the lungs two ounces of blood, and that the proportion of air decomposed by it amounts to 8.5603 cubic inches, or very nearly a quarter of a pint. According to this estimate, as the heart contracts on an average four times for each act of inspiration, it follows that for every time we breathe, eight ounces of blood will be acted upon by one pint of air. But if from any cause the quantity of air entering the lungs be reduced to three-fourths of a pint, or, what is the same thing, if the air inhaled be so impure as to contain only three-fourths of its proper proportion of oxygen, it is clear that the oxygenation of the blood will be incomplete, and that it will be insufficient for the purposes of health.

In like manner, to use Mr Finlaison's results, it appears that in one individual 24 hogsheads of blood are acted upon by 57 hogsheads of air in 24 hours, and that in the course of this action the air loses 328¼ ounces, or about 11½ hogsheads of oxygen, and is farther deteriorated by the addition of a corresponding bulk of carbonic acid given out from the lungs. In other words, 24 persons inhale 57 hogsheads of air, and deteriorate its composition to the extent just stated, *in one hour*. So that, where a hundred people are shut up for an hour in one room, in attending a lecture for example, they breathe in that time upwards of 228 hogsheads of air, consume 45 hogsheads of its oxygen, and vitiate it by the addition of a proportionate bulk of carbonic acid, besides the watery vapour which is also thrown out. But as air is capable of supporting healthy respiration only when it contains its full proportion of oxygen, it is obvious that if the audience continue to *breathe the same air for another hour*, they must suffer from the imperfect oxygenation of the blood. Hence, where on such occasions adequate means are not used to renew the air within the room, at least as fast as it is vitiated, the oxygen diminishes, and the carbonic acid accumulates, in undue proportion, till the air becomes altogether unfit for the complete aëration of the blood, and for the support of life. Hence the languor, exhaustion, and headachs which ensue in churches, theatres, and ball-rooms, are just so many warnings that the lungs are insufficiently supplied with oxygen to decarbonise the blood passing through them, and that the system is suffering the penalty.

When these warnings are neglected, and the same air continues to be breathed again and again, the proportion of carbonic acid at last becomes so large as to cause it to act as a poison, and extinguish life. This result occurs when the quantity of carbonic acid in the air reaches the amount of 10 per cent. Beyond this point, insensibility and death are speedily induced, and hence the frequent loss of life from charcoal fires or stoves being left burning all night in close bed-rooms; and hence, also, the deaths from suffocation mentioned on p. 4, as having lately occurred in the confined cabins of several sloops. But of all the terrible catastrophes known to have arisen from this cause, that which occurred in the Black Hole of Calcutta in 1756, was the most frightful and attended with the greatest suffering. One hundred and forty-six Englishmen were thrust into a wretched prison only 18 feet square, in which there were only two very small windows by which air could be admitted, but as both of these were on the same side, ventilation was utterly impossible. Scarcely was the door shut upon the prisoners, when their sufferings commenced, and in a short time a delirious and mortal struggle ensued to get near the windows. Within four hours, those who survived lay in the silence of apoplectic stupor; and at the end of six hours, *ninety-six* were relieved by death! In the morning when the door was opened, 23 only were found alive, many of whom were subsequently cut off by putrid fever, caused by the dreadful effluvia and corruption of the air.

But it may be said, such a catastrophe as the above could happen only among a barbarous and ignorant people. One would think so, and yet such is the ignorance prevailing among ourselves, that more than one parallel to it can be pointed out even in our own history. Of two instances to which I shall allude, one has lately been published in the Life of Crabbe the Poet. When ten or eleven years of age, Crabbe was sent to a school at Bungay. "Soon after his arrival he had a very narrow escape. He and several of his schoolfellows were punished for playing at soldiers, by being put into a large dog-kennel, known by the terrible name of the 'Black Hole;'—George was the first that entered; and the place being crammed full with offenders, the atmosphere soon became pestilentially close. The poor boy in vain shrieked that he was about to be suffocated. At last in despair, he bit the lad next to him violently in the hand,—'Crabbe is dying—Crabbe is dying,' roared the sufferer; and the sentinel at length opened the door, and allowed the boys to rush out into the air. My father said, 'A minute more and I must have died.'"*

Another instance of a very similar kind is mentioned in Walpole's Letters. A parcel of *drunken* constables, he says, took it into their heads to arrest every body they met, and thrust them into St Martin's round-house. Five or six and twenty persons were thus shut up all night with closed doors and windows. In the morning, four were found suffocated from want of air, two died shortly after, and a dozen more were "in a shocking way."

In these deplorable examples of the miseries caused by ignorance of the simplest laws of the animal economy, the effects arising from the absence of a due proportion of oxygen in the air inhaled are portrayed in appalling colours. But those which are produced by breathing an atmosphere vitiated to a much smaller extent, although not so strikingly obvious, are by no means less real. God has decreed that a certain proportion of oxygen shall suffice for the aëration of only a fixed and determinate quantity of venous blood. If we adapt our circumstances to this law, we reap our reward in comfort and health. Whereas, if we transgress it and persevere in breathing an atmosphere containing less than the requisite quantity of oxygen, and more than the usual quantity of carbonic acid, we have no more right to expect to enjoy health, energy, and activity of mind and body, than to expect a fire to burn without air, or a fish to live out of the water. In domestic and social life, this

* Crabbe's Life, by his Son, p. 17.

important truth is habitually disregarded to an extent which will appear incredible when the practical benefits of physiology shall be more correctly appreciated, and its innumerable applications be made more extensively known as a part of the ordinary education of the young. To hasten the arrival of this period, so far as lies in my power, I shall, in the following chapter, direct attention to a few of the more prominent advantages to be obtained from the regular observance of the laws of respiration, not only in the prevention and cure of disease, but in promoting the moral and intellectual as well as physical well-being and happiness of the race.

CHAPTER X.

LAWS OF RESPIRATION.—CONDITIONS OF HEALTH OF THE LUNGS.

Extreme prevalence of diseases of respiratory organs.—Conditions of healthy respiration.—An abundant supply of pure air is required—also free inspiration—obstacles to obtaining these.—Compression of the chest and waist by tight lacing.—Hence more females than males die consumptive. Bad health of dressmakers, shoemakers, &c., explained.—Consumption prevails in trades carried on in confined air.—Influence of vitiated air in causing disease illustrated and explained.—Examples of typhus, consumption, and scrofula thence arising.—Effect of sedentary habits and inaction on respiration.—Diseases thus induced.—Depressing passions act in the same way.—The influence of vitiated air often slow and insidious, but only the more dangerous.—Conditions of health in the lungs.—The first is pure air.—Hence necessity of ventilation—this condition too much neglected.—Evils thence arising.—Preservative power of proper ventilation.—Free respiration indispensable—hence necessity of bodily activity and cheerfulness of mind.—Importance of a sound hereditary constitution—and of good diet.—Precautions to be observed in youth.

In the instructive and elaborate appendix by Mr Farr to the Registrar's Second Annual Report of Births, Marriages, and Deaths, it is stated that 27½ per cent. of the total deaths in England and Wales for 1838 were owing to diseases of the respiratory organs, and that of these no less than 59,025 arose from consumption alone. Of that number 31,090 were of females, and 27,935 of males, being in the proportion of 16.0 of males to 19.2 of females. Supposing the deaths from consumption in Scotland and Ireland to bear the same relation to the population as in England and Wales, the total number for the United Kingdom will fall little short of 90,000 annually. If any thing farther were required to excite an interest in the investigation of the causes and means of preventing this prodigious fatality, the fact that the young, the amiable, and the gifted are carried off in a far higher proportion by consumption than by any other disease, would be sufficient to arouse our solicitude. But I feel assured that the inherent importance of the inquiry will of itself be sufficient to enlist the attention of every reflecting reader.

From the general explanation already given of the structure and uses of the lungs, it will be obvious that several conditions, which it is our interest specially to know and observe, are essential to the healthy performance of respiration. *First* among those we may rank *an abundant supply of pure atmospheric air, containing its full proportion of twenty-one per cent. of oxygen, and not more than its due proportion of about one part in a thousand of carbonic acid.* Implied in this condition, or at least practically inseparable from it, is another, that nothing shall impede the full play and dilatation of the lungs, so that *at every inspiration a sufficient quantity of pure air shall be received into the air-cells to ensure the due and complete oxygenation of the whole venous blood subjected to its action.* Let us treat of these in succession.

If a mouse be confined under a large glass-jar, full of air, but so arranged that no fresh air can possibly enter, it will not for some time shew any appearance of inconvenience, because as yet the air which the jar contains will be tolerably pure. In proportion as the consumption of oxygen and the consequent exhalation of carbonic acid proceed, it will begin to shew symptoms of uneasiness analogous to those which are experienced by delicate persons in a close and crowded hall. In a little while longer it will be observed to pant in its breathing, and to dilate its lungs to their utmost limits, as if struggling for air, precisely as is described to have occurred with the wretched prisoners in the Black Hole of Calcutta, and the poet Crabbe. In a few hours more it will die convulsed, exactly as if drowned or suffocated. Precisely analogous results follow the deprivation of air in man, in fishes, and all other animated beings; and in hanging, death ensues, not from dislocation of the neck, as is often supposed, but simply from the want of air in the lungs to effect the necessary changes in the constitution of the venous blood.

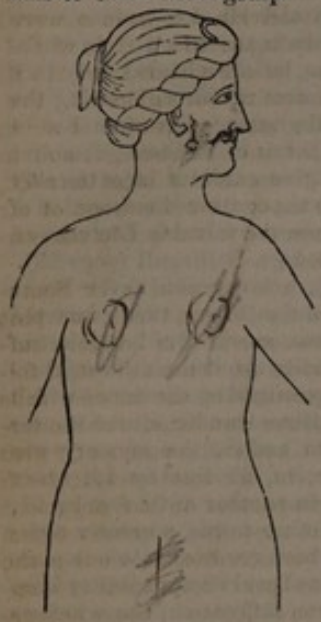
Assuming the accuracy of the estimate by Dr Southwood Smith, that in a person of average size, one pint of pure air, containing about one-fifth of oxygen, suffices to oxygenate eight ounces of venous blood, it follows that whenever the quantity of air inhaled falls short of one pint, it will prove insufficient for the formation of proper vital blood, and will consequently give rise to impaired health, or, in extreme cases, to death itself. It is perfectly unimportant to the argument whether Dr Smith has hit upon the precise relation which the air holds to the blood or not, or whether the proportion varies at different times, in different circumstances, and in different constitutions. Some proportion *does* exist which is better adapted than any other for the arterialization of the venous blood; and whatever that may be, the conclusion founded on its being observed or broken is equally applicable, whether one or twenty pints of air be required to oxygenate any given quantity of blood. For this reason I shall adopt Dr Smith's calculation as at least a probable one, although I am quite aware that the quantity of oxygen required varies with the state of the system and the constitution of the blood.

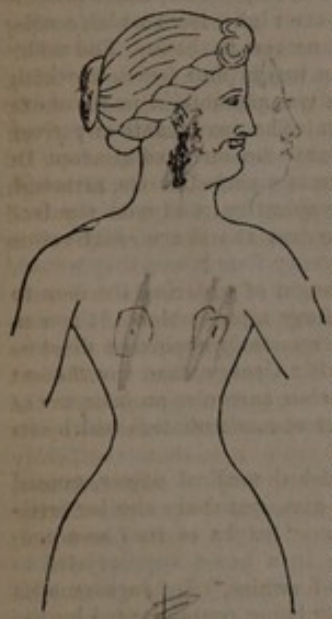
If, then, a certain proportion of pure air be necessary to convert venous into healthy arterial blood, it is manifest, that any departure from that proportion must be injurious, because it will be to that extent insufficient for the purposes of respiration, and in opposition to the express laws of the animal economy as ordained by its omniscient Creator. We have now to shew that, daily and hourly, and under every variety of circumstances, that proportion is often broken, and that much suffering and great mortality, which might be easily prevented, are thereby induced.

There are various ways in which the lungs may be deprived of the requisite supply of pure air for respiration. *First*, An obstacle may prevent the passage of the air through the windpipe. This sometimes happens in quinsy and in croup. It may also occur from foreign bodies choking up the throat, and from strangulation. In this state, no air can be admitted to the lungs, and death is the speedy result.

Secondly, The lungs may be deprived of their due proportion of air by any cause compressing the chest externally in such a way as to prevent the proper expansion of the lungs and air-cells. This is also a frequent occurrence, and when continued, is a very common source of bad health and diseased lungs. The most prevalent mode of compression of the chest consists in the use of tight waist-bands and corsets by young women, who are anxious to possess what they consider a fine figure. Compression to a hurtful extent is also met with in many trades in which a bent position is required. Shoemakers, for example, who, when at work, sit almost doubled up, suffer from compression of the chest, and can rarely take a full breath. But in all

such cases the principle is the same. The lungs are deprived of sufficient air to oxygenate the blood; and, as a consequence, the latter is deteriorated in quality, and affords imperfect sustenance to the organization. This result and its explanation are so obvious that I shall not dwell upon them, but only add two or three illustrations of the extent to which young women *voluntarily* injure themselves by compression of the chest, in the vain pursuit of an object which, thus aimed at, never fails to elude their grasp.





According to the natural formation of the lungs and chest, both are narrowest at the upper part, and become broader and broader till below the sixth or seventh rib. This will be apparent on inspecting the woodcut of the skeleton on page 47, and also the subjoined figures, the one copied from the outline of the Medicean Venus, and the other from a figure altered by compression.

That of the Venus is the natural form, and is recognised by artists and persons of a cultivated taste as the most beautiful which the female figure can assume. Accordingly, it is that aimed at in all the finest statues of ancient and modern times. Misled, however, by ignorance, and a false and most preposterous taste, women of fashion, and their countless thousands of imitators, down to even the lowest ranks of life, have gradually come to regard a narrow or spider-waist as an ornament worthy of attainment at any cost or sacrifice, and endeavoured, with a courage and perseverance worthy of martyrs, to reverse the proportions of nature, and produce the misshapen figure which appears above in contrast with that of the Venus, and which is, of course, the *beau ideal* of fashionable beauty! The simple inspection of these two figures will enable the reader to judge of the extent to which, under such compression, full respiration must be impeded, or rather be rendered impossible, and how certainly the blood must be deteriorated from the want of a sufficient supply of oxygen.

That such results are really experienced from compression, is proved by many facts. In the course of some experiments on the subject, Mr Thackrah found that, while the young men employed in a flax-mill could expel from the chest by a forced expiration from six to ten pints of air, the young women employed in the same mill, and consequently under similar circumstances, could expel only from two to four pints. In ten of these females, of about 18½ years of age, stated by Mr Thackrah to be "labouring under no disease," he found the average to be three and a half pints, while in the young men of the same age it amounted to six pints. Some allowance must of course be made for the naturally smaller size of the lungs in females; but Mr Thackrah seems to me to be correct in ascribing this great disparity "*chiefly* to the lacing of the chest."* I have seen one case in which the ribs were disfigured, and even the liver was deeply indented by the pressure of a very tight waistband, and in which long-continued bad health, and ultimately death were the results. In another case which I met with a few months ago, the liver was also indented, and its lower margin flattened by the pressure. In the report of the Glasgow Lunatic Asylum for 1838–9, another instructive case is mentioned. The patient was "a female pauper, aged fifty-two, who died of dropsy of the chest, connected with a singular displacement of the liver, lungs, and heart, in consequence of the very injurious practice of tight lacing, to which she had been addicted, with maniacal obstinacy, from early life." In all of these cases, the lower lobes of the lungs must have been so much compressed as to render their due dilatation impossible.

Estimating an ordinary inspiration in a healthy well-formed young woman to be twenty cubic inches of air, and supposing that, from excessive compression by corsets, or a tight waistband, the expansion of the lungs be reduced so far that only fifteen inches of air can be inhaled at each inspiration, it will not be difficult to understand the deleterious influence produced by it on the general health, and on the lungs themselves. The proportion of oxygen in twenty inches of pure air is as nearly as possible one-fifth or four inches. This, therefore, is the quantity which we assume to be required to aërate the eight ounces of blood subjected to its action. But if from tight lacing only fifteen inches of air can enter the lungs at each inspiration, it is as clear as noonday that the requisite proportion of oxygen to the blood will be diminished by *one-fourth*, or reduced from *four* to *three* inches. Hence the venous blood passing through the lungs will be imperfectly arterialized, and will be relatively unfit for the support of life and nutrition. I repeat, that I do not adduce these proportions as either mathematically correct or invariable, but merely as sufficient to illustrate *the principle* according to which compression acts; and that its effects are really as deleterious as the application of the principle would lead us to expect, I shall now attempt to shew by a reference to actual experience.

We have already seen from Mr Farr's Appendix to the Registrar-General's Second Report, that, in 1838, 27½ per cent., or 90,823 deaths, arose from diseases of the respiratory organs; and that of that number no less than 59,025 were ascribed to consumption alone. Considering the numerous active causes of disease to which males are subjected, and the comparative freedom from restraint which they enjoy at the most dangerous period of life, viz. during the effervescence of youth, one should expect to meet with a large majority of the victims among them rather than among females, who are so much less exposed. In reality, however, it is far otherwise. According to Mr Farr's calculations from the returns for 1838, only 3.8 in 1000 males died of consumption, whereas in females the proportion was so high as 4.1 in 1000, the actual numbers having been 27,935 to 31,090. "This higher mortality of English women by consumption," says Mr Farr, "may be ascribed partly to the in-door life they lead, and partly *to the compression, preventing the expansion of the chest, by costume. In both ways they are deprived of free draughts of vital air, and the altered blood deposits tuberculous matter with a fatal and unnatural facility. Thirty-one thousand and ninety* English women died in one year of the incurable malady! Will not this impressive fact induce persons of rank and influence to set their countrywomen right in the article of dress, and lead them to abandon a practice which *disfigures the body, strangles the chest*, produces nervous and other disorders, and has

* Thackrah on Employments as affecting Health and Longevity, p. 95.

an unquestionable tendency to implant an incurable hectic malady in the frame?"*

When to a diminished capacity of the lungs, caused by external compression, the breathing of an already vitiated air is added, the oxygen inhaled is still farther reduced in quantity, the blood is still more imperfectly aërated, and, as a necessary consequence, the health still more rapidly deteriorated. This combination of evils is nowhere seen in greater intensity than among the dressmakers of the metropolis. Deprived of that free exercise in the open air which is essential to the full expansion of the chest, they are confined in the vitiated air of a crowded workroom often for fourteen or sixteen hours a-day, and at some seasons even longer. From the tightness of their dress, and the stooping and motionless attitude in which they sit, the play of the lungs is still further impeded. In many other trades, the same fatal combination exists; and its effects are aggravated in proportion to the impurity of the air respired. In flax-mills and other factories where the vitiation of the air is carried to an extreme, scarcely any of the work-people are free from disease of the lungs. In the heckling department, according to Thackrah, a large proportion of the men die young. The same author mentions that, when conducting his experiments to ascertain the state of the lungs in the work-people employed in the flax-mills of Leeds, "the coughs of the persons waiting to be examined were so troublesome as continually to interrupt and confuse the exploration by the stethoscope."† These, it ought to be observed, were not patients selected for examination as such, but the ordinary workers from the mill.

From breathing a highly vitiated air in a constrained position, the people employed in some of the coal-mines where the seams are thin and the ventilation bad, are subject to a singular and fatal affection of the lungs, named *black spit*. In East Lothian it is very prevalent, and attacks the strongest as well as the feeblest of those exposed to its causes. It is accompanied by wasting and the copious expectoration of an intensely black matter in large quantity, which may continue for months, but is never cured. In such situations, few of the men arrive at the age of forty years; and if they do, they have already the appearance of old age. Is it wonderful that with such destructive machinery at work, disease and death should leave their traces in ill-ventilated workshops, factories, and mines, almost as distinctly as on the battle-field?

The *third* form in which the lungs are often deprived of the proportion of oxygen required to aërate the quantity of blood passing through them, is that of breathing an impure or vitiated air. If from any external cause, such as the crowding together of many people, the burning of many lamps, or the want of ventilation, the air be rendered so impure that the twenty inches required for each inspiration contain only *three* instead of *four* cubic inches of oxygen, and if the place of the absent quantity be supplied by one cubic inch of carbonic acid, it is obvious that the blood subjected to its action will be even more imperfectly oxygenated than if only fifteen cubic inches of *pure* air were admitted to the lungs. The presence of the additional inch of carbonic acid will add to the evil arising from the want of the oxygen by acting to that extent as a direct poison, and hence the bad health and ultimately fatal results which, as shewn in the preceding page, have so often been produced by the continued breathing of a vitiated air, especially when the vitiation is considerable in degree. And yet how very much is this important truth practically held in contempt, not only in the want of ventilation of our churches, hospitals, theatres, ball-rooms, and public assemblies, but even in our private dwellings! There is scarcely a day passes in which a well-employed medical man does not meet with some instance in which health has suffered, or recovery been retarded, by the thoughtless or ignorant disregard of the value of pure air to the well-being of the animal economy. This must be my apology for insisting, at so much length, on what may seem to many a trite and exhausted topic.

Begging the reader to bear in mind the evidence already submitted of the deadly influence of *extremely* vitiated air, as experienced in the Black Hole of Calcutta, in the round-house of St Martin's, and in the kennel into which Crabbe and his companions were thrust, and the examples of the injurious effects in workrooms, factories, and mines, of air vitiated only in a less degree, I shall now confine myself to shewing the powerful influence which the same cause often has in the production of specific forms of disease. The first illustration which I shall give exhibits incontestably the origin of *typhus fever* in the continued respiration of vitiated air, and is taken from the valuable Lectures on Military Surgery by Sir George Ballingall (page 28).

In the summer of 1811, a low typhus fever broke out in the fourth battalion of the Royals, then quartered in Stirling Castle. The season was the healthiest of the whole year, and the locality about the most salubrious in the country. On investigating the causes which could give rise to so much illness under circumstances apparently so favourable to health, the mystery was speedily solved. In one room, 21 feet by 18, SIXTY men had been placed; and in another of 31 feet by 21, SEVENTY-TWO men; or, in other words, a greater number of human beings had been crowded into one place than the air which it contained could by possibility keep alive! To prevent absolute suffocation, the windows were thrown open during the night, from which a cold air streamed in upon those nearest to them. The natural result of this crowding was typhus fever, to which inflammation of the lungs was superadded in those exposed to the cold draughts. The two together proved very fatal. Had the officers who assigned quarters to these unfortunate men been acquainted, in the remotest degree, with the laws of respiration, and with the fact that one pair of lungs requires the use of fifty-seven hogsheads of pure air in twenty-four hours, they would, I believe, as soon have thought of ordering the men to be shot, as of exposing so large a proportion of them to almost certain death from an easily avoidable disease. The simple fact added by Sir George, that "*in the less crowded apartments of the same barracks, no instances of fever occurred,*" is the severest condemnation which can be recorded against them.

Dr Jackson, a distinguished medical officer, quoted by Sir George Ballingall, gives precisely similar testimony. When insisting on "height of roof as a property of great importance in a house appropriated to the reception of the sick of armies," Dr Jackson adds as the reason, that "the air being contaminated by the breathing of a crowd of people in a confined space, disease is originated, and mortality is multiplied to an extraordinary extent. It was often proved in the history of the late war, that *more human life was destroyed by accumulating sick men in low and ill-ventilated apartments, than by leaving them exposed in severe and inclement weather, at the side of a hedge or common dike.*" The dreadful mortality from typhus fever in the British Legion in Spain a few years ago affords another striking confirmation of the same principle.

It would be very easy to detail additional proofs of the influence of confined and vitiated air in the production of typhus fever, because they abound in the writings of every author who has treated of the subject, in the Parliamentary Reports "on the Health of Towns," and in the Registrar-General's Reports. But as the fact is almost universally admitted, I need only refer to the death "from putrid fever" of most of the survivors of the Black Hole of Calcutta; to the fearful mortality from fever in slave-ships, more from vitiated air

* Registrar-General's Second Report, 8vo., edit. p. 73.
† Thackrah on the Effects of Employments on Health, p. 43.

than from any other single cause, and to the following example both of the extent to which atmospheric impurity operates, and the facility with which its deadly influence may be obviated by due attention to the simplest laws of the animal economy.

In the number of Chambers's Edinburgh Journal for 17th April 1841, in reference to the possibility of removing the causes of fever, it is said, "The chief causes assigned by medical inquirers are dense population, bad ventilation, and destitution. We shall here adduce strong reasons, to shew that however destitution or any other cause may operate remotely, the *immediate* cause is deficient ventilation. There is, in the suburbs of Anderston, a large house, called, from its mode of construction and the vast crowd of human beings who live in it, the *Barrack*. It is said that nearly five hundred persons, chiefly poor Irish, live in this building, each family having one, or at most two, little rooms. At one time, fever was never absent from the Barrack; *five had been seen ill at once in one room, and in the last two months of* 1831, *the cases in this single house were fifty-seven.* During the five years ending with 1839, there were 55,949 cases of fever in the whole city: consequently, it will be observed, this house with (say) 480 inhabitants, ought to have had, as its fair proportion, 112 cases, the population of the city being considered as, at a medium, 240,000. But how does the case really stand? Early in 1832, at the recommendation of an ingenious surgeon of the district (Mr Fleming), a simple tin tube, about two inches in diameter, had been led from the ceiling of each room of the Barrack into a general tube, the extremity of which was inserted into the chimney of a furnace connected with a neighbouring factory; by which means a perpetual draft was established upon the atmospheric contents of every room, and its inmates compelled, whether they would or not, to breathe pure air. The consequence—for we cannot but consider it as the consequence—was, that during the ensuing eight years fever was scarcely known in that house. Laying aside one year, during which Mr Fleming had not the charge of the apparatus, there were up to last December *only four cases.*" This remarkable exemption from fever in a building where it was formerly so prevalent is the more instructive, because the purification of the air is the only change which has been effected; and as fever was very prevalent in the whole city during the very time of this exemption, it is impossible not to ascribe the chief part of the protective power to the purer atmosphere now supplied to the inmates of the Barrack.

The same general results are afforded by the statistical returns of the Registrar-General; but I can make room for only one "Table, shewing the mean mortality in three groups of the Metropolitan Districts," extracted from the valuable appendix by Mr Farr, and designed to shew that, *cæteris paribus*, the mortality increases with the density of the population and the impurity of the air.

DISTRICTS.	Square Yards to one person.	Annual rate of mortality per 1000.	The epidemic class.	Typhus.	The Nervous System.	Phthisis.	Other classes.
1 to 10 (mean)	35	3.428	.994	.349	.518	.4°5	.831
11 to 20 ...	119	2.786	.679	.181	.440	.405	.716
21 to 30 ...	180	2.289	.539	.131	.374	.375	.584

From this table, it appears that .349 deaths from typhus occur in the most crowded districts of the metropolis, and only .131 in the more favourably situate; the proportions being nearly as *five* to *two*.

The influence of vitiated air in the production of *consumption* has been noticed and commented upon by many observers, but the evidence of Dr Lombard of Geneva is the most conclusive, because founded on an accurate inquiry into individual cases, in the course of which he extended his researches into "a total of 4300 deaths from phthisis, and 54,572 individuals exercising 220 different occupations, and found, by a comparison of all the professions carried on in the open air and in workshops, that the proportion of deaths from phthisis was *double* among the latter, and this proportion increased as the apartments were close, narrow, and imperfectly ventilated."* I need not add one word in support of this most convincing testimony, but only refer to another form of disease closely allied to consumption, and itself the cause of an immense mortality, viz. *scrofula*.

The three grand sources of scrofulous disease in those not strongly predisposed to it, are now universally admitted to be the habitual breathing of a vitiated atmosphere, an impoverished diet, and impaired nutrition. Of the active influence of the first, the rapid production of scrofula in animals previously healthy, by confining them for a time to the inspiration of an impure air, affords demonstrative proof. But, unfortunately, the fact may be witnessed at any time in the more confined dwellings of the poor in most of our large towns, and also in ill-situate and ill-ventilated workhouses or asylums for the young. Among the children in the Dublin House of Industry, for instance, scrofula prevailed very extensively about thirty years ago, and its ravages were not arrested till Mr Carmichael, the distinguished surgeon of that city, called attention to its chief cause in the extreme impurity of the air in the wards. In one ward of moderate height, 60 feet by 18, Mr Carmichael found *thirty-eight* beds, each containing *three* children, or more than one hundred in all! The matron told him, that "there is no enduring the air of this apartment when the doors are first thrown open in the morning; and that it is in vain to raise any of the windows, as those children who happen to be inconvenienced by the cold, close them as soon as they have an opportunity. The air they breathe in the day is little better: many are confined to the apartments they sleep in, or crowded to the number of several hundreds in the school-room."† Can any one read this account, and wonder at the prevalence of scrofula under such circumstances!

The *fourth* cause by which the necessary supply of oxygen to the lungs is frequently impeded and disease consequently produced, arises out of the sedentary habits of modern society, and the depression or monotony of mental condition which is apt to result from them. If ever a Divine law was legibly imprinted on any part of animated nature, it is that which declares *activity* to be the indispensable condition of human health and happiness. Every organ, from the highest to the lowest, in the structure of man is framed with a view to daily and habitual exercise, and this law holds equally with the lungs as with the muscles or brain. When we obey this condition of existence, and actively employ the body for some hours every day in the open air, the circulation is invigorated and equalized, the respiration is rendered free and deep, and a feeling of vivacity and enjoyment arises, which is the sure accompaniment of health and energy. These results are rendered very obvious in the process of *training*, during which *the wind*, as it is called, is known to become remarkably improved. Of this, I witnessed some years ago a very curious instance in a strong-built little Irishman, who, for a mere trifle, ran alongside of one of the Glasgow coaches for 32 miles in a very wet day and on a muddy road. The average speed was nine miles an hour, and yet the poor fellow did not seem at all distressed, and stopped only because he had arrived at his destination. In him this amazing strength and activity were obviously connected with the very complete oxygenation of the blood in a pair of capacious and well-exercised lungs.

The well-known salubrious influence of a gay and

* Penny Cyclop. Phthisis.

† Carmichael's Essay on the Nature of Scrofula. Dublin, 1810.

exhilarating mental stimulus and of cheerful and gratified moral emotions, and the sickening and destructive influence of despondency, grief, and other depressing passions, depend partly on the operation of the same principle. The exciting emotions stimulate the circulation, quicken respiration, and increase the vital powers, so that it becomes difficult to remain passive or quiescent. The depressing emotions, on the other hand, diminish the force of the circulation, render the breathing slow and feeble, and thereby withdraw the natural stimulus of life to an extent which leads directly to meditation or brooding *inaction*, and produces a positive aversion to bodily activity. Great depression of mind thus leads naturally to imperfect respiration, a more sluggish flow of blood, and the various diseases of diminished vitality; while great excitement induces full respiration, quickened circulation, and the various diseases of exalted vitality. It is then by diminishing inspiration, and thus depriving the lungs of the necessary oxygen, that the depressing passions and sedentary mode of life act so injuriously in predisposing to pulmonary consumption,—a fact which has been remarked from a very early period, and which ought never to be lost sight of by parents, teachers, or the young themselves. In modern society, thousands of both sexes unconsciously suffer in this way, without a suspicion being entertained that their mode of life is injurious. In female seminaries, especially, this error prevails to a lamentable extent, and is aggravated by the restraints so generally imposed upon the natural outpourings of the juvenile voice in sports and play.

Many writers have been at pains to point out the actual occurrence of the evils which sound physiology would lead us to anticipate, from the continued breathing of *impure* air, or from the imperfect breathing of *pure* air, owing to obstacles impeding the expansion of the lungs. But the principle according to which the injury is done has not been sufficiently explained or insisted upon, and hence the public at large remain unimpressed with the reality of the mischief such as I have endeavoured to set it before them. The bad effects, indeed, are often so gradual in their appearance, and apparently so disjoined from their true cause, that the latter is apt to be overlooked even when to an informed mind it is as obvious as the sun at noonday. But the influence of impure air or imperfect respiration is not the less positive or ultimately less subversive of health, from being slow and insidious in its progress. An individual possessing a strong constitution may indeed withstand the bad consequences of occasionally breathing an impure atmosphere, but even he will suffer for a time. He will not experience the same amount of mischief from it as the invalid, but will be perfectly conscious of a temporary feeling of discomfort, the very purpose of which is, like pain from a burn, to impel him to shun the danger, and seek relief in a purer air. The comparative harmlessness of a single exposure is the circumstance which blinds us to the magnitude of the ultimate result, and makes us fancy ourselves safe and prudent, when every day is surely, though imperceptibly, adding to the sum of the mischief. But let any one who doubts the importance of this condition of health watch the dyspeptic, the pulmonary, or the nervous invalid, through a season devoted to attendance on crowded parties and public amusements, and he will find the frequency of headachs, colds, and other fits of illness, increase in exact proportion to the accumulated exposure, till, at the end of spring, a general debility has been induced, which imperatively demands a cessation of festivity, and a change of scene and air. This debility is often erroneously ascribed wholly to the unwholesome influence of spring,—a season extolled by the poets, not as a cause of relaxation and feebleness, but as the dispenser of renovated life and vigour to all created beings.

It is in vain to warn such persons beforehand that Nature is always consistent, and that if bad air be really unfit for healthy respiration, it must be detrimental *to them*, and to all who breathe it; and that its ill effects are not less real because at first gradual and unperceived in their approach. They know too little of the animal economy and of Nature's laws, and are too much devoted to their own objects, to be impressed by cautions of this kind; and, in looking forward to the ball-room or crowded evening party, few of them will believe that any possible connection can exist between breathing its vitiated atmosphere, and the headachs, indigestion, and cutaneous eruptions which so frequently follow, and to be delivered from which they would sacrifice almost every other enjoyment.

If it be said that nobody will be troubled with all this trifling care, and that thousands who expose themselves in every way, nevertheless enjoy good health and a long life, I can only answer that this is partially true; but that an infinitely greater proportion pass through life as habitual invalids, and scarcely know from experience what a day of good health really is. The late discussions in parliament on the health of the poor and of large towns have demonstrated, by an unassailable mass of evidence, that many circumstances, rarely considered as injurious, because they have no immediate effect in suddenly destroying life by acute diseases, have nevertheless a marked influence in slowly undermining health and shortening human existence. There are trades, for example, at which workmen may labour for fifteen or twenty years, without having been a month confined by disease during all that time, and which are therefore said to be healthy trades; and yet, when the investigation is pursued a little farther, it is found that the general health is so steadily, although imperceptibly, encroached upon, that scarcely a single workman survives his fortieth or fiftieth year.

It is this insidious influence of impure air to which I am anxious to direct attention. So long as delicacy is the rule, and robust health the exception, especially among females, and so long as more than one-fourth of the annual deaths in Great Britain are caused by consumption alone, it will be difficult to persuade any rational and instructed mind that every cause of disease is already removed, and that farther care is superfluous. My own conviction on the contrary is, that, by proper care, and a stricter observance of the laws of the animal economy, on the part of the parents and guardians of the young, the development of the disease might be prevented in a large proportion of the number, and that even the robust would enjoy health in a higher degree and with increased security.

Having now made the reader acquainted with the nature and laws of *the function of respiration*, it will not be difficult for him to understand the principal conditions on which *the health of the lungs* or organs of respiration more immediately depends and the means by which they may, when feeble or predisposed to disease, be best protected and invigorated. Considering the yearly mortality from consumption, this part of our subject cannot fail to excite a deep interest in the mind of every rational parent.

If, as we have shewn, the habitual breathing of a pure air be essential to the proper constitution of vital blood, and to the general well-being of the system, there can be no doubt that the same condition will exercise a still more direct influence on the health of the lungs themselves. This is accordingly the case, and following the order of our previous exposition, it may be stated, that the *first* great requisite for the health of the lungs is *the habitual respiration of a pure air at a moderate degree of temperature, and of a moderate degree of humidity or dryness.*

There are only two ways by which we can obtain an unlimited command of pure air for respiration. The

first is by living in the open air; and the other is by making arrangements for the frequent and regular renewal of the air within our houses, workshops, churches, schools, and other places of public resort. The former is clearly impracticable in this climate, for however much we may benefit by a few hours spent every day in active exercise in the open air, no one will venture to affirm that we could safely spend the whole four and twenty under similar exposure. The only other way requiring consideration is, the regular renewal of the air in our houses and places of general resort.

Keeping in mind that every pair of lungs consumes on an average about two and a half hogsheads of air per hour, in the oxygenation of rather more than one hogshead of blood, and also the numerous other sources of impurity of air, such as fires, lights, and the cutaneous and pulmonary exhalations, there can be no difficulty in understanding how indispensable a regular supply of pure air must be to the health and comfort of every one who remains even for an hour within the four walls of a room, and especially of one crowded by other human beings. If we suppose, for example, that a thousand persons remain together in a church for one hour and a half, and that no provision be made to renew its contained air, what will be the results? A thousand pairs of lungs will, in that space of time, require for healthy respiration little short of *four thousand hogsheads of pure air* to oxygenate about *fifteen hundred* hogsheads of venous blood. But if no provision be made for the supply and equal diffusion of pure air, and for withdrawing that which has been vitiated, healthy respiration will become physically impossible. The vitiated air does not contain, and consequently cannot afford, the 21 per cent. of oxygen which the blood demands, and which pure air always contains. But in place of the deficient oxygen, the corrupted air contains a superabundance of carbonic acid, thereby directly adding to its deleterious effects.

So wholly, however, have considerations of this description been without influence on the public mind, and so complete and all-pervading has been the ignorance of physiology even among the best-educated classes, that in Edinburgh, and almost every large town, we have instances of large public rooms, capable of holding from 800 to 1000 persons, built within these few years, without any means of adequate ventilation being provided, and apparently without the subject having ever cost the architect a thought! When these rooms are crowded and the meeting lasts for some hours, especially if it be in winter, the consequences are sufficiently marked. Either such a multitude must be subjected to all the evils of a contaminated and unwholesome atmosphere, or they must be partially relieved by opening the windows, and allowing a continued stream of cold air to pour down upon the heated bodies of those who are near them, till the latter are thoroughly chilled, and perhaps, as in the case of the soldiers in Stirling Castle, fatal illness is induced; and unfortunately, even at such a price, the relief is only partial; for the windows being all on one side of the room, and not extending much above half-way to the ceiling, complete ventilation is impracticable. This neglect is glaringly the result of ignorance, and could never have happened had either the architects or their employers known the laws of the human constitution; and yet it is still doubted whether it be prudent or right to teach the intelligent portion of the community any knowledge of the structure and uses of their own organization.*

Striking, indeed, as these and innumerable other facts of a similar nature are, we still remain so blind to the instructions of experience, until we acquire a knowledge of the principles which give it value, that we go on, especially in towns, constructing our houses in utter defiance of scientific rules. The public rooms which can be easily ventilated at any time,—which are in fact ventilated by the constant opening and shutting of the door, and by the draught of the chimney,—and in which, therefore, large dimensions are less necessary for salubrity, are always the most spacious and airy. The bed-rooms, on the other hand, in which, from the doors being shut, and from there being no current of air in the whole seven or eight hours during which they are occupied, the vitiation of the air is the greatest, and in which, consequently, size is most required, are uniformly the smallest and most confined; and, as if this source of impurity were not sufficient, we still farther reduce the already too limited space, by surrounding the bed closely with curtains, for the express purpose of preventing ventilation, and keeping us enveloped in the same heated atmosphere. Can any thing be imagined more directly at variance than this with the fundamental laws of respiration? Or could such practices ever have been resorted to, had the nature of the human constitution been regarded before they were adopted? In this respect we are more humane towards the lower animals than towards our own species; for, notwithstanding all the refinements of civilization, we have not yet aggravated the want of ventilation in the stable or the cow-house, by adding curtains to the individual stalls of their inmates.

In dwelling-houses lighted by gas, the frequent renewal of the air acquires increased importance. A single gas-burner will consume more oxygen, and produce more carbonic acid to deteriorate the atmosphere of a room, than six or eight candles. If, therefore, where several burners are used, no provision be made for the escape of the corrupted air, and for the introduction of pure air from without, the health will necessarily suffer. A ventilator placed over the burners like an inverted funnel, and opening into the chimney, is an efficient and easy remedy for the former evil; and a small tube forming a communication between the external air and the room, would supply fresh air, where necessary. The tube might be made to pass, like a distiller's worm, through a vessel containing hot water, by which means the air might be heated in very cold weather, before being thrown into the room, and thus the danger arising from cold draughts and inequalities of temperature be avoided.

Many of our churches and schools are extremely ill ventilated; and accordingly it is observed, that fainting and hysterics occur in churches much more frequently in the afternoon than in the forenoon, because the air is then at its maximum of vitiation. Indeed, it is impossible to look around us in a crowded church, towards the close of the service, without perceiving the effects of deficient air in the expression of every one present. Either a relaxed sallow paleness of the surface, or the hectic flush of fever, is observable; and, as the necessary accompaniment, a sensation of mental and bodily lassitude is felt, which is immediately relieved by getting into the open air.

I have seen churches frequented by upwards of a thousand people, in which, during winter, not only no means of ventilation are employed during service, but even during the interval between the forenoon and afternoon services, the windows are kept as carefully closed as if deadly contagion lay outside, watching for an opportunity to enter by the first open chink—and where, consequently, the congregation must inhale, for two or three hours in the afternoon, an exceedingly corrupted air, and suffer the penalty in headachs, colds, and bilious and nervous attacks.

Most of our schools are also extremely defective in this respect. It is now several years since, on the occasion of a visit to one of the classes of a great public seminary, my attention was first strongly attracted to the injury resulting to the mental and bodily functions

* I rejoice to say, that, since the publication of the former editions of this work, the want of ventilation in the Assembly and Waterloo Rooms has been partially obviated. Their original construction scarcely admits of a complete remedy.

from the inhalation of impure air. About 150 boys were assembled in one large room, where they had been already confined nearly an hour and a half, when I entered. The windows were partly open; but, notwithstanding this, the change from the fresh atmosphere outside to the close contaminated air within, was exceedingly obvious, and most certainly was not without its effect on the mind itself, accompanied as it was with a sensation of fulness in the forehead, and slight headach. The boys, with every motive to activity that an excellent system and an enthusiastic teacher could bestow, presented an aspect of weariness and fatigue which the mental stimulus they were under could not overcome, and which recalled forcibly sensations long bygone, which I had experienced to a woful extent when seated on the benches of the same school.

These observations stirred up a train of reflections; and, when I called to mind the freshness and alacrity with which, when at school, our morning operations were carried on, the gradual approach to languor and yawning which took place as the day advanced, and the almost instant resuscitation of the whole energies of mind and body that ensued on our dismissal, I could not help thinking that, even after making every necessary deduction for the mental fatigue of the lessons and the inaction of body, a great deal of the comparative listlessness and indifference was owing to the continued inhalation of an air too much vitiated to be able to afford the requisite stimulus to the blood, on which last condition the efficiency of the brain so essentially depends. This became the more probable, on recollecting the pleasing excitement occasionally experienced for a few moments, from the rush of fresh air which took place when the door was opened to admit some casual visitor. Indeed, on referring to the symptoms induced by breathing carbonic acid gas or fixed air, it is impossible not to perceive that the headach, languor, and debility consequent on confinement in an ill-ventilated apartment, or in air vitiated by many people, are nothing but minor degrees of the same process of poisoning which ensues on immersion in fixed air. Of this latter state, "*great heaviness in the head, tingling in the ears, troubled sight, a great inclination to sleep, diminution of strength, and falling down,*" are stated by Orfila as the chief symptoms, and every one knows how closely these resemble what is felt in crowded halls.

Another instance of the noxious influence of vitiated air, which made a very strong impression on my mind, was during a three hours' service in a crowded country church, in a warm Sunday of July. The windows were all shut, and in consequence the open door was of little use in purifying the atmosphere, which was unusually contaminated, not only by the respiration and animal effluvia proceeding from so many people, but by their very abundant perspiration, excited by the heat and confinement. Few of the lower classes, either in town or country, extend their cleanliness beyond the washing of the hands and face. Hence the cutaneous exudation, in such persons, is characterized by a strong and nauseous smell, which, when concentrated, as it was on this occasion, becomes absolutely overpowering. Accordingly, at the conclusion of the service, there was heard one general buzz of complaint of headach, sickness, and oppression; and the reality of the suffering was amply testified by the pale and wearied appearance even of the most robust.

One of the circumstances which greatly aggravates the bad effects of the vitiated air in most schools, is the very long hours during which the pupils are subjected to its influence. In winter, the whole day is generally spent in school, and exercise in the open air becomes impossible. In the summer, six or seven successive hours of confinement are common, in addition to which even the evenings are consumed in private preparation for the *tasks* of the morrow. Considering the structure and constitution of the human being, a more irrational and more injurious system of education could scarcely be invented. The mind and brain alone are exercised, and their exercise is carried to the degree of exhaustion; while the lungs, the muscles, and the bones, on the exercise of which the health even of the brain directly depends, are neglected and injured by disuse. The effects of breathing air vitiated by the lungs of so many companions for so many successive hours are apathy and exhaustion. The attention flags, the mind becomes indifferent to every thing except an intense longing for liberty and the open air, and the body itself becomes weary and restless.

Since the publication of the former editions of this volume, several intelligent teachers, who were struck with the truth of these remarks, and had the courage to act upon the dictates of a sound physiology by greatly abridging the hours of confinement, encouraging active play in the open air several times a-day, and ensuring the thorough ventilation of the school-rooms at all times, have expressed themselves delighted with the results, and declared that even the intellectual progress was greater with only one half of the confinement, while the health and power of sustained and vigorous attention were greatly improved. Similar testimony was repeatedly offered to Mr Combe by the teachers of the United States. "After the lecture," he says on one occasion, "the teacher of a distinguished private seminary mentioned to me, that, in consequence of the views which he had derived from my lectures on phrenology last year, he had ventilated his school, alternated the studies, and increased the hours of relaxation, and had found the health of himself and his scholars improved, their powers of application increased, and greater enjoyment imparted to them all."* In speaking of a new and thoroughly ventilated public school at Boston, Mr Combe again adds, "the teachers told me that since they have occupied this school-house, the vivacity and capacity of the scholars have obviously been raised, and their own health and energy increased." (P. 155.)

Of the direct influence thus produced on the health of the children, the following facts taken from among many others in the Honourable Horace Mann's Second Report to the Board of Education of Massachusetts, will be sufficient evidence. Of two school-houses situate near each other, the one was dry and *well-ventilated*, and the other damp, and so placed that *ventilation was impracticable*. "In the former," says Mr Mann, "during a period of 45 days, *five* scholars were absent from sickness, to the amount in the whole of twenty days. In the latter, during the same period of time, and for the same cause, *nineteen* children were absent to an amount in the whole of *one hundred and forty-five* days." "The appearances of the children thus detained by sickness indicated a marked difference in their condition as to health."

One of the evils of ignorance is, that we often sin and suffer the punishment, without being aware that we are sinning, and that it is in our power to escape the suffering by avoiding the sin. For many generations, mankind have experienced the evil results of deficient ventilation, especially in towns, and suffered the penalty of delicate health, headachs, fevers, consumptions, and cutaneous and nervous diseases; and yet, from ignorance of the true nature and importance of the function of respiration, and of the great consumption of air in its performance, architects have gone on planning and constructing edifices, without bestowing a thought on the means of supplying them with fresh air, although animal life cannot be carried on without it; and, while ingenuity and science have been taxed to the uttermost to secure a proper supply of water, the admission of pure air, though far more essential, has been left to steal in like a thief in the night, through any hole by which it can find an entrance. In constructing hospitals, indeed, ventilation has been thought of, because a notion is pre-

* Combe's Visit to the United States, vol. iii. p. 169.

valent that the *sick* require fresh air, and cannot recover without it; but it seems not to have been perceived, that what is indispensable for the recovery of the sick, may be not less advantageous in *preserving* from sickness those who are well. Were a general knowledge of the structure of man to constitute a regular part of a liberal education, such inconsistencies as this would soon disappear, and the scientific architect would speedily devise the best means of supplying our houses with pure air, as the engineer has already supplied them with pure water.

The truth of the preceding remarks is strongly confirmed by the recent experience of the highly respectable establishment by which this volume is printed. For years the workmen employed in it were exposed to the full influence of the vitiated air arising in printing-houses from the nature of the materials, the presence of many persons in the same room, and the numerous lights required, especially in winter, the whole of which combined formed an atmosphere sickening and oppressive to those unaccustomed to it, but of the true nature of which, those habitually exposed to it received a much fainter impression. On the attention of the partners being drawn to the importance of pure air to bodily health and mental activity, they became anxious to effect a thorough ventilation of their own premises. The plan resorted to was very simple, viz. opening a hole of six or eight inches square into a disused chimney at each end of the principal apartments, the upper edge of it being on a level with the ceiling. The warm vitiated air naturally ascends, and having the benefit of the draught through the chimney, is readily carried up, and a good ventilation thus established. The consequent improvement in the comfort and working power of the men is, I understand, not less remarkable than the difference in comfort and freshness to a stranger entering from the open air. The same simple plan has been adopted in the printing-office of the *Scotsman* newspaper; and I have been told by one of the proprietors, that there the workmen are now as little exhausted by two or three hours of extra labour, as they were before with their ordinary exertion. But in admitting an abundant supply of fresh air, especially into hospitals, care must be taken that it do not form currents which may be prejudicial to the persons within. A writer in the Lancet, of 29th December 1832, after narrating a case of a patient who was carried off by pleurisy, while under treatment of Dr Elliotson, in St Thomas's Hospital, for disease of the pylorus, gives his opinion, that the pleurisy "was most likely occasioned *by the extreme draughts of this ward.* There is a great current of air in the ward, and I have seen many persons in it suffer very much indeed." In a note it is added, "*The number of patients who are thus carried off yearly, forms a startling list to be laid before the eyes of the Governors of this Institution. Such results are shamefully frequent.*" I have already noticed the occurrence of pneumonic inflammation from the same causes in the garrison at Stirling Castle, and it is to be feared that there are many, both schools and hospitals, as much in need of improvement in this respect as St Thomas's.

It would serve only to encumber these pages needlessly, were I to adduce here in detail any farther evidence that the purity and due renovation of the air which we breathe is really influential in promoting the healthy and energetic activity of both mind and body. The proofs already given are amply sufficient to establish the fact. But, that no doubt may exist in the mind of even the most incredulous or inattentive reader, I shall refer shortly to one or two instances, in which, by the fulfilment of this law of the human constitution, health was extensively preserved, where, when the law was infringed, unusual sickness and mortality prevailed.

We have already seen that a free circulation of air in the sick-room is the most effectual means of preventing the spread of fever. Sir Walter Scott notices incidentally that it was equally efficacious in preventing the extension of plague to the inmates of the Old Tolbooth or Prison of Edinburgh, which he has rendered famous under the name of the "Heart of Mid-Lothian." "Gloomy and dismal as it was," says Sir Walter, "the situation in the centre of the High Street rendered it *so particularly well-aired, that when the plague laid waste the city in* 1645, *it affected none within these melancholy precincts;*"* and yet, in other respects, a jail was precisely the place where the plague might have been expected to prevail with the greatest virulence.

About a hundred years ago, when the pauper infants of London were brought up in the workhouses amidst impure air, crowding, and want of proper food, out of 2800 received into them annually, the frightful proportion of 2690 died within the year! When this murderous mortality at length attracted the notice of Parliament, an act was passed obliging the parish-officers to send the infants to nurse in the country. By this more humane treatment, the mortality speedily fell to 450, being a diminution of 2240 annually. In my *Treatise on the Management of Infancy*, I mention other facts of a similar nature which occurred in the island of St Kilda, and in the Dublin House of Industry, in both of which places the efficacy of ventilation in reducing the mortality among the young was strikingly illustrated, but it would lead to unnecessary repetition to give the particulars here.

In many trades, a great mortality is caused by breathing air rendered impure by dust, metallic fumes, or other irritating agents floating in it; but even in the worst of them, the fatality may be much diminished by attending, as far as possible, to due ventilation, and to the supply of a pure air. In Sir James Clark's excellent work on Consumption and Scrofula, we find an instructive instance of this fact. When treating of vitiated air as a cause of consumption among the fork-grinders of Sheffield, Sir James states, that those who reside in the country, in the enjoyment of a more free circulation of air, live, on an average, eight years longer than those resident in the town, In both, the irritating causes and the habits of life are the same, but the rooms in which the country workmen carry on their labours are much better ventilated, and they consequently live on an average about forty years, while among their town companions the average of life extends only to between *twenty-eight* and *thirty-two* years.

The greater prevalence of consumption among females and persons leading a sedentary life within doors, and its comparative unfrequency among males, and especially among those who live much in the open air, also afford strong evidence that the habitual breathing of pure air, when combined with ordinary prudence in other respects, is one of the surest protections we can have against pul monary disease.

With regard to the *temperature* and *dryness* of the air which we breathe, some precautions are necessary, especially in winter. When in the enjoyment of a nourishing diet and frequent and active exercise in the open air, the young are not very susceptible of cold. But when confined to the house and deprived of active exertion, as happens during winter in many seminaries, they suffer severely from sitting or sleeping in cold rooms In such circumstances, chilliness of the surface, coldness of the feet, and a feeble circulation, are commonly complained of, and loudly demand indulgence in ample exercise in the open air, and the provision of a temperate atmosphere within doors. If these remedies be denied, permanent bad health, retarded development of the bodily system, and consumption, will frequently ensue.

Since the introduction of Arnott's and other stoves into churches, sitting and bed rooms, it has become doubly necessary to attend to the degree of *dryness* in

* Heart of Mid-Lothian, vol. i. chap. 6, note.

the air we breathe. In its natural state, the air always contains more or less moisture, and the system is constituted with relation to that fact. When, however, a room is heated by a stove, the air which it contains is rendered far too dry for healthy respiration, and in that state, it acts injuriously both on the lining membrane of the air-cells and on the skin. On the Continent, where stoves are much used, a large vessel containing water is generally placed on the top of them to supply the necessary humidity by evaporation; and the plan answers very well, as the warmer the stove, the more rapid will also be the evapo ation. Dr Arnott very properly insists strongly on some such precaution being combined with the use of his stoves in this country.

A very *moist* atmosphere is also injurious. It impedes exhalation from, and stimulates absorption by, the lungs and skin, so that any deleterious impurity, such as miasma or contagion, is much more likely to be received into the system when floating in a moist air. But as this condition admits of remedy only by a change of residence to a drier locality or by draining, it would be foreign to my present purpose to enlarge upon it here.

The next method for promoting the health of the lungs has a direct reference to the second condition of healthy respiration, and consists in the *perfectly free expansion of the chest, so that the pure air which has been provided may have easy and full access to the air-cells of the lungs*. This condition of health implies not only that all external restraints upon the expansion of the chest shall be removed, but that, as a general rule, the mode of life shall be sufficiently active to ensure that full and deep respiration, without which the aëration of the blood cannot be adequately effected.

At all periods of life this condition of health is very important, but in youth, and especially during the rapid developement of the organization, it may justly be said to be indispensable. The formation of a sound constitution will depend more upon its fulfilment than upon any other single condition; and yet, if we examine the prevailing methods of education and usages of society to ascertain how far it is acted upon, we shall find but little room for boasting, and much for disappointment. Instead of frequent intervals of varied and active exertion in the open air being made to divide the long periods of confinement and mental occupation to which the young are subjected, we find scarcely a moment left, or a change of position allowed, between one lesson and another. Even during the short time allotted for exercise, a formal monotonous walk, at a pace which leaves the breathing as limited and feeble as before, is often all the indulgence which is granted. In more mature life, the habit thus cultivated becomes confirmed, and many, especially females, spend their days in sedentary occupations and complete bodily inaction, which render freedom of respiration impossible. If, however, we regard the laws of the animal economy in their true light of clear expressions of the will of the all-wise Creator who instituted them, and not as mere emanations of the mind of man, we shall be much less likely to fall into errors of this kind, and far more anxious to carry the Divine intentions into practical effect. The common notion is, that physiological principles and hygienic laws are the mere inventions of man, and hence that they may be attended to or neglected with equal impunity as if they really were so. This is a fatal mistake.

Not only, however, is general exercise or bodily activity required to ensure the health of the lungs by the complete and effectual respiration which it necessitates, but the direct exercise of the lungs themselves is, when judiciously managed, one of the most efficacious means which we can employ for promoting their development and warding off their diseases. In this respect the organs of respiration closely resemble the muscles and all other organized parts. They are made to be used, and if they are left in habitual inactivity, their strength and health are unavoidably impaired; while, if their exercise be ill-timed or excessive, disease will also as certainly follow.

The lungs may be exercised *indirectly* by such kinds of bodily or muscular exertion as require quicker and deeper breathing; and *directly* by the employment of the voice in speaking, singing, reading aloud, or crying. In general both ought to be conjoined. But where the chief object is to improve the lungs, those kinds which have a tendency to expand the chest, and call the organs of respiration into play, ought to be especially preferred. Rowing a boat, fencing, quoits, cricket, shuttlecock, and the proper use of the skipping rope, dumbbells, and gymnastics, are of this description. All of them employ actively the muscles of the chest and trunk, and excite the lungs themselves to freer and fuller expansion. Climbing up hill is, for the same reason, an exercise of high utility in giving tone and freedom to the pulmonary functions.

Where, either from hereditary predisposition or accidental causes, the chest is unusually weak, every effort should be made, from infancy upwards, to favour the growth and strength of the lungs, by the habitual use of such of the above-mentioned exercises as can most easily be practised. The earlier they are resorted to, and the more steadily they are pursued, the more certainly will their beneficial results be experienced. In their employment, the principles explained in the chapter on the Muscles ought to be adhered to.

Habitual exercise in a hilly country, and the frequent ascent of acclivities, especially in pursuit of an object, are well known to have a powerful effect in *improving the wind* and strengthening the lungs; which is just another way of saying that they increase the capacity of the chest, promote free circulation through the pulmonary vessels, and lead to the more complete oxygenation of the blood. Hence the vigorous appetite, the increased muscular power, and the cheerfulness of mind so commonly felt by the invalid on his removal to the mountains, are not to be wondered at. I was myself sensible of advantage from this kind of exercise during a Highland excursion. The necessity of frequent and deep inspirations, and the stimulus thus given to the general and pulmonary circulation, had an obvious effect in increasing the capacity of the lungs and the power of bearing exertion without fatigue. Even when I was wearied, the fatigue went off much sooner than after a walk of equal length on a level road, and was unattended with the languor which generally accompanied the latter. In fact, the most agreeable feeling which I experienced during the whole time was while resting after undergoing, in the ascent of a hill, a degree of exertion sufficient to accelerate the breathing, and bring out free perspiration. A lightness and activity of mind, and freedom about the chest, which I never felt to the same extent at any other time, followed such excursions, and made the fatigue comparatively light.

Before such practices, however, can be resorted to with advantage, or even with safety, there must be nothing in the shape of active disease existing. If there be, the adoption of such exercise will, in all probability, occasion the most serious injury. This also I experienced in my own case, as, for many months at an earlier stage of convalescence, going up a stair, ascending the most gentle acclivity, or speaking aloud for a few minutes, was equally fatiguing and hurtful, and often brought on cough, and occasionally a slight spitting of blood. All that time, riding on horseback, which exercises the body without hurrying the breathing, was especially useful. The advantage of these exercises in giving tone and capacity to the lungs, where debility rather than disease is complained of, is shewn in their being uniformly resorted to in preparing for the race-course and for the field. The true sportsman puts himself in training as well as his dog or his horse,

and fits himself for the moors by regular excursions previous to the 12th of August. By so doing he improves his wind and increases his muscular strength to a remarkable extent in a very short time.

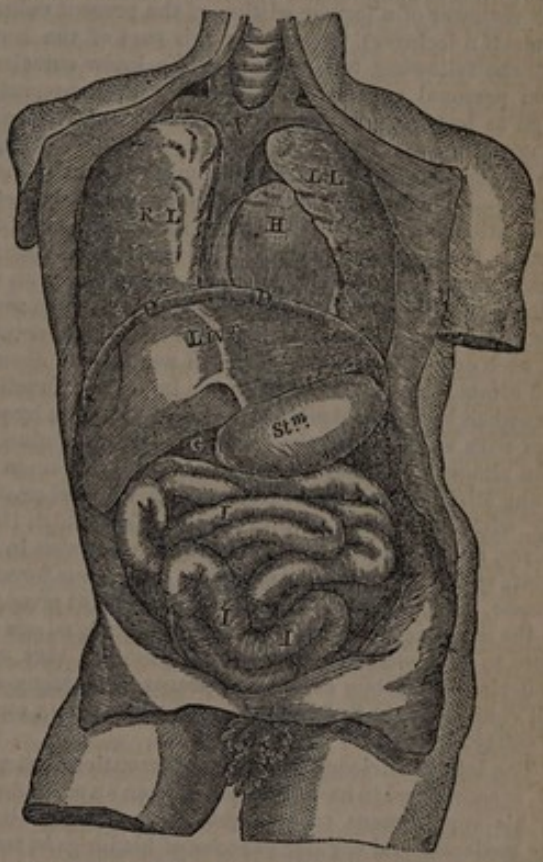
When no active pulmonary disease exists, these exercises may, with the best effects, be frequently carried so far as to induce free perspiration; only great care ought to be taken not to remain inactive, but immediately to rub the surface of the body thoroughly dry, and to change the dress. It is quite ascertained that, with these precautions, perspiration from exercise is the reverse of debilitating. It equalizes and gently stimulates the circulation, relieves the internal organs, improves digestion, and invigorates the skin. Jackson testifies strongly to these results, when he declares that the severe exercise undergone in training, not only improves the lungs, but always renders the skin "quite clear, *even though formerly subject to eruptions.*"* These assertions are, of course, to be received as the statements of a man partial to his own art; but they are in accordance with experience, and with the laws of the animal functions, so far as these are known. They, therefore, merit the consideration of professional men, and of those whose features are often disfigured by eruptions which they find it difficult to remove by any kind of medicine.

I need hardly repeat, that, when wishing to favour the development of the lungs, we ought to be scrupulous in avoiding such positions of the body as hinder their full expansion. Tailors, shoemakers, clerks at a writing-desk, and the like, are unfavourably situated in this respect, as their bent position constrains the chest, and impedes the breathing and circulation.

Direct exercise of the lungs in practising deep inspiration, speaking, reciting, singing, and playing on wind instruments, is very influential for good or for evil, according as it is indulged in with or without due reference to the constitution of the individual. If it is properly managed and persevered in, particularly before the frame has become consolidated, nothing tends more to expand the chest, and give tone and health to the important organs contanied in it; but if either ill-timed, or carried to excess, nothing can be more detrimental. In this respect, as well as morally, the introduction of singing into our common schools, as lately encouraged by Government, will prove an inestimable advantage; and I should rejoice to see it universally adopted as an essential element of physical, intellectual, and moral education, in all classes of society. To the poor especially, it will supply a means of enjoyment and refinement which will do much to improve their existence, and diminish the attractions of the ale-house. As a preventive of disease, Sir James Clark is in the habit of recommending the full expansion of the chest in the following manner: "We desire the young person, while standing, to throw his arms and shoulders back, and, while in this position, to inhale slowly as much air as he can, and repeat this exercise at short intervals, several times in succession; when this can be done in the open air, it is most desirable, a double advantage being thus obtained from the practice. Some exercise of this kind should be adopted daily by all young persons, more especially by those whose chests are narrow or deformed, and should be slowly and gradually increased."† In this recommendation I heartily concur.

On the same principle, even the crying and sobbing of children contribute to their future health, unless they are caused by disease, and carried to a very unusual extent. The loud laugh and noisy exclamations attending the sports of the young, have an evident relation to the same beneficial end; and ought therefore to be encouraged instead of being repressed, as they are often sought to be, by those who, forgetting that they themselves were once young, seek in childhood the gravity and decorum of more advanced age. I have already noticed at p. 35, an instance on a large scale, in which the inmates of an institution were, for the purpose of preserving their health, shut up within the limits of their hall for six months, and not allowed to indulge in any noisy and romping sports. The aim of the directors was undoubtedly the purest benevolence, but, from their want of knowledge, their object was defeated, and the arrangement itself became the instrument of evil.

Beneficial as the direct exercise of the lungs is thus shewn to be in strengthening the chest, its influence extends still farther. If we examine the position of the lungs as represented in the subjoined figure, we



shall see, that, when fully inflated, they must necessarily push downwards and flatten the moveable arch of the diaphragm D D, by which they are separated from the belly or abdomen. This alteration, however, cannot take place without the diaphragm in its turn pushing down the liver (Liv$^{r.}$), stomach (St$^{m.}$), and bowels (I. I.), which it accordingly does, causing them to project forwards and outwards. But no sooner are the lungs fully inflated, than the contained air is again thrown out. The lungs diminish in size, the diaphragm rises, and with it all the contents of the abdomen return to their former position. The whole digestive apparatus is thus subjected to a continual pressure and change of place; and the stimulus thence arising is in truth essential to the healthy performance of the digestive functions, and is one of the means arranged by the Creator for the purpose. Consequently, if the lungs be rarely called into active exercise, not only do *they* suffer, but an important aid to digestion being withdrawn, the *stomach* and *bowels* also become weakened, and indigestion and costiveness make their appearance. I have already alluded to this subject in the chapter on muscular exercise, and also considered it in detail in my work *On Digestion and Diet*; but the general principle will be sufficiently understood by the inspection of the above figure.

After this exposition I need hardly say that the loud and distinct speaking enforced in many public schools is productive of much good to the young, and that the lessons in singing now to be carried into effect in other institutions besides Infant Schools are much to be com-

* Sir John Sinclair's Code of Health, 5th edition. Appendix, p. 37.

† Clark on Consumption and Scrofula, p. 298.

mended. Let any one who doubts their efficacy as exercises of the lungs, attend to what passes in his own body on reading aloud a single paragraph, and he will find not only that deep inspirations and full expirations are encouraged, but that a considerable impulse is communicated to the bowels; affording a marked contrast to the slight breathing and quiescent posture of those whose voices never rise above a whisper.

Reading aloud, public speaking, and lecturing are excellent exercises for developing the lungs and the chest. But, as they require some exertion, they ought to be indulged in with prudence, and with constant reference to the constitution and health of the individual. The reviewer of a former edition of the present volume (himself a lecturer), in noticing this part of the book, adds the following testimony:—"We know ourselves, from personal experience, that, often when preparing to go to lecture, a languor has crept upon us, inducing an unwillingness to exert ourselves. We have gone,—the lecture has commenced,—the mind was called into action,—a perspiration broke forth on the brow,—the circulation was equalized,—and, at the conclusion of the lecture, the languor was gone." Hence he recommends "reading to one's family in the evening," "as an excellent practice, and one tending much to sweeten social life."* When early resorted to, and steadily persevered in, such exercises are very useful in warding off disease, and communicating strength to an important function. But when begun suddenly, and carried to excess by persons with weak lungs, they are more directly injurious than almost any other cause. It is not uncommon for young divines to make excessive exertions in preaching, without any preparation for the effort which it requires, and to experience, in consequence, pains in the chest, spitting of blood, and other dangerous forms of disease, which often extinguish their brightest prospects in the morning of life. Sacrifices of this kind are the more to be lamented, because it is probable that, by a well-planned system of gradual preparation, many who fall victims might find in their profession even a source of safety.

The late illustrious Cuvier, as was mentioned at page 45, is considered to have been saved from an early death, by his appointment to a professorship leading him to the moderate and regular exercise of his lungs in teaching—a practice which soon removed the delicacy of chest to which he was subject, and enabled him to pass uninjured through a long and active life. Other examples of the same kind might be mentioned. But it is important to observe that in all of them the exercise was, at all times, accurately proportioned to the existing state of the lungs. Had active disease existed, or the exertion required been beyond what the lungs were fully able to bear, the effect would have been, not to improve health, but to destroy life; and this condition of accurate relation between the amount of exercise and the state of the organization must never for a moment be overlooked. With a little care, however, the point at which direct exercise of the lungs ought to stop may easily be determined by observing its effects.

The same principle leads to another obvious rule: When disease of any kind exists in the chest, exercise of the lungs in speaking, reading, and singing, and also in ordinary muscular exertion, ought either to be entirely refrained from, or strictly regulated by professional advice. When a joint is sore or inflamed, we know that motion impedes its recovery. When the eye is affected, we, for a similar reason, shut out the light; and when the stomach is disordered, we have respect to its condition, and become more careful about diet. The lungs demand a treatment founded on the same general principle. If they are inflamed, they must be exercised as little as possible, otherwise mischief will ensue. Hence, in a common cold of any severity, silence, which is the absence of direct pulmonary exercise, ought to be preserved, and will, in truth, be its own reward. In severe cases, and in acute inflammations of the chest, this rule is of the greatest importance. It is common to meet with patients who cannot speak three words without exciting a fit of coughing, and who, notwithstanding, cannot be persuaded that speaking retards their recovery. In like manner, in spitting of blood, and in the early stage of tubercular consumption, when the breathing cannot be excited without direct mischief, it is often difficult to convince either the patient or his friends of the necessity of silence. He perhaps does not feel pain on attempting to speak, and says, that "it merely raises a short tickling cough, which is nothing." But if he persists, dearly bought experience will teach him his error, and dispose him to regret as did a lamented friend of the author, that a few weeks out of the years which he had dedicated to the study of the classics had not been devoted to the acquisition of some little knowledge of the structure and functions of his own body. In the instance alluded to, after spitting of blood had been induced by severe bodily labour, the patient continued talking almost the whole day to the visiters and inmates of a large public establishment, and believed himself all the time to be very careful, as he said he was no longer exerting his body. When the error was pointed out, and the mechanism of the lungs explained to him, he deeply bewailed the ignorance which had allowed him to act in a manner so pernicious.

All violent exercise ought, for similar reasons, to be refrained from, during at least the active stages of cold. Every thing which hurries the breathing, whether walking fast, ascending an acclivity, or reading aloud, has the same effect on the diseased lungs that motion of the bone has on an inflamed joint. It seems to me, that many people hurt themselves much more by the active exercise they take during a severe cold than by the mere exposure to the weather. It is well known that a person, when suffering from cold, may go out for a short time even in an open carriage more safely than on foot; and there is much reason to believe, that it is the absence of active exertion of the lungs in the former case, which makes the exposure less hurtful.

After all active disease has been subdued, or when nothing but delicacy remains, the adequate exercise of the lungs is one of the best means of promoting effectual recovery. Those parents, therefore, act most erroneously, who, in their apprehensive anxiety for the protection of their delicate children, scrupulously prohibit them from every kind of exercise which requires the least effort, and shut them up from the open air during winter, with the false hope of thereby warding off colds and protecting their lungs. I have seen the greatest delicacy of constitution thus engendered, especially where an undue quantity of warm clothing was at the same time employed. When tested by the principles above explained, such conduct is found to be as ill adapted as possible to the end in view, and utterly at variance with the laws of the animal economy.

Considering the delicacy and extent of the lining membrane of the lungs, and the ready access to it which the external air has, it cannot be a matter of surprise that sudden or great changes in its temperature or constitution should often operate injuriously on the lungs, and be the means of inducing not only colds but more serious disease. Hence, especially in delicate subjects, the obvious propriety of diminishing the risk of sudden transitions by breathing through several folds of woollen fabric or silk when obliged to pass from a warm room to the cold external air, or to breathe a cold or damp air for a length of time. The cold air becomes partially heated and deprived of its moisture in passing through such a medium, and the protection thus afforded is so marked, that few who have tried the precaution will ever afterwards neglect it. Since these remarks were first published, a very ingenious instrument has

* London Medical and Surgical Journal, No. 134, p. 107.

been contrived by Mr Jeffreys of London, for wearing over the mouth and preserving a uniform temperature in the air we breathe, even in passing from a warm drawing-room to a cold wintry atmosphere. From personal experience, as well as observation of its effects on others, I can speak very favourably of its usefulness for pulmonary invalids, and for persons who suffer from delicacy in any part of the air-passages. The instrument is called "Jeffreys' Respirator."

Perhaps the most important time in the life of a person born with a predisposition to consumption is that of puberty, comprising from the commencement of rapid growth to the full consolidation of the system about or after the twenty-fourth year. In most young people, the transition from adolescence to maturity is so rapid, that for two or three years all the animal powers are tasked to enable nutrition to keep pace with growth, and a corresponding debility of both body and mind is often observed to co-exist, indicating in the clearest manner the necessity of a temporary remission from such studies and occupations as require much mental exertion or confinement within doors. The development and health of the physical system ought then to be almost exclusively attended to; and when the body has acquired its solidity, the mental faculties will again become active. I have seen instances where a knowledge of the latter fact afforded substantial consolation to young men who, while their bodies were growing rapidly, were apt to become despondent, on account of the unusual sluggishness and inefficiency of their intellectual powers. In the course of a few years, when growth and consolidation were completed, the brain vigorously resumed its functions.

In such circumstances, relaxation from study, residence in the country, exercise in the open air, plenty of food, and freedom from care, will often do immense good, if sufficiently persisted in, and go far to protect the careful patient against the future invasion of consumption. Whereas, if, under the mistaken notion that such precautionary measures are a waste of time, a delicate growing youth is allowed to continue at his studies or his desk till disease has actually commenced, the disappointed parent may discover that it is too late to take alarm when health is gone.

I am desirous to draw the attention of parents to this subject, because a good deal of observation has satisfied me that too little attention is paid to the *preservation* of health at this critical period of life, and that, by proper management during the transition from adolescence to maturity, many might be saved who now fall victims. The statistical returns of large towns shew that in the male sex the period between seventeen and twenty-four years of age is really, as described by a late careful investigator of the laws of mortality, "one of restlessness, toil, and danger; the human faculties are then exercised to the utmost, and life is more freely expended than at any other season."* It appears, for example, from Count Chabrol's Statistical Researches of the City of Paris and Department of the Seine, that, in 1819, the total mortality was 22,445, of whom 10,865, were males, and 11,580 were females. Of this number there died—

	Males.	Females.
Between the ages of 10 and 15,	198	238
. . . . . 15 . . 20,	420	391
. . . . . 20 . . 25,	815	650
. . . . . 25 . . 30,	374	567

Shewing a remarkable increase in the number of deaths between 15 and 20 over those beween 10 and 15, and again another increase of nearly double in those between 20 and 25 over those between 25 and 30. In the females, from circumstances not now to be explained, the period of increased mortality extends to nearly 30 years of age. Similar results were obtained in the succeeding years.

These tables, confirmed by others drawn up with equal accuracy, place in a striking point of view the dangers of the state of transition from youth to manhood, especially amidst the temptations of a luxurious capital; and the necessity of attempting, by early instruction and timely prudence, to protect the young against the numerous causes of disease which then come into active and fatal operation. They ought also to serve as a warning to those who, in the spring-time of life, are inclined to trust implicitly for their safety to the strength of a good constitution, and to despise the prudence which dictates the avoidance of unnecessary exposure. The experience derived from the limited observation of one man may be set aside as undeserving of trust; but when the unvarying results exhibited to us are deduced from the changes in nearly a million of people, it is impossible to ascribe them to chance, or to deny their bearing on ourselves. Many invaluable practical truths will, ere long, be furnished to the world by the statistical researches now in progress.

The earlier maximum of mortality in the male sex, especially in cities, is explicable by the fact, that it is at the approach of manhood, when both mind and body are in a state of transition, that dissipation is most indulged in, and presses with its deadliest force. Many delicate youths are carried off, who would have escaped without injury, if they could have been persuaded to act with prudence during these two or three critical years. Many, I am constrained to say, first learn the means of their destruction in boarding-schools and places of public resort, and that often when no mischief is suspected by their respectable teachers. On this topic, however, the nonprofessional character of the present work precludes me from entering into details.

There is another requisite for the permanent health of the lungs, to which sufficient weight is far from being attached in society, and which I can scarcely urge too strongly upon the attention of parents and the guardians of the young, as well as of the young themselves. I allude to the influence of the original constitution of the lungs. No fact in medicine is better established than that which proves the hereditary transmission from parents to children of a constitutional liability to pulmonary disease, and especially to consumption; yet no condition is less attended to in forming matrimonial engagements. The children of scrofulous and consumptive parents are generally precocious, and their minds being early matured, they engage early in the business of life, and often enter the married state before their bodily frame has had time to consolidate. For a few years, every thing seems to go on prosperously, and a numerous family gathers around them. All at once, however, even while youth remains, their physical powers begin to give way, and they drop prematurely into the grave, exhausted by consumption, and leaving children behind them, destined in all probability either to be cut off as they approach maturity, or to run through the same delusive but fatal career as that of the parents from whom they derived their existence.

Many examples of this kind might be pointed out among the higher classes of society, who are not restrained from following their predominant inclinations by any necessity of seeking subsistence in professional pursuits. And many instances might be referred to, in which no regard was shewn to the manifest existence of the same disposition in the family of either parent, and in which, consequently, the married state was embittered either by barrenness, which is then the most favourable result, or by the prevalence of disease and delicacy in the progeny. It may not be easy to enforce upon the young and inexperienced the requisite degree of attention to these circumstances; but surely education, especially when backed by example, might do much, if the young were properly instructed at an early period in the lead-

* On the Natural and Mathematical Laws concerning Population, Vitality, and Mortality. By Francis Corbaux. P. 92.

ing facts and principles of the human constitution. Where hereditary precocity and delicacy of frame exist, marriage, instead of being hastened, ought invariably to be delayed at least till the fullest maturity and consolidation of the system; otherwise the consequences will be equally unhappy for the individual and for his progeny. During growth and for a considerable time afterwards, the constitution is still imperfect even in healthy subjects, and wants the enduring strength which it acquires in mature age, and the possession of which marks the period which nature has fixed for the exercise of the functions of reproduction. Many young people of both sexes fall sacrifices to early marriages, who might have withstood the ordinary risks of life, and lived together in happiness, if they had delayed their union for a few years, and allowed time for the consolidation of their constitutions.

I have urged this point strongly, because hereditary predisposition is, avowedly and beyond all doubt, a frequent source of the more serious forms of pulmonary disease, and it would be worse than folly to allow past and painful experience to go for nothing. Medical men have much in their power in preventing such violations of the laws of the Creator, at least where they are regarded, as they always ought to be, as the friends not less than the professional advisers of the family.

As connected with this subject, I may mention that Sir James Clark has the merit of having drawn attention to the important fact, that a state of impaired health in the parent, *whether constitutional or acquired*, and particularly if caused by imperfect digestion and assimilation, is as productive of a tendency to scrofula and consumption in the children as if it had descended by hereditary transmission. If parents in general were duly impressed with the truth and bearing of this fact, many of them might be induced, on account of their children, to take that rational care of their own health which they seem to be incapable of doing for its own sake.

The last requisite for the health of the lungs which I need mention here, is a due supply of rich and healthy blood. When, from defective food, or impaired digestion, the blood is impoverished in quality, and rendered unfit for adequate nutrition, the lungs speedily suffer, and that often to a fatal extent. So certain is this fact, that, in the lower animals, *tubercles* (the cause of incurable consumption) *can be produced in the lungs to almost any extent, by withholding a sufficiency of nourishing food, or by causing them to breathe a vitiated atmosphere.* The same circumstances operate to a lamentable extent among the poorly fed population of our manufacturing towns; whereas it is proverbial that butchers—a class of men who eat animal food twice or thrice a-day, and live much in the open air,—are almost exempt from pulmonary consumption. Among the higher classes, again, the blood is impoverished, and the lungs are injured, not from want of food, but *from want of the power of adequately digesting it;* and hence we find, in every treatise on consumption, a section devoted specially to "*dyspeptic phthisis*," as it is called, or simply "consumption from bad digestion." The late hours, heavy meals, and deficient exercise, which are so generally complained of, but still so regularly adhered to in society, are the chief sources of many of these evils.

Before quitting this important subject, I may add another word of advice, in regard to those who are predisposed to consumption or weakness of chest. As soon as active growth commences, permanent benefit may be derived from removal, for a few years, to a milder and less variable climate. Many who are sent abroad only to die painfully in a foreign land, in the noonday of life, might have lived for years in the enjoyment of health and usefulness, had they been sent abroad *before* the appearance of disease, instead of after its unequivocal commencement. The previous delicacy, whence the susceptibility to colds and pulmonary affections arises, ought to attract the earliest attention, and excite the most persevering efforts, for its removal. If it be allowed to make progress till consumption has commenced, medicine may come armed with its most powerful remedies, and directed by the most consummate skill; but it will too often come in vain. The rage which now prevails for mere intellectual education, and the utter neglect of the bodily health to which it leads, is too often carried so far as to be a curse rather than a blessing; and till its fury be moderated by an increase of good sense in the parents, great mischief must, I fear, continue to ensue.

I cannot dismiss this subject without again referring the reader to Sir James Clark's work on Consumption and Scrofula as affording, I may almost say for the first time, a comprehensive, philosophical, and practical view of the causes, nature, and treatment of consumption; the able author has not, it is true, greatly extended our power over that fatal disease in its most advanced periods; but he has done more to throw light upon its causes, to obviate its development, and to arrest it in its incipient stages, than any author with whose writings I am acquainted.

CHAPTER XI.

THE BRAIN AND NERVES CONSIDERED IN THEIR RELATION TO THE REST OF THE BODY AND TO THE MENTAL FACULTIES.

The whole organization subservient to the mind.—The mind acts through the medium of organs, and cannot act without them.—Necessity of attending to this fact.—The mind and its organs not identical.—The mind the true characteristic of the human being—the bodily features take their expression from it.—The brain alone necessary to the mind—the rest of the body may be mutilated without impairing the mind—example.—The connexion of brain and mind theoretically admitted, but practically neglected by educationists and others—consequences of this neglect.—The brain the organ of the internal mind—the muscles and bones its executive organs—the hand and limbs subservient to, not creative of, mental power.—Hence brain and bodily structure simple and rude where instincts and capacities few and limited—examples in the sheep, tiger, antelope, and oyster.—Relation of organs of nutrition to the mind.—Animal and organic or vegetative functions.—Summary of the constitution of the human body.—The brain described—the nerves, and their uses in connecting man with the external world.—The brain becomes complex in proportion as new powers are added—Necessity of observing and conforming to its laws of action.

THE more carefully we investigate the nature and objects of the human constitution, it becomes only the more demonstrable that THE MIND, which feels, and thinks, and directs, is, so to speak, the truly human or characteristic portion of our being, and that the whole corporeal frame is constructed with direct reference to its properties and wants; or, in other words, that *subservience to the purposes of the mind is the fundamental principle on which the bodily organization has been fashioned.*

Placed as we are in the midst of a material world, acted upon at every moment of our lives by material objects, and requiring to act upon them in return, a material organization is indispensable for the operations of mind. Accordingly, we know mind only as it exists and acts during life in combination with the living organization, and can no more form a conception of its abstract qualities as disjoined from the body than we can of the principle of gravitation as disjoined from matter.

Palpable and undeniable as this great truth is, and universally as it is admitted in the abstract, there is, and always has been, a strange tendency in mankind to shrink from its contemplation as a practical proposi-

tion, and from accepting its legitimate consequences. Not remembering that, if it be so, "the thing is of God," and therefore good, many have entertained an apprehension that if the mind be admitted to be under the influence of the organization during life, its eternal existence must be thereby rendered doubtful. But such a fear displays a lamentable distrust of the omnipotence and wisdom of God. If, in the first place, the evidence be sufficient to demonstrate the fact that, during life, the mind acts, and is acted upon, by material instruments, we have no choice but to believe it, and to make the most of it for our own advantage. To shut our eyes to its perception, or our understandings to its consequences, cannot alter the reality, or undo that which God has seen right to ordain. If, again, we reject the fact, on the ground that it implies the impossibility of continued existence in another world, our distrust becomes mixed up with the grossest presumption which a fallible creature can shew towards its infallible Creator. Reason tells us that the future destiny of the mind or soul depends wholly on the will or *fiat* of the Almighty, and not in the very least on its own nature or essence. Whether material or immaterial, it is equally capable of receiving at His hands an eternity of existence.

Individually, therefore, I attach no manner of importance to this long agitated question, but rely with unshaken constancy on God having given to the human being, in mind as in body, that constitution which He saw to be best fitted for him. But, for the sake of those who are influenced by such considerations, I may remark, that, although the mind acts through the medium of the organization, this is very far from implying that the mind and its organs are identical. The mind sees through the medium of the eye, and, in this world, cannot see without it; but it is not itself the eye. In like manner my mind now expresses its thoughts through the medium of the arm and hand which guide my pen; but will any one maintain that therefore my mind and arm are one and the same? When insensibility follows a severe blow on the head, are we to suppose that the immaterial mind is shattered by the shock? Or when fever racks the brain, and raving delirium ensues, are we to believe that it is the mind itself which is sick and in danger of death? On the contrary, we perceive at once that if the brain be the instrument by which the mind works, the destruction or disease of the instrument alone becomes sufficient to explain the disturbance of the mind, without the necessity of supposing the immaterial principle itself to be involved.

As, then, every faculty or quality, by which man is distinguished from the rest of the animal creation, is possessed, and acts, in immediate connexion with some corresponding peculiarity of organization, it follows that the structure of the human being must hold the same high relation to the less perfect structure of the lower animals which the elevated qualities of man hold to the instincts and limited capacities of the brutes. To ascertain how far this inference is well founded, let us shortly inquire what the qualities are by which man is characterized, and with what parts of the organization these qualities are more immediately connected?

For the elucidation of the first point, we have only to reflect upon what passes through the mind when we wish to form or to communicate a correct opinion of any historical personage or private friend whose worth and character we are anxious to see duly appreciated by others. Instinctively we fix at once upon the QUALITIES OF THE MIND—the peculiar combination of affections and moral and intellectual excellencies which we believe him to possess—as constituting the features which distinguish him from other men, and give him a claim to our regard. Knowing mind in this world only as it exists in connexion with the living organization, we, no doubt, always associate these mental endowments with some form of body and peculiarity of features; but in the very act of doing so, we are still perfectly conscious that it is the *stamp of mind* imprinted on them which constitutes their chief attraction, and which, more than any merely physical advantage, gives to man his acknowledged superiority over the rest of the animal kingdom. Accordingly, when we warmly recommend one friend to another, we never think of saying, Love him because he is six feet high, or because he has a Roman nose, a Grecian mouth, fine eyes, or a well turned limb. Allowing all these personal advantages (which in themselves are not to be despised) to make their own impression, we instinctively feel that they constitute a very sandy and unstable foundation for esteem and confidence, and rest our claims on his intelligence, prudence, benevolence, or integrity; certain that, if we succeed in establishing the *mental and moral excellence* of our friend, we shall serve him far more effectually than if we could prove him to possess the grace and symmetry of an Apollo or an Adonis.

The mind being thus the ruling principle or power for the use of which the whole bodily organization has been designed, it follows, that, whatever injury the body may sustain in other respects, so long as those parts of it which minister directly to the mental and moral faculties remain entire and in health, the human being will continue in undiminished possession of all the qualities for which we really value him, and by which he is distinguished from creatures of a lower grade. Thus a person may be born without arms or legs, be almost as incapable of locomotion, and even more incapable of supplying his own wants, than the oyster within its shell, and yet excel in every moral and intellectual attribute for which humanity is prized. In the same way a friend may lose one or more of his limbs, or his body be disfigured by accident or disease; but so long as his mind remains, with its affections as warm, its moral feelings as active and pure, and its intellectual powers as vigorous, as before, we recognise his identity, love him with the same ardour, rely upon him with the same unfaltering constancy, and rate his worth as highly, as when his form was distinguished for its symmetry, and every motion for its gracefulness and ease. Since this remark was written, a beautiful example of its truth has appeared in the newspapers, under the not inappropriate title of of an "*Exquisite Anecdote of Woman's Affection.*"—It is stated that "Sir Robert Barclay, who commanded the British squadron in the battle of Lake Erie, was horribly mutilated by the wounds he received in that action, having lost his right arm and one of his legs. Previously to his leaving England, he was engaged to a young lady, to whom he was most tenderly attached. Feeling acutely, on his return, that he was a mere wreck, he sent a friend to the lady, informing her of his mutilated condition, and generously offering to release her from her engagement. 'Tell him,' replied the noble girl, 'that *I will joyfully marry him, if he only has enough of body left to hold his soul!*'" The appositeness of this illustration is too obvious to require any comment.

If, then, the mind be the directing power for the use of which the bodily organization was originally designed by the omniscient Creator, and if the limbs which act as the executors of its will may be removed, and yet the powers and capacities of the mind itself remain unimpaired, it necessarily follows that these parts cannot be directly essential to its integrity, and that for the various purposes of perception, thought, and feeling, the mind must be in immediate connection with some other portion of the bodily organization, which not only remains entire amidst so much destruction, but also must be so placed and so constituted as to maintain a communication with, and exercise an influence upon, all other parts of the body. Such accordingly is the fact, and by universal consent THE BRAIN is now admitted to be the immediate organ of

the mind, and the seat of emotion, perception, and thought; and *the nerves* which connect it with the rest of the body are ascertained to be the means by which it maintains its communication with the external world, and exercises an influence over all the other functions. Hence the deep interest which attaches to the study of the brain and nervous system, and which renders an accurate acquaintance with their functions and laws of action so useful to every one engaged in the great work of human improvement.

To many of my readers it may seem needless to enforce, at so much length, a proposition which, in its abstract form, nobody thinks of denying; but unfortunately, there is a vital difference between admitting theoretically that the mental powers cannot act during life except through the medium of their appropriate organs and adopting the same great truth as a practical principle, to be applied in the daily conduct of life, and in the education and general treatment of the young. Turn where we will to the best authors on education, to the most highly gifted and experienced of our physicians and teachers, and to the purest and most sincere among the moral and religious guides of the young, we find each and all of them thinking and acting as if the minds under their charge were, even in this life, abstract and separate entities, entirely beyond the influence of the organization. They study the mind and try to discover its laws, altogether without regard to the properties of the living organization with which God has connected it. In so doing they proceed much in the same way as if, in physics, we were to investigate the nature and laws of caloric, without paying any regard to the properties and modifying influence of the bodies in combination with which alone caloric can come under the cognizance of our senses; and yet we are daily surrounded by the most conclusive and even startling evidence that the mental functions are as immediately affected by the condition of the organs which execute them as the action of caloric is by the properties of the objects with which it is combined.

If, then, we really wish to obtain consistent and useful results in the investigation of mind, this is not the way in which we ought to proceed. As we cannot alter the constitution which God has given us, it behoves us to study its nature and laws as He has presented it to us, combined with and influenced by a living organization,—in short, to follow the same course which has been so successfully pursued in our researches into other departments of science. It is long since Bacon demonstrated that the inductive method of inquiry is the only one which can avail us; and since mere speculation on mind has been tried for two thousand years, and tried in vain, why should we be longer deterred from entering upon the only path which can lead to success in the investigation of *mental*, as well as of *physical* nature?

In inquiring into the mutual relations of the mind and body, the great leading fact which ought never to to be lost sight of, is, that one part of the organization —namely, the *brain*—is directly appropriated to what may be called the *central* or *internal* operations of mind, such as perception, emotion, thought, and judgment; and that other parts—the muscles and bones, *or organs of voluntary motion*—are appropriated to what may be called its *external* operations, viz. executing the external commands of the will. Palpable as is the distinction between these two classes of operations, it has, strange to say, been often overlooked; and hence certain philosophers have gravely contended that man owes all his mental superiority to the perfection of his hands. The propounders of this most untenable doctrine overlook the fact, that the hands are useful only in proportion to the intelligence and skill of the mind which guides and directs them, and that the well formed hands of an idiot are of no advantage to him, and impart to him none of the mental power of which he stands so much in need. Accordingly, the more carefully we shall enquire, the more certain will it appear that it is not by any perfection of the merely secondary instruments of voluntary motion, but by the combined superiority of mind and brain, that man is peculiarly distinguished from all other animals. It is the mind which is the truly human portion of our being; and in man the mind is conjoined with a more perfect and complicated brain than we meet with in other animals, simply because he is remarkable above them all for the variety and extent of the faculties with which he is endowed. It is true that in his body and limbs he possesses executive instruments, also far superior to those of other creatures, but it is not to these he owes his high position in the scale of creation. They are given to him only to place him in harmony with his own elevated mind; and if the instruments which it employs to effect its purposes were not perfect in proportion, he would be constantly fretting under the conception of plans and designs which he had not the means of either fulfilling or communicating, and thus would form a singular exception to the wisdom and benevolence displayed in all the other works of God.

The same subservience of the organization to the capacities and instincts is observable throughout the whole animal kingdom. In proportion as the intelligence of an animal is limited and its instincts are few, its brain is observed to be simple and rude, and its executive instruments correspondingly few and imperfect. The brain and the four legs and cloven feet of the sheep, for example, are in exact accordance with its limited faculties and desires; whereas, had they been joined to reasoning powers and moral faculties like those of man, what a maddening incongruity would have been the result! Or even supposing the form of the sheep to have been conferred upon a creature possessing the brain and ferocious impulses of the tiger, speedy destruction must have been its inevitable end. In like manner, if the towering instincts of the eagle had been united to the long legs and small wings of the ostrich, how utterly incongruous would the gift have been! Throughout the whole animal creation, accordingly, we find the *bodily structure invariably fashioned according to the instincts* and kind of intelligence with which each species is endowed. If the antelope bounds over the plain with the speed of a race-horse, it is not merely because it has long legs; but it has long legs and great activity to enable it to obey and live in harmony with its own natural instincts. If along with its present form and activity it had possessed the instincts of the sloth and been doomed to remain upon a single tree till it had eaten up all its leaves, it would have been the most miserable of animals; and again, if the sloth, with its present form, were suddenly endowed with the instincts of the antelope, and impelled to scour the plain in search of food, it also would be a most wretched creature, because its claws and limbs are fashioned for climbing and holding fast, and not at all for running. Or, to pursue the parallel to an extreme, if the oyster, which has neither legs nor arms, because it has no sphere of action beyond its shell, and no faculties impelling it to change its place, were to become endowed with a human mind and feelings, in what a condition would it be placed! and on the other hand, if the human organization was animated only by the instincts of an oyster, what would become of all its admirable and complicated mechanism, and of man's happiness?

Having thus shewn that subservience to the purposes of the mind is the fundamental principle on which the bodily organization has been designed and constructed, it will be proper to add a few remarks concerning the only remaining group of organs required to complete the animal frame, and which are only *indirectly* essential to the mental functions. I allude to those by which nutrition is carried on, and the life of the whole body sustained. In one respect, these stand in much the same relation to the immediate organs of the mind that the

steam does to the executive machinery. The spinning-jenny is the *direct* producer of the thread; but without the animating though indirect aid of the steam to keep it in action, it would be utterly unavailing for any useful purpose. In like manner the brain is the immediate source of emotion and thought, but without the organs of nutrition to sustain it in life and activity, it would speedily become an inert and useless encumbrance.

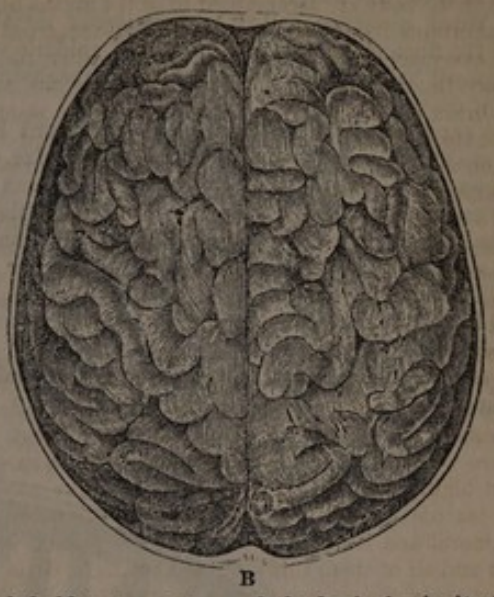
In accordance with this special difference of purpose, these two groupes of functions are appropriately enough termed the *animal* and the *organic* functions; because, while sensation, emotion, and thought, are peculiar to animals, nutrition and life are common to both animals and vegetables; whence, indeed, the latter are also not unfrequently termed the *vegetative* functions. So very distinct are they in nature, that even in man the latter may continue after all thought and consciousness are destroyed.

From this general analysis, the reader will now be aware that the human body consists of the following distinct groupes of organs, each charged with its own special functions:—1*st*, The brain, or immediate organ of the mind, or seat of sensation, perception, emotion, and thought; 2*dly*, The organs of the five senses, and certain nerves, serving to convey to the brain and mind the impressions made upon them by external objects; 3*dly*, The muscles, bones, ligaments, &c., which, along with the nerves of motion, constitute the limbs and the frame-work of the trunk, and serve to execute the behests of the mind, transmitted to them from the brain; and *lastly*, the organs of digestion, respiration, circulation, and nutrition, by means of which life is supported, and growth and decay are carried on. The first three are the organs of the *animal*, and the last, of the *organic* or *vegetative* functions. Having already treated of digestion and nutrition in another volume,* and of the organs of voluntary motion, circulation, and respiration, in the preceding chapters, I shall now confine myself to the consideration of the brain as the immediate organ of the mind.

The brain is that large organized mass which, along with its enveloping membranes, completely fills the cavity of the skull. It is, as we have seen, the seat of thought, of feeling, and of consciousness, and the centre towards which all impressions made on the nerves distributed over the body are conveyed, and from which the commands of the will are transmitted by other nerves to put the various parts in motion.

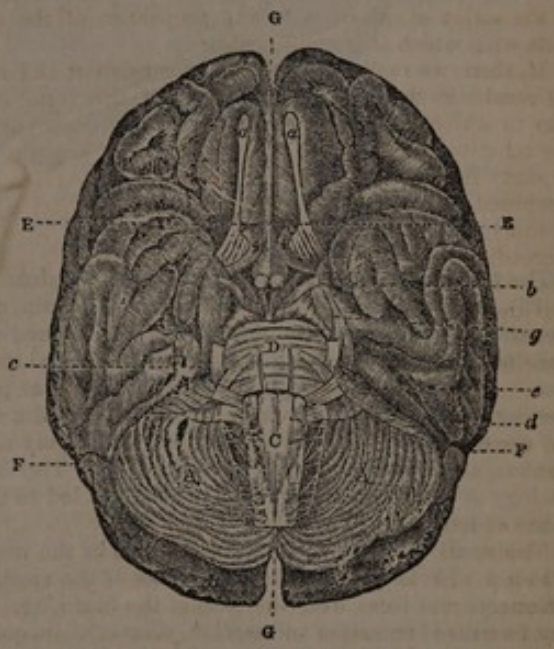
The structure of the brain is so complicated, that less is known of its true nature than of that of almost any other organ. It would therefore be entirely out of place to attempt to describe it here, farther than by stating generally its principal divisions. On sawing off the upper half of the skull horizontally, and removing the firm tough membrane called *dura mater* (hard mother), which adheres closely to its inner or concave surface, the *cerebrum* or *brain proper* presents itself, marked on the surface with a great variety of undulating windings or *convolutions*, and extending from the fore to the back part of the head somewhat in the form of an ellipse. In the annexed wood-cut, the convolutions are represented as seen on the upper surface of the brain.

In the middle line from A to B, there is a deep cleft separating the brain, in its whole length, into two halves or *hemispheres* as they are called. Into this cleft dips a tight stiff membrane, resembling a scythe in shape, and hence called the *falx* (scythe), or, sometimes, from its being a mere fold of the *dura mater*, the *falciform* (*scythe-like*) *process* of the *dura mater*. From its dipping down between the two halves of the brain, the chief purpose of this membrane seems to be, to relieve the one side from the pressure of the other, when the head is reclining to either side.



B

Each half or *hemisphere* of the brain is, in its turn, divided into three portions, called, from their situations, the *anterior*, *middle*, and *posterior lobes*, each occupying nearly a third of the whole length of the brain. These divisions are manifest only on the under surface of the brain, and in the subjoined wood-cut they are represented by the lines E E and F F. In their natural situation, the anterior lobe lying above the dotted line E E, occupies the forehead; the middle lobe, or that portion lying between the two transverse lines E E and F F, is situate above and a little in front of the ears; and the posterior lobe lying below the transverse line F F, corresponds to the back part of the head.



Beneath the posterior lobe, a strong fold of the dura mater, called the *tentorium*, is extended horizontally to support it and separate it from the *cerebellum* or little brain A A lying below it. The cerebellum forms the last great division of the contents of the skull. Its surface is marked by convolutions, differing, however, in size and appearance from those observed in the brain.

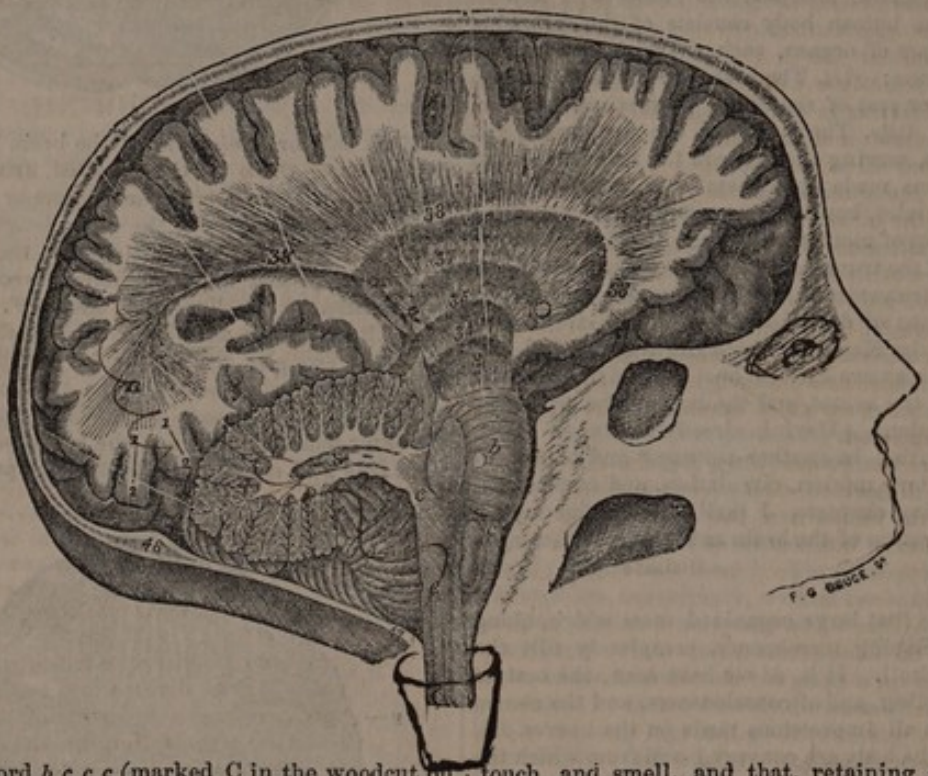
Adhering to the surface of the convolutions, and consequently dipping down into and lining the *sulci* or furrows between them, another membrane of a finer texture and greater vascularity, called *pia mater*, is found. The bloodvessels going to the brain branch out so extensively on the pia mater, that, when a little inflamed, it seems to constitute a perfect vascular net-

* On Digestion and Diet.

work. This minute subdivision is probably of use in preventing the blood from being impelled with too great force against the delicate tissue of the brain.

A third covering called the *arachnoid* membrane, from its fineness resembling that of a spider's web, is interposed between the other two, and is frequently the seat of disease.

On examining the convolutions in different brains, they are found to vary a good deal in number, size, depth, and general appearance. In the various regions of the same brain they are also different, but preserve the same general aspect. Thus, they are always small and numerous in the anterior lobe, larger and deeper in the middle, and still larger in the posterior. The depth to which they penetrate may be judged of from their appearance in the subjoined figure, representing a vertical section of the brain, cerebellum, and medulla oblongata.



The thick cord *b c c c* (marked C in the woodcut on p. 75), seen springing from the base of the brain, and stretching downwards towards the spine, is named the *medulla oblongata*, or oblong portion of the spinal marrow. At one time the brain has been regarded as proceeding from, and at another as giving rise to, the spinal marrow; but, in reality, the two are merely continuous, and neither grows from the other. The false analogy of a stem growing from a root has led to this abuse of language.

The small round filaments or cords seen in the woodcut on p. 75 to proceed from the sides of the medulla oblongata, and from near the base of the brain, are various *nerves* of sensation and motion, some of them going to the organs of sense, and others to the skin and muscles of the face, head, and other more distant parts. The long flat-looking nerve *a a*, lying on the lower surface of the anterior lobe, is the *olfactory nerve*, or nerve of smell, going to the nose. The round thick nerve 4 4, near the roots of the former, is the *optic nerve*, or nerve of vision, going to the eye. That marked *b* is the *motor nerve*, which supplies the muscles of the eyeball. A little farther back the fifth pair *c*, is seen to issue apparently from the arch D, called *Pons Varolii*, or *bridge of Varolius*. It is a large compound nerve, and divides into three branches, which are ramified on almost all the parts connected with the head and face, and the upper and under jaw. It comprehends nerves of both sensation and motion, and one branch of it ramified on the tongue is the nerve of taste. Other branches supply and give sensibility to the teeth, glands and skin. The seventh or *auditory* nerve *e*, is distributed on the internal ear, and serves for hearing. The eighth or *pneumogastric* nerve *d*, sends filaments to the windpipe, lungs, heart, and stomach, and is one of great importance in the production of the voice and respiration. It also influences the action of the heart, and the process of digestion.

Before quitting this part of the subject it may be useful to the reader to state generally, that *the nerves of animal life* serve chiefly to place the mind and its organ the brain in communication with the external world; and that their importance may be best understood by imagining what man would be without them. Suppose, for example, that any one were suddenly deprived of the services of the nerves of sight, hearing, sensation, touch, and smell, and that, retaining all his *internal* powers of emotion and thought unimpaired, he were, from the destruction of his muscular nerves, also to lose the power of regulating his own movements, what would be the result, and how long could he exist? Is it not clear that he would be left in the midst of creation in a darkness, silence, and death, compared with which the awful solitude of "the last man" would be a pleasurable and social crowd? Without nerves to convey to the brain the impressions derived from external objects, no interchange whatever of thought or feeling could take place between man and man, and no image from without ever reach the mind. Unless the nerves of sight and hearing announce to our consciousness the entrance of our friend, we must remain unmoved and unaffected by his presence; and unless the muscular nerves were ready to obey the commands of the will, we could no more extend a hand to welcome him or give expression to our joy, than if we lay in a swoon powerless at his feet. In this way the mind and body are equally dependent on each other. Without a brain to think, and nerves, muscles, and bones to execute, the mind would be, so far as we are concerned, powerless and useless. And these organs, on the other hand, without mind to guide and direct them in their exercise, would be, like the paralyzed limb, an unmeaning and motionless encumbrance.

Such, then, is a brief outline of the relative uses of

the brain and nerves. The study of the functions of the nerves abounds in interest and attractions for every intelligent mind; but as their minute investigation would lead me too far from the objects more immediately in view, I must, for the present, pass them over in silence, and return to the consideration of the brain, which, as the organ by which all the mental operations are carried on and continually influenced, possesses claims upon our attention which it is impossible to overrate.

As already remarked, all physiologists are agreed that the brain is the organ of the mind, and that during life its co-operation is as indispensable to the active manifestations of the mental faculties as the eye is to the sense of sight, or the ear to that of hearing. But for practical purposes, it is extremely important to go a step farther than this general fact, and ascertain whether, in manifesting the mind, the brain acts as a single organ in *every* mental operation, or whether it is really an aggregate of different parts, each appropriated to the exercise of a distinct power of the mind, in the same way as each of the organs of the external senses is appropriated to its special function. On this question, also, there is now scarcely any diversity of opinion, as almost all observers concur in considering the latter to be the only correct view; and even those who deny the minuter subdivisions advocated by the phrenologists, agree in regarding the anterior lobe as the immediate seat of *intellect*, and the other parts of the brain as the seat of the passions and moral feelings, as well as of consciousness and every other mental act. There are so few exceptions to the general belief of these propositions, that I consider myself fairly entitled to hold them as established; particularly as the phrenologists have of late years succeeded in demonstrating their truth by a mass of evidence which, when carefully examined, it is impossible successfully to resist.

If this were the proper place for the discussion, it would not be difficult to adduce very conclusive evidence in favour of the proposition, that every primary mental power, whether of intellect or of feeling, has a portion of the brain specially appropriated for its own exercise. Many, indeed, who have not examined the question, deny this great truth, on the ground that it is incompatible with the *unity* of the mind itself. But this objection entirely disappears when we recollect that each of the external senses, which we know to be equally distinct primary powers of the mind, acts through the medium of an organ appropriated for its exclusive use; and yet, in this unquestionable fact, no one sees anything in the least incompatible with the unity of the mind. When we come to treat of the applications of the physiology of the brain and nervous system to the purposes of human improvement, we shall perceive the importance of keeping the above principle in view as a practical guide. But at present I shall merely remark, that the simple axiom now recognised in comparative anatomy,—that no single organ can execute more than one distinct function,—is of itself sufficient to prove that one organ cannot serve for the operation of all the mental powers. Accordingly, even the Edinburgh Review, which, in more than one instance, has evinced great hostility to some of the above views, as included among those of the phrenologists, has another time powerfully inculcated them as acknowledged physiological truths. Undeterred by the statement in one volume, that we have no evidence for believing that the brain is at all concerned in any mental acts except those connected with the external senses, a reviewer expressly and truly asserts in another, that, exactly in proportion as we ascend in the scale of creation, and the animal acquires a sense, a power, or an instinct, do its nerves multiply, and "its brain improve in structure and augment in volume; *each addition being marked by some addition to, or amplification of, the powers of the animal, until in man we behold it possessing some parts of which animals are destitute, and wanting none which they possess;*" so that "*we are enabled to associate every faculty which gives superiority with some addition to the nervous mass, even from the smallest indications of sensation and will, up to the highest degree of sensibility, judgment, and expression.*"* It is thus that while many animals possess individual senses or instincts in greater perfection than man, there is not one which can be compared with him in the number and range of its faculties; and, concurrently with this, there is not one which approaches him in the development and perfection of its nervous system.

The mind and brain being thus so closely associated during life, that the former acts in strict obedience to the laws which regulate the latter, it becomes an object of primary importance in education to discover what these laws are, in order that we may yield them willing obedience, and escape the numerous evils consequent on their violation. To this inquiry I shall devote the following chapter, and begin with those which apply to the brain considered as a whole.

CHAPTER XII.

CONDITIONS OF HEALTH OF THE BRAIN—LAWS OF MENTAL EXERCISE.

Conditions of cerebral health, organic and functional.—Organic conditions. Influence of hereditary constitution—of the state of the mother during pregnancy—of a due supply of well-constituted blood—of diet, especially in early life—of errors in diet—of insufficient nourishment.—Influence of the quantity of blood upon the brain.—Connexion between the activity of the circulation and that of the brain—examples in illustration.—Functional conditions of health and their mode of action.—Physiological laws of exercise.—Cerebral and mental activity always coincident.—Influence of inactivity of brain upon its health—shewn in persons in solitary confinement or living in retirement.—Beneficial effects of regular exercise of the brain and mind.—Influence of excessive mental activity and excitement of brain—examples of it in infancy, youth, and old age—Cases of Sir H. Davy, Scott, and Lord Dudley.

THE principal conditions on which the health of the brain depends may be divided into two great classes,—the one having reference to its nature as a constituent part of the living organization, and the other to the peculiar and important functions which it performs. Under the first head may be included every thing which directly affects the nutrition and physical well-being of the brain: while under the latter may be comprehended whatever affects the brain indirectly or through the medium of the mind. In ordinary language, the former may be designated as the *physical or organic*, and the latter as the *mental* or *functional* conditions of cerebral health. In a strictly logical sense, however, both may be termed organic, since mental causes produce disease only by inducing changes in the brain itself; but as the distinction will be useful in practice, I shall not hesitate to adopt it.

If we inquire attentively by what peculiarities those individuals have been distinguished who have enjoyed a high degree of mental and bodily health, throughout a long and active life, we shall find that, with scarcely an exception, they have all inherited from their progenitors a sound constitution of both mind and body. The reflecting reader, therefore, will not be surprised that, among the *organic conditions* by which the health of the brain is most directly secured, I should name first, the possession of a *sound hereditary constitution*. Experience shews, indeed, that the importance of this condition, as a preservative, can scarcely be overrated. Where it is possessed, and where no unusual susceptibility of disease has been generated by mismanagement

* Edinburgh Review, No. xciv. p. 442-3.

in early infancy, it constitutes by far the most efficient safeguard which any human being can obtain of future cerebral and mental health under whatever circumstances of trial and anxiety he may be afterwards placed. Where, on the other hand, it is wanting, and where an individual has the misfortune to be sent into the world with a brain and nervous system on which the peculiarities of insane, eccentric, or highly excitable parents are strongly imprinted, and especially where injudicious treatment in childhood has aggravated the original defect, the most careful and rational management in after life will often fail to prevent the invasion of nervous misery or mental derangement, from causes to which those more soundly constituted may be habitually exposed, without injury to either mind or body. Let it never be forgotten, then, that the transmission of a *hereditary* tendency from parents to children, producing in the latter an unusual liability to the maladies under which the parents have laboured, is one of the most powerful causes which *predispose* to cerebral and mental disease.

Even where the original defect in the parent is merely some peculiarity of disposition or temper, amounting perhaps to eccentricity, it is astonishing how clearly its influence on some one or other of the progeny may often be traced, and how completely a constitutional bias of this description may interfere with a man's happiness or success in life. I have seen instances in which it pervaded every member of a family, and others in which it affected only one or two. When the original eccentricity is on the mother's side, and she is gifted with much force of character, the evil extends more widely among the children than when it is on the father's side. Where both parents are descended from tainted families, the progeny is, of course, more deeply affected than where one of them is from a pure stock; and, seemingly for this reason, hereditary predisposition is a more usual cause of nervous disease in the higher classes, who intermarry much with each other, than in the lower, who have a wider choice.

Unhappily, it is not merely as a cause of disease that this predisposition is to be dreaded. The obstacles which it throws in the way of permanent recovery, are even more formidable, and can never be entirely removed; and hence the direct interest we have in avoiding the perpetuation of the mischief by imprudent intermarriages. If two persons, each naturally of an excitable and delicate nervous temperament, choose to unite for life, and especially if they marry at a very early age, when the natural excitability of the system is at the highest, it will be almost impossible to prevent the concentrated influence of these peculiarities from destroying the health of their offspring, and subjecting them to all the miseries of nervous disease, madness, or melancholy.

Even where no hereditary defect exists, the state of the mother during pregnancy has an influence on the mental character and health of the offspring of which few parents have any adequate conception, but with which every mother ought to be familiar. In my work on Mental Derangement, I referred in proof of this fact, to the testimony of the late M. Esquirol, whose talent, general accuracy, and extensive experience, give great weight to all his well-considered opinions. It is often, he says, in the maternal womb that we are to look for the true cause, not only of imbecility, but also of the different kinds of mania. During the agitated periods of the French revolution, many women then pregnant, and whose minds were kept constantly on the stretch by the anxiety and alarm inseparable from the epoch at which they lived, and whose nervous systems were thereby rendered irritable in the highest degree compatible with sanity, were afterwards delivered of infants whose brains and nervous systems had been affected to such a degree by the state of their parent, that in future life, as children they were subject to spasms, convulsions, and other nervous affections, and in youth to imbecility or dementia, almost without any exciting cause. The extent to which the temporary state of the mother during gestation may influence the whole future life of the child, may be conceived from a single fact recorded by the same author. A pregnant woman, otherwise healthy, was greatly alarmed and terrified by the threats of her husband, when in a state of intoxication. She was afterwards delivered, at the usual time, of a very delicate child. The child had, however, been so much affected by its mother's agitation, that, up to the age of eighteen, it continued subject to panic terrors, and then became completely maniacal. The nervous timidity of James VI., so ludicrously exhibited by Sir Walter Scott in the Fortunes of Nigel, is said to have had a similar origin. I have myself seen several instances of the same kind, and among others one of a young lady, whose extreme nervous sensibility was partly attributable to prolonged excitement and alarm in her mother, who, when pregnant with her, spent several days half immersed in water during a storm at sea, and in hourly expectation of shipwreck and death. But as, in my work *On the Management of Infancy*, I have dedicated a chapter to the consideration of the influence of the mother upon the health of the child, I need not continue the subject here.

The next of the organic conditions by which the health of the brain is directly affected, is a due supply of well-constituted blood. The effects of slight differences in the quality of the blood are not easily recognised, but, when extreme, they are too obvious to be overlooked. If the stimulus of arterial blood be altogether withdrawn, the brain ceases to act, and sensibility and consciousness become extinct. Thus, when fixed air is inhaled, the blood circulating through the lungs does not undergo that process of oxygenation which is essential to life; and as it is in this state unfit to support the action of the brain, the mental functions become impaired, and death speedily closes the scene. If, on the other hand, the blood be too highly oxygenated, as by breathing oxygen gas instead of common air, the brain is too much stimulated, and an intensity of action bordering on inflammation takes place, which also soon terminates in death.

Such are the consequences of the two extremes; but the slighter variations in the state of the blood have equally sure, although less palpable, effects. If its vitality be impaired by breathing an atmosphere so much vitiated as to be insufficient to produce the proper degree of oxygenation, the blood then affords an imperfect stimulus to the brain; and, as a necessary consequence, languor and inactivity of the mental and nervous functions ensue, and a tendency to headach, syncope, or hysteria, makes its appearance. This is seen every day in the listlessness and apathy prevalent in crowded and ill-ventilated schools; and in the headaehs and liability to fainting which are so sure to attack persons of a delicate habit in the contaminated atmospheres of crowded theatres, churches, and assemblies. It is seen less strikingly, but more permanently, in the irritable and sensitive condition of the inmates of cotton-manufactories and public hospitals. In these instances, the operation of the principle cannot be disputed, for the languor and nervous debility consequent on confinement in ill-ventilated apartments, or in air vitiated by the breath of many people, are neither more nor less than minor degrees of the same process of poisoning to which I have formerly alluded. It is not real debility which produces them; for, unless the exposure has been very long, egress to the open air almost instantly restores activity and vigour to both mind and body. In cases of disease, also, the influence of pure air upon the action of the brain is not less remarkable. Dr A. T. Thomson, in his late work on the *Management of the Sick-Room*, mentions having "seen patients labouring under high delirium in a close ill-ventilated room, be

come rapidly collected by merely lowering the heat of the apartment twelve or fifteen degrees," (p. 117.) Other testimony to the same effect might easily be produced.

But impure air is not the only medium through which the brain is deprived of a proper supply of well-constituted and nutritious blood. Want of wholesome food, and defective powers of digestion, are equally influential in impairing the vital properties of that fluid; and hence, at all periods of life, but especially in childhood and youth, when the brain, in common with other organs, is in a state of great activity and rapid development, the proper management of diet is a subject of the greatest practical importance. In my other works,* I have already fully explained the mode in which defective nourishment impairs the powers of the mind by weakening the brain, and unfolded the principles by which diet ought to be regulated at different periods of life, so as to secure the highest bodily and mental health of which the constitution is capable. But there are still one or two circumstances to which, from their practical importance, and from their being often overlooked in the dietetic arrangements for the young, I must again solicit the attention of the reader.

In my work *on Diet*, I have shewn that, in conformity with the great activity of growth and nutrition in early youth, the craving for food returns much sooner than in mature age, and that to sustain the healthy vigour of the system, a wholesome and substantial dinner ought to follow within at most five hours after breakfast. When, as often happens from a bad arrangement of the school hours, dinner is postponed much beyond this interval, and only some slight refreshment is allowed in the forenoon, the inevitable result of the want of due sustenance is, that the system becomes proportionally exhausted, and the mind itself impaired in energy and activity. Where much constitutional delicacy exists at the same time, the health also suffers slowly but certainly. In boarding schools, such results are not unfrequently observed, especially in winter, when the teacher is sometimes induced, by the shortness of the day, to omit muscular exercise altogether, and to postpone dinner to a late hour, with a view to having all the lessons over before darkness comes on. I have known this arrangement adopted at the solicitation of the pupils themselves, who were too ignorant to perceive the evils which it entailed upon them, and who ought never to have been indulged in a way so prejudicial to their own welfare. In one instance in which continued bad health was thus induced, it resisted all the curative efforts of the physician and the parents, so long as the cause was left in operation; but recovery began from the moment that a more rational plan was adopted, at my suggestion. By a simple change of hours, and allowing a long interval at mid-day for an early dinner, the boy was enabled to continue his education without interruption, although matters had gone so far, that the parents had made up their minds to remove him from school and send him to the country, as the only probable means of saving his life.

Another form in which the brain, in common with the rest of the body, often suffers from defective nutrition in early life, consists in neglect of sufficient relaxation during, and for some time after, eating. In many schools and families, books are taken up, lessons resumed, or tasks begun, almost immediately after meals, instead of an interval of relaxation being allowed to facilitate digestion and give the system the benefit of the food. Strong healthy children resist this cause of impaired health more or less successfully; but it often injures very seriously the more delicately constituted, and helps to ruin both the stomach and the nervous system. But it would lead me too far from the proper object of this work to go more minutely into its consideration here.

Those who have never reflected on the influence of a well-arranged diet and sound digestion on the health of the brain and mental functions, may obtain some idea of its reality from the examination of extreme cases. Starvation, for example, is well known to affect the brain so much as often to produce ferocious delirium. This result was painfully exemplified not many years ago, after the wreck of the Medusa French frigate on the coast of Africa, when scenes of cruelty and horror took place under the influence of hunger, which it is impossible to read of without shuddering. In the Milanese, also, a species of insanity arising from defective nourishment is very prevalent, and is easily cured by the nourishing diet provided in the hospitals to which the patients are sent. I have seen the mental functions weakened, and the brain disordered, by the same cause —inadequate nutrition—at the period of rapid growth. This defective nutrition, however, it must be observed, does not always depend on want of proper food. On the contrary, it is often the result, among the higher classes, of too much or too stimulating food over-exciting, and ultimately impairing, the digestive powers. The proneness to morbid excitement in the brain, induced by insufficient food, is one cause why, in times of public distress, the suffering poor are so apt to resort to violence to remove the sources of their discontent.

But important as is the *quality* of the blood to the healthy action of the brain, the *quantity* and regularity of its supply are of scarcely inferior consequence. If, as often happens from accidental wounds, and during blood-letting, the quantity of blood circulating through the brain be suddenly diminished, the effect may be so great as entirely to arrest its action and destroy consciousness. Even where the loss of blood, although considerable, is not sufficient to produce this result, it will, nevertheless, impair the vitality of the brain, and often lower the mental vigour so much as to unfit the individual for a time for active or energetic thinking. When, on the contrary, the circulation of the blood through the brain is accelerated within certain limits, increased action and its accompaniment increased mental activity, are the certain results. In this respect the brain is situated precisely as is every other organ of the body. When not stimulated by a full supply of well-constituted blood, it acts feebly and imperfectly; and when a full supply is afforded, it becomes proportionally excited to higher activity, till, if this condition be carried to excess, the excitement may end in violent delirium or maniacal furor.

The law, in virtue of which excitement of function and activity of circulation in the organ performing it, are always coincident, being thus as applicable to the brain as to all other organs, common prudence requires, that, in conducting both physical and mental education, we should take the fact into account, and regulate our management so as to prevent either deficiency or excess in the cerebral circulation, and to preserve it as far as possible in that equable state which is so manifestly conducive to the health of both mind and brain. But as few unprofessional readers are at all aware of the necessary relation which really subsists between organic and mental activity, I shall adduce two or three illustrative facts before attempting to explain the physiological law which connects them together and which is calculated to afford us much assistance as a practical guide.

In some parts of the body the increased circulation which always accompanies excitement of function may be made the direct subject of experiment. When, for instance, we use the eye too long, or in too bright a light, it is soon observed to become bloodshot, and the increased action of its vessels and nerves gives rise to a sensation of fatigue and pain requiring us to desist. If we turn away the eye, the irritation gradually subsides,

* On Digestion and Diet, third edition. On the Physiology and Moral Management of Infancy, third edition.

and the healthy state returns; but if we continue to look intently, or resume our employment before the eye has regained its natural state by repose, the irritation at last becomes permanent, and disease, followed by weakness of sight or even blindness, may ensue; as often happens to glass-blowers, smiths, and others, who are obliged to work in an intense light.

Precisely analogous phenomena occur when, from intense mental excitement, the brain is kept long in a state of excessive activity. The only difference is, that we can always see what happens in the eye, but rarely what takes place in the brain. Occasionally, however, cases of fracture of the skull occur, in which, from part of the bone being removed, we *can see* the quickened circulation in the vessels of the brain as easily as in those of the eye. Sir Astley Cooper had a young gentleman brought to him who had lost a portion of his skull just above the eyebrow. "On examining the head," says Sir Astley, "I distinctly saw the pulsation of the brain was regular and slow; but at this time he was agitated by some opposition to his wishes, and directly *the blood was sent with increased force to the brain, the pulsation became frequent and violent; if, therefore,*" continues Sir Astley, "*you omit to keep the mind free from agitation, your other means will be unavailing*" in the treatment of injuries of the brain.* A still more remarkable case is mentioned by Dr Caldwell, as having occurred to Dr Pierquin in the hospital of Montpellier in 1821. "The subject of it was a female at the age of twenty-six, who had lost a large portion of her scalp, skull-bone, and dura mater, in a neglected attack of lues venerea. A corresponding portion of her brain was consequently bare, and subject to inspection. When she was in a *dreamless sleep* her brain was *motionless*, and *lay within* the cranium. When her sleep was *imperfect* and she was agitated by dreams, her brain *moved* and *protruded without* the cranium, forming *cerebral hernia*. In *vivid* dreams, reported as such by herself, the protrusion was considerable; and when she was perfectly awake, especially if engaged in active thought or sprightly conversation, it was still greater."† This protrusion arose, of course, from the greater quantity of blood sent to the brain during its activity, than when it was quiet: and if the case be accurately reported, it is certainly one of the most interesting on record.

To these cases, as published in the former editions, I may now add another which has lately appeared in Mr Combe's "Notes on the United States" (vol. ii. p. 279). The patient, a daughter of Mr Mapes of New York, fell from a window when about four years of age, and had her skull so severely fractured, that portions of it, to the extent, in all of about three inches square, were removed near the crown of the head. The brain was of course uncovered to the same extent, and in the region of the organs of Self-Esteem and Love of Approbation. At the time of Mr Combe's visit, the girl was eight years old. The skin over the wound was thin and covered with fine hair; on applying the hand over it a curious leech-like motion was felt in the brain, accompanied with a prominence and pulsation in the part whenever the corresponding feelings were excited. When the feelings were at rest, and her intellect alone was active, as when intent on solving an arithmetical question, only the gentle and equal pulsation of the arterial system was perceptible. In all of these cases, mental activity, and increased circulation, were found invariably to accompany each other.

The well known impulse given to thought and feeling by wine and other stimulants, which act chiefly by increasing the flow of blood to the brain, is but another example of the operation of the same general law, and goes far to justify the opinion of Dr Caldwell, that, if it were "possible, without doing an injury to other parts, to augment the constant afflux of healthy arterial blood to the brain, the mental operations would be invigorated by it. I state," says he, "this opinion confidently, because we often witness its verification. When a public speaker is flushed and heated in debate, his mind works more freely and powerfully than at any other time. Why? Because his brain is in better tune. What has thus suddenly improved its condition? An increased current of blood into it, produced by the excitement of its own increased action. That the blood does, on such occasions, flow more copiously into the brain, no one can doubt who is at all acquainted with the cerebral sensations which the orator himself experiences at the time, or who witnesses the unusual fulness and flush of his countenance, the dewiness, flashing, and protrusion of his eye, and the throbbing of his temporal and carotid arteries. It is well known that, while intensely engaged in a memorable debate last winter in Washington, a distinguished senator became so giddy, by the inordinate rushing of blood into his brain, that he was obliged to sit down, and the senate adjourned to give him time to recover. And, more recently, a new member in the House of Representatives fell while speaking, and suddenly expired from the same cause. A member of the law class of Transylvania, moreover, experienced, a few weeks ago, a convulsive affection from a congestion of blood in the head, induced by excessive excitement of the brain in the ardour of debate,"* In many instances, indeed, the increased circulation in the brain attendant on high mental excitement, reveals itself by its effects when least expected, and leaves traces after death which a. but too legible. How many public men, like Whitbr d, Romilly, Castlereagh, and Canning, urged on by ambition or natural eagerness of mind, have been suddenly arrested in their career, by the inordinate action of the brain induced by incessant toil! And how many more have had their mental power for ever impaired by similar excess! When tasked beyond its strength, the eye becomes insensible to light, and no longer conveys any impressions to the mind. In like manner, the brain, when much exhausted, becomes incapable of thought, and consciousness is almost lost in a feeling of utter confusion.

In delicate persons and in invalids recovering from severe illness, the influence of the quantity of blood upon the action of the brain is often very marked; a mere change from the horizontal to the sitting position will often be sufficient to induce fainting, simply from the want of sufficient blood in the brain to sustain its action. By the same cause, mental power may be impaired without being actually extinguished. A case of this kind was lately communicated to me by an experienced teacher in England, in which the effect of change of position on the brain was so great that the boy seemed to be of "two different characters" when sitting up and lying down. In the former attitude, when the brain was scanti y supplied with blood, he was inactive and looked apathetic and sullen; whereas, when he lay down and the circulation was assisted by the natural gravity of the blood, his real powers of mind became manifest, and he was "animated, talkative, and highly intelligent." This case deserves attention, both because it is in itself of a striking nature, and because it was not communicated as an illustration of the point under discussion, but merely in reference to the general discipline of the institution.

Such are the principal *organic* conditions on which the health of the brain depends. We come now to the consideration of its *functional* or *mental* conditions.

When treating of the laws of exercise (see pages 42 and 50), and explaining the changes which take place in every organ of the body when it is called into activity or in other words when its function is exercised, I took some pains to shew, 1*st*, That when an organ is left too long inactive, the circulation of blood through its vessels becomes feeble and imperfect, and the organ itself im-

* See Sir A. Cooper's Lect. on Surg. by Tyrrel, vol. i. p. 276.
† Annals of Phrenology, No. i. p. 37.—Boston, 1833.

* Caldwell's Thoughts on Physical Education, p. 114.

paired in tone, and unfit to act with ease or energy; 2*dly*, That when an organ is regularly and duly exercised, it receives a proportionably copious supply of blood, and acquires a healthy and vigorous tone, with a corresponding aptitude for free and ready action; and, lastly, that when functional exercise is carried to excess, or is repeated without sufficient intervals of repose, the circulation through the organ becomes unduly accelerated, and that, as a consequence, the function becomes excited, and is carried on with an energy and activity which are apt to exceed the limits of health, and to induce either disease or exhaustion. From these fundamental principles I deduced the practical rule, that, in our management of ourselves and others, the second degree of exercise is that at which we ought to aim with a stedfast eye, and from which alone we can expect beneficial results. I have now to shew that this practical inference applies with equal force to the brain as to other organs, and that, in endeavouring to promote its health, we must either regulate the exercise of all its functions by the ordinary laws of physiology, or forfeit the advantages which their fulfilment is destined to confer upon us.

Having already shewn not only that increased activity of brain, and an increased flow of blood through its vessels, are inseparably connected, but that within certain limits the one is always proportioned to the other, it follows that, as the function of the brain is to manifest the various powers of the mind, *activity of mind* necessarily implies a corresponding *activity of brain*, and is attended with all its physiological results. Or, in other words, activity of mind is as much the mode of exercise of the brain as walking is of the muscles, or vision of the eye; and it is only by keeping this fact steadily in view that we can see our way clearly through the inconsistencies of different educational theories, and arrive at principles sufficient for our own guidance. Let us now see how far the ordinary laws of physiology apply to the exercise of the cerebral functions.

That *inactivity of the brain* impairs its healthy energy, and, as a necessary consequence, diminishes mental power, is amply proved by daily and hourly experience. Nor will this truth surprise any reflecting person who keeps in mind that, by disuse, muscles become emaciated and weakened, bloodvessels and nerves obliterated, and bone itself softened and altered in structure; and who considers that, as a part of the same animal system, the brain is nourished by the same blood, and subjected to the same vital laws, as the muscles, bones, and nerves. For direct proof, however, I need only refer the reader to the well known influence of solitary confinement upon the bodily and mental condition of even the most energetic and robust. Solitary confinement impairs and destroys mental vigour solely by the forced inaction into which it throws the brain, and unless relieved by occupation and the occasional visits of the attendants, it becomes the most destructive punishment which can be inflicted upon any human being. By its unmitigated infliction, the strong minded man lapses in a few days into the feebleness of childhood, and the sternest resolution yields like the willow to the gentlest breeze.

It is from a similar cause that men accustomed for years to a busy and bustling life, almost inevitably become hypochondriacal, melancholy, and enfeebled in mind and resolution, on retiring from business, or from active public service to the quiet of the country, without any pursuit to occupy their attention. The brain and mind, being left in inaction, soon lose their healthy tone, and indolence and ennui appear where calm enjoyment was confidently, but most unreasonably, looked for. It is the same cause which renders that seclusion from society into which invalids are apt to fall, so injurious to both bodily and mental soundness, and which often renders the situation of governesses one of misery and bad health, even where every kindness is meant to be shewn towards them. In many families, especially in the higher ranks, the governess lives so secluded, that she is as much out of society as if she were placed in solitary confinement. For the same reason, those who are cut off from social converse by any bodily infirmity, often become discontented and morose in spite of every resolution to the contrary. The feelings and faculties of the mind, which had formerly full play in their intercourse with their fellow-creatures, have no longer scope for sufficient exercise; and the almost inevitable result is irritability and weakness in the corresponding parts of the brain.

This fact is particularly observed among the deaf and blind, in whom, from their being precluded from a full participation in the same sources of interest as are accessible to their more favoured brethren, irritability, weakness of mind, and idiocy, are known to be much more prevalent than among other classes of people. In the *Dictionnaire de Médécine* (vol. xx. p. 87), Andral gives a description of the deaf and dumb, every word of which bears a direct reference to the above principle; and a similar account has been lately given of the blind by an equally intelligent observer. "The deaf-mute," says Andral, "presents, in his intelligence, his character, and the development of his passions, certain modifications which depend on his state of isolation in the midst of society. He remains habitually in a state of half childishness, is very credulous, but, like the savage, remains free from many of the prejudices acquired in society. In him the tender feelings are not deep; he appears susceptible neither of strong attachment nor of lively gratitude; pity moves him feebly; he has little emulation, few enjoyments, and few desires. This is what is commonly observed in the deaf and dumb, but the picture is far from being of universal application; some, more happily endowed, are remarkable for the great development of their intellectual and moral nature, but others, on the contrary, remain immersed in complete idiocy." Andral adds, that we must not infer from this, that the deaf and dumb are therefore constitutionally inferior in mind to other men. "*Their powers are not developed, because they live isolated from society: place them, by some means or other, in relation with their fellow-men, and they will become their equals.*" This is the cause of the rapid brightening up of both mind and features, which is so often observed in blind or deaf children, when transferred from home to public institutions, and there taught the means of converse with their fellows. In these instructive instances, the whole change is from a state of inactivity of the mind and brain to that of their wholesome and regular exercise.

Our next proposition was, that when all the mental powers are duly and regularly exercised, the brain receives a proportionably copious supply of blood, acquires a healthy and vigorous tone, and becomes fitted for the prompt, free, and energetic action of all the functions appertaining to the mind. In support of this proposition, I shall enter into no details. Besides its being almost self-evident, proofs of its accuracy are of easy access, and abound everywhere in society to such an extent, that it would be a waste of time to reproduce them here. I shall, therefore, pass at once to the principle implied in the third proposition, namely, that when mental exercise is carried to excess, either in duration or in frequency, the circulation through the vessels of the brain becomes excited in a corresponding degree, and ultimately induces a state of disease, which it is not always easy to remove.

When the eye has been intently exercised for a length of time without sufficient intervals of repose, it is observed, as I have said, to become blood-shot and unusually sensitive to the light; and if the exercise be persevered in, inflammation and loss of sight may be the ultimate results.

Precisely analogous consequences ensue when the mind is employed to excess. The vessels of the brain become distended, and its action becomes excited, till

it borders upon, or actually passes into, disease. At any time of life, accordingly, excessive and continued mental exertion is hurtful; but in infancy and early youth, when the structure of the brain is still immature and delicate, permanent mischief is more easily inflicted by injudicious treatment than at any subsequent period; and, in this respect, the analogy is complete between the brain and the other parts of the body, as we have already seen exemplified in the injurious effects of premature exercise of the bones and muscles. Scrofulous and rickety children are the most usual sufferers in this way. They are generally remarkable for large heads, great precocity of understanding, and small delicate bodies. But, in such instances, the great size of the brain and the acuteness of mind are the results of morbid growth; and, even with the best management, the child passes the first years of its life constantly on the brink of active disease. Instead, however, of trying to repress its mental activity, the fond parents, misled by the early promise of genius, too often excite it still farther, by unceasing cultivation and the never-failing stimulus of emulation and praise; and finding its progress, for a time, equal to their warmest wishes, they look forward with ecstasy to the day when its talent will break forth and shed a lustre on its name. But in exact proportion as the picture becomes brighter to their fancy, the probability of its being realized becomes less; for the brain, worn out by premature exertion, either becomes diseased or loses its tone, leaving the mental powers slow and depressed for the remainder of life. The expected prodigy is thus ultimately and easily out-stripped in the social race by many whose dull outset promised him an easy victory.

In speaking of children of this description, Dr Brigham, in an excellent little work on the influence of mental excitement on health, published a few years ago in America, says: "Dangerous forms of scrofulous disease among children have repeatedly fallen under my observation, for which I could not account in any other way, than by supposing that the brain had been exercised at the expense of other parts of the system, and at a time of life when nature is endeavouring to perfect all the organs of the body; and after the disease commenced, I have seen with grief the influence of the same cause in retarding or preventing recovery. I have seen several affecting and melancholy instances of children five or six years of age lingering awhile with diseases from which those less gifted readily recover, and at last dying, notwithstanding the utmost efforts to restore them. During their sickness they constantly manifested a passion for books and mental excitement, and were admired for the maturity of their minds. The chance for the recovery of such precocious children is, in my opinion, small, when attacked by disease; and several medical men have informed me, that their own observations had led them to form the same opinion, and have remarked, that in two cases of sickness, if one of the patients was a child of superior and highly cultivated mental powers, and the other one equally sick, but whose mind had not been excited by study, they should feel less confident of the recovery of the former than of the latter. This mental precocity results from an unnatural development of one organ of the body at the expense of the constitution." (P. 45.)*

Dr Brigham justly remarks, that it is ignorance in the parents which leads to the too early and excessive cultivation of the minds of children, especially those who are precocious and delicate; but from the examples which he gives, and the general bearing of his admonitions, the error of commencing systematic education too soon, and stimulating the infant mind too highly, seems to be decidedly more prevalent in the United States than in this country. Among the "children's books" in the United States, many are announced as purposely prepared "for children from *two* to *three* years old!" and among others are "INFANT Manuals" for Botany, Geometry, and Astronomy!! That mode of teaching is considered the best which forces on the infant mind at the most rapid rate, without regard to health or any other consideration. In this country, children are not generally sent to school so early; but education is still too much restricted to the exclusive exercise of the mental powers, to the neglect of the physical; and, in the instance of delicate children, is pushed on too rapidly. I lately witnessed the fate of one of these early prodigies, and the circumstances were exactly such as those above described. The prematurely developed intellect was admired, and constantly stimulated by injudicious praise, and by daily exhibition to every visiter who chanced to call. Entertaining books were thrown in the way; reading by the fireside encouraged; play and exercise neglected; the diet allowed to be full and heating, and the appetite pampered by every delicacy. The results were the speedy deterioration of a weak constitution, a high degree of nervous sensibility, deranged digestion, disordered bowels, defective nutrition, and, lastly, *death*, at the very time when the interest excited by the mental precocity was at its height.

Such, however, is the ignorance of parents on all physiological subjects, that when one of these infant prodigies dies from erroneous treatment, it is not unusual to publish a memoir of his life, that other parents may see by what means such transcendent qualities were called forth. Dr Brigham refers to a memoir of this kind, in which the history of John Mooney Mead, aged four years and eleven months, is narrated as approved of by "several judicious persons—ministers and others, all of whom united in the request that it might be published, and all agreed in the opinion, that *a knowledge of the manner in which the child was treated, together with the results, would be profitable both to parents and children, and a benefit to the cause of Education.*" This infantile philosopher was "taught hymns before he could speak plainly;" "reasoned with" and constantly instructed until his last illness, which, "*without any assignable cause*," put on a violent and unexpected form, and carried him off. As a WARNING not to force education too soon or too fast, this case may be truly "profitable both to parents and children;" but, as an example to be followed, it assuredly cannot be too strongly or loudly condemned. Infant Schools, however, in which physical health and moral training are duly attended to, are excellent institutions. Such are those established and regulated on the plan of the benevolent Wilderspin, whose exertions have gone so far to demonstrate the importance of early infant training. But I regret to say that many schools lately opened under the same name have scarcely any one sound principle in action, and threaten to do more injury to the children by forced and injudicious intellectual cultivation and close confinement, than will be easily remedied even by the best management in after-life. I know some schools consisting of a single small apartment without any play-ground, and with very imperfect means of ventilation, where upwards of 150 children are crowded together for four or five hours a-day, with no free access to the open air,—no adequate muscular or pulmonary exercise,—no mental recreation worthy of the name,—no systematic cultivation of the moral and social feelings in actual intercourse with each other,—and where, with a few intervals of rest, an occasional march round the room, and a frequent change of subject, the time is consumed in intellectual tasks, to the almost complete exclusion of every thing else. Schools of this description cannot be too strongly denounced as fraught with mischief to the young, and as flagrant abuses of a most valuable principle. But in thus censuring what is radically wrong, we must be careful not to go to the other extreme, and, like Cobbett, condemn as bad that which is so only in its abuses. A

* Remarks on the Influence of Mental Cultivation and Mental Excitement upon Health. By Amariah Brigham, M.D. Boston, 1833.

well-regulated Infant School is an instrument of great power in improving and humanizing mankind.*

In youth, too, much mischief is done by the long daily periods of attendance at school, by the want of adequate sustenance at an early period of the day, and by the continued application of mind, which the ordinary system of education requires. The law of exercise, that long-sustained action exhausts the vital powers of an organ, applies, I cannot too often repeat, as well to the brain as to the muscles; and hence the necessity of varying the occupations of the young, and allowing frequent intervals of active exercise in the open air, instead of enforcing the continued confinement now so common. This exclusive attention to mental culture fails, as might be expected, even in its essential object; for experience shews, that, with a rational distribution of employment and exercise, a child will make greater progress than in double the time employed in continuous mental exertion. If the human being were made up of nothing but a brain and nervous system, it would be very well to content ourselves with sedentary pursuits, and to confine ourselves entirely to the mind. But when observation tells us that we have numerous other important organs of motion, sanguification, digestion, circulation, and nutrition, all demanding exercise in the open air as essential both to their own health and to that of the nervous system, it is worse than folly to shut our eyes to the truth, and to act as if we could, by denying it, alter the constitution of nature, and thereby escape the consequences of our misconduct.

Reason and experience being thus set at nought by both parents and teachers in the management of children, young people naturally grow up with the notion that no such influences as the laws of organization exist, and that they may follow any course of life which inclination leads them to prefer, without injury to health, provided they avoid what is called dissipation. It is owing to this ignorance, that we find young men of a studious or literary habit enter heedlessly upon an amount of mental exertion unalleviated by bodily exercise or intervals of repose, which is quite incompatible with the continued enjoyment of a sound mind in a sound body. Such, however, is the effect of the total neglect of all instruction in the laws of the organic frame during early education, that it becomes almost impossible to warn an ardent student against the dangers to which he is exposing himself, and nothing but actual experience will convince him of the truth. I have lately seen several instances of insanity, and also of total incapacity for future useful exertion, brought on by long protracted and severe study, in subjects whose talents, under a better system of cultivation, would have raised them to that eminence, the injudicious pursuit of which had defeated their own object, and ruined their general health. Pope was a remarkable example of this truth. By excessive application, he had reduced his health to such a deplorable state, that he at last gave way to it and prepared to die. "He fell into that state of exhaustion, which Smollett, too, once experienced for half a year, a *coma vigil*—an affection of the brain, when the principle of life is so reduced that all external objects appear as if passing in a dream,—a sort of torpid indistinct existence." Dr Radcliffe heard of his condition, ordered him to give up study, and to ride on horseback. Pope fortunately followed the advice, and regained comparative health. In two cases of a similar description which came under my own notice, the sufferers made the remark, that early instruction in the structure and laws of the animal economy, such as that which I am now attempting to communicate, might have saved them. Both meant well, and erred from ignorance more than headstrong zeal.

In the first number of the "American Annals of Education," the reader will find an instructive article, which strikingly illustrates the objects of the preceding exposition. "For twenty years and more," says the writer, in reference to what had taken place in an American seminary, "the unnatural union of sedentary with studious habits, contracted by the monastic system, has been killing in the middle age. The Register of Education shews, in one year, 120 deaths. Examine into the particular cases, and these will be found the undoubted effects of sedentary habits. Look at one name there. He had valuable gifts, perfected by two years' academic, four years' collegiate, and three years' theological studies. *He preached, gave much promise, and then died of a stomach disease. He contracted it when a student.* He did not alternate bodily with mental labour, or he had lived and been a blessing to the church. *When he entered on his studies, he was growing into full size and strength. He sat down till his muscles dwindled, his digestion became disordered, his chest contracted, his lungs congested, and his head liable to periodical pains.* He sat four years in College, and three years in theological application. *Look at him now.* He has gained much useful knowledge, and has improved his talents; he has lost his health. The duties of his mind and heart were done, and faithfully so; but those of his body were left undone. *Three hundred and seventy-five muscles, organs of motion, have been robbed of their appropriate action for nine or ten years, and now they have become, alike with the rest of his frame, the prey of near one hundred and fifty diseased and irritable nerves.*"—"Look at another case. Exposure incident to the parson or missionary has developed the disease in his chest, planted there while fitting himself for usefulness. He contracted a sedentary, while he was gaining a studious habit. That which he sows that also shall he reap. The east winds give him colds; a pulpit effort causes hoarseness and cough, oppression and pain. He becomes alarmed and nervous. His views of usefulness begin to be limited. *He must now go by direction, and not so much to labour where otherwise he would have been most wanted, as to nurse his broken constitution.* He soon adds to the number of *mysterious providences*,—to the number of innocent victims, rather, of cultivating the mind and heart, at the unnecessary and sinful expense of the body,—to the number of loud calls to alternate mental and corporeal action daily, for the reciprocal sanity and vigour of both body and mind."

In early and middle life, fever, with an unusual degree of cerebral disorder, is a common consequence of the excessive and continued excitement of the brain, which is brought on by severe study, unremitted mental exertion, anxiety, and watching. Some very marked cases of this kind have come under my observation; but that of Sir Humphrey Davy is so strikingly illustrative of the dangers alluded to, that I cannot do better than lay it before the reader. In November 1807, Sir Humphrey Davy was seized with very severe fever, in consequence of the excitement and fatigue which he underwent when engaged in the researches which led to his splendid discovery of the alkaline metals. "The laboratory of the Institution was crowded with persons of every rank and description, and Davy, as may be readily supposed, was kept in a continued state of excitement throughout the day. This circumstance, co-operating with the effects of the fatigue he had previously undergone, produced a most severe fit of illness, which, for a time, caused an awful pause in his researches, broke the thread of his pursuits, and turned his reflections into different channels. Davy ascribed his illness to contagion caught in experimenting on the fumigation of hospitals." "Upon conversing, however, with Dr Babington, who, with Dr Frank, attended

* Many of my readers will be glad to learn that Dr Brigham's little work has been reprinted in this country in a very cheap form, with notes by the late Dr Macnish of Glasgow. Dr Caldwell's "Thoughts on Physical Education" have also been republished, with notes by Mr Robert Cox. Both works contain facts and principles of great interest to every parent and teacher, and are calculated to be highly useful in advancing the cause of rational education.

Davy throughout this illness, he assured me that there was not the slightest ground for this opinion, and that the fever was evidently the effect of *fatigue and an over-excited brain.* The reader will not feel much hesitation in believing this statement, when he is made acquainted with the habits of Davy at this period. *His intellectual exertions were of the most injurious kind,* and yet, unlike the philosophers of old, he sought not to fortify himself by habits of temperance." "Such was his great celebrity at this period of his career, that persons of the highest rank contended for the honour of his company at dinner, and he did not possess sufficient resolution to resist the gratification thus afforded, although it generally happened that *his pursuits in the laboratory were not suspended until the appointed dinner hour had passed. On his return in the evening, he resumed his chemical labours, and commonly continued them till three or four o'clock in the morning, and yet the servants of the establishment not unfrequently found that he had risen before them.*" Such was the alarming state of his health, that for many weeks his physician regularly visited him four times in the day; and the housekeeper, Mrs Greenwood, never retired to bed except one night during eleven weeks. In the latter part of his illness "he was reduced to the extreme of weakness, and his mind participated in the debility of his body."*

Instances sometimes occur of persons, exhausted by anxiety and long attendance on others, being themselves attacked by fever, and dying, more from the unfavourable state to which previous exhaustion had reduced them, than from the intensity of the fever itself.

Nervous disease from excessive mental labour and exaltation of feeling, sometimes shews itself in another form. From the want of proper intervals of rest, the vascular excitement of the brain, which always accompanies activity of mind, has never time to subside, and a restless irritability of temper and disposition comes on, attended with sleeplessness and anxiety, for which no external cause can be assigned. The symptoms gradually become aggravated, the digestive functions give way, nutrition is impaired, and a sense of wretchedness is constantly present, which often leads to attempts at suicide. While all this is going on, however, the patient will talk or transact business with perfect propriety and accuracy, and no stranger could tell that any thing ails him. But in his intercourse with his intimate friends or physician, the havoc made upon the mind becomes apparent; and, if not speedily arrested, it soon terminates according to the constitution and circumstances of the individual case, in derangement, palsy, apoplexy, fever, suicide, or permanent weakness.

As age advances, moderation in mental exertion becomes still more necessary than in early or mature years. Scipion Pinel, in adverting to the evil consequences of excessive moral or intellectual excitement, acutely remarks, that although in youth and manhood the wear of the brain thus induced may be repaired, no such salutary result follows over-exertion in the decline of life; "*what is lost then is lost for ever.* At that period, we must learn to wait for what the brain is willing to give, and allow it to work at its own time: *to attempt to force it is to weaken it to no purpose;* it becomes excited and quickly exhausted when forced to vigorous thinking."—"Men of exalted intellect perish by their brains, and such is the noble end of those whose genius procures for them that immortality which so many ardently desire."†

Who can peruse these lines without the fate of Scott instantly occurring to his mind as a practical illustration of their truth? In the vigour of manhood, few ever wrote so much, or with greater ease. But when, on the verge of old age, adversity forced him to unparalleled exertion, the organic waste could no longer be repaired, and perseverance only "weakened the brain to no purpose," till morbid irritability became the substitute of healthy power, and he perished by that brain which had served him so faithfully and so efficiently, but which could no longer perform with safety the gigantic efforts which he continued to demand from it.

It is well remarked by Tissot, that the disorders produced by the efforts of the mind fall soonest upon such as are incessantly engaged in the contemplation of the same object. In this case, he adds, there is *only one part of the sensorium* (brain) *acted upon, and that is kept always on the stretch: it is not relieved by the action of the other parts, and therefore is sooner fatigued and injured;* the same rule holding with the brain as with the muscles, that the exercise, which, if divided among the different parts of which it is composed, will strengthen them, will, if confined to a few, exhaust and impair them. Boerhaave himself, after a long period of intense thinking, suffered for six weeks from excitement of the brain, bordering on madness, and characterized by that want of sleep, irritability, and indifference to ordinary interests, which so often appear as the harbingers of insanity.

The number of literary and public men, students and persons in business, who do themselves irreparable injury in this way, is so great, that few of my readers who have had experience of the world will be at a loss for examples even among their own acquaintances. In addition to Davy, Scott, and others, already mentioned, Sir Isaac Newton may be referred to, as it is now certain that his mind was for a time disordered by excessive application, and there is much reason to believe that he never altogether recovered from the shock. The more limited the sphere of talent, the greater the danger of the brain being over-exercised, particularly where the temperament is quick and irritable; and hence the frequency of nervous affections in musicians, and others of susceptible minds, who dedicate their lives to the exclusive cultivation of their arts. It is said that Gretry not only ruined his own health, but lost three highly gifted and beautiful daughters in succession, from over-excitement of the nervous system thus induced; and there can be no doubt that the melancholy fate of Weber was greatly hastened by intense application. He continued deeply engaged in musical composition long after his health was undermined; and even when the hand of death was almost upon him, his avocations pressed so heavily that he could not help exclaiming, "*Would that I were a tailor, for then I should have a Sunday's holiday!*" The philanthropic physician will rather be inclined to exclaim, "Would that mankind would study their bodily structure and functions, and thus learn to preserve longer the health and existence of those whose genius is the source of so many pleasures to the world at large!"

So little, however, is this close connexion of the mind with the brain practically understood, even among educated people, that instances are constantly occurring of the health of the nervous system being ruined by excessive application of mind, without the sufferer in the least suspecting the true cause of his ailments. This fact is well exemplified in the biography of the late Lord Dudley, which presents so many instructive particulars in a physiological point of view, that I regret being unable to notice it at greater length. The following extracts from the Quarterly Review are, however, so appropriate in themselves, and express so clearly the value of the principles which I have been expounding, that I cannot resist laying them before the reader. After mentioning that Lord Dudley was brought up from his earliest years in a state of entire isolation, the reviewer adds, that "the solitary boy, without brothers, sisters, or playfellows of his own age, became a man in habits while yet a child." "Deprived of out-of-door pastimes congenial to youth, he was driven to his books alone for solace and companionship. The lurking hereditary malady was strengthened by his own overstudious and sedentary habits. The irritable susceptibility of the brain was stimulated at the expense of bodily power and health, without which pleasure itself ceases to be *pleasure.* Dear, indeed, is knowledge purchased at the expense of happiness. His foolish

* Paris's Life of Sir H. Davy, p. 183.

† Physiologie de l'Homme Aliéné, p. 177.

tutors took a pride in his precocious progress, which they ought to have kept back. They watered the forced plant with the blood of life; they encouraged the violation of Nature's laws, which are not to be broken in vain; they infringed the condition of conjoint moral and physical existence; they imprisoned him in a vicious circle, where the over-worked brain injured the stomach, which re-acted to the injury of the brain. *They watched the slightest deviation from the rules of logic, and neglected those of dietetics, to which the former are a farce. They thought* of no exercises but in Latin,—they gave him a gradus instead of a cricket-bat, until his mind became too keen for its mortal coil; and the foundation was laid for ill health, derangement of stomach, moral pusillanimity, irresolution, lowness of spirits, and all the Protean miseries of nervous disorders by which his after-life was haunted, and which are sadly depicted in every letter now before us."

"One, indeed, of the boy's many instructors observed the silent operation of these morbid causes; and having learned Latin to some purpose, pursued the golden rule of education, *Mens sana in corpore sano*. This was a wise man after the manner of Anaxagoras, that respectable ancient, who requested on his deathbed that all the schoolboys might have a month's holidays. He accordingly locked the study-door, threw logic to the dogs, turned his pupil out to grass, and set him to work at the unscholastic pursuit of foxes. He opined that it was bodily exertion and mental inaction which generates the rude health—the '*dura ilia*' of country squires and haymakers, who never fatigue their sensoriums, nor fritter away their nervous energy: nor rob their gastric juices from a mistaken regard to their pia maters. The new instructor, therefore, took the Aristotelian method in this decided case of perversion—he bent the twig in the contrary direction, in the hope of ultimately bringing it to the perpendicular. But, unfortunately, the news of this prodigious idling ere long reached the ear of the father, who, never interfering except injudiciously, dismissed the tutor who might have saved his pupil, and people of the old stamp continued in function until the *toga quasi virilis* (of undergraduateship) was assumed."

"The very first lines of Lord Dudley's in the volume before us reveal the sad consequences of this system, already fixed and chronic at the early age of nineteeen. Affixed to the portrait is this postscript—'The verses go on *miserably;* YET I neither drink, hunt, shoot, or fish.' On a smaller peg than this Tissot or Combe would hang a quarto treatise; and truly might Lord Dudley point the moral of their tale, the sure effect of the organic laws of physiology." . . . "Lord Dudley 'writes *because he is unable to sleep.*' Well would it have been had the killing 'yet' of the 'postscript' been corrected into *because*." (*Quart. Rev.* No. 133, p. 85.)

Such is the instructive and melancholy case of Lord Dudley, and such are many more, the details of which are never given to the world. In justice to the reviewer's sagacity, however, I am bound to confess that, as I read his interesting narrative, I had resolved to "point a moral" with it before I came to the expression of his own opinion that it was truly fitted for the purpose.

CHAPTER XIII.

APPLICATION OF THE PRECEDING PRINCIPLES TO THE HEALTH OF THE BRAIN AND NERVOUS SYSTEM, AND TO GENERAL EDUCATION.

Mental or functional conditions of cerebral health.—Manner in which abuse of its functions affects the brain.—Physiological relation between mental power and cerebral organ.—Advantages from acting in accordance with it.—Evils from neglecting it.—Its importance in intellectual and moral education—in the sick-room and in the treatment of the insane.—Every mental faculty and cerebral organ to be exercised for itself.—This principle acted upon in other things, even in savage life—examples—its importance in education—moral as well as intellectual.—Judicious repetition of mental act is the next requisite—examples.—Mental exertion to be avoided after meals.—Bad health from neglecting this.—Best time for study and activity of mind.—Periodicity of action in the nervous system—hence regularity indispensable.—Necessity of distinguishing between mode of cultivation and subjects to be taught.—Consequences of confounding these.—Uses of phrenology in education.

In the present chapter I need not enlarge farther upon the means of fulfilling the *organic* conditions of cerebral and nervous health. These have been already sufficiently explained; but a few additional remarks will be required concerning those conditions which, having a direct reference to the manner in which the mind is exercised, may be correctly designated as *mental or functional.*

It may be stated as a general fact, confirmed by the widest experience, that functional causes, or those which operate by impairing, exciting, or perverting functional activity, are the most efficient of all in inducing organic disease; and as a corollary from this proposition, that the well-regulated exercise of the function is one of the best preservatives of organic health. In the case of the eye, for example, the insufficient or excessive exercise of its function, in straining over minute objects, or in exposing the eye to a very bright light, rarely fails, if continued, to induce disease; while the regulated exercise of vision on a variety of objects in an appropriate light, and at appropriate intervals, tends greatly to strengthen and preserve the eye. In like manner, vitiation of the digestive function from aberrations in diet is the most direct cause of disease in the stomach; while its proper exercise in the use of a well-regulated diet in harmony with the constitution and mode of life, is the best safeguard of its health. The same principle applies to the lungs, the liver, and the heart, in all of which, disease is excited by abuse of their respective functions, more readily perhaps than by any other cause.

In this respect, as shewn in the preceding chapter, the brain, considered as a whole and serving for the operation of all the powers of the mind, constitutes no exception to the general rule; and, accordingly, its health suffers most frequently from causes which disturb its *mode of action*, and is best promoted or restored by the proper regulation of the mental functions. The same rule applies of course to the individual parts of which the brain is composed, each considered as the special organ of an individual mental faculty. Here, consequently, the real importance of the question, Whether the brain is a single or compound organ? becomes more and more apparent. If, as I have endeavoured to shew (see p. 77), the brain is not a single organ serving equally for the manifestation of the whole mind, but an aggregate of many individual parts, each serving for the operation of an individual mental faculty, in the same way as the eye, the ear, and the nose, serve for vision, hearing, and smelling, it follows that each may be exercised independently, and that to provide for the health of *the whole* brain, we must secure the direct and adequate exercise of the whole of its component organs by the corresponding exercise of *all* the moral and intellectual faculties specially connected with them. This may seem a very simple and natural proposition; but the evils which flow from its practical neglect are nevertheless very numerous. If, as phrenology proves, and as most physiologists admit, the moral faculties have their seat in one region of the brain, the intellectual powers in another, and the affections and appetites in a third, it is clear that any one of these groups of faculties, and their corresponding cerebral organs, may be exercised singly without the slightest beneficial influence thence necessarily result,

ing to the other two. By the well-regulated employment of the intellectual faculties, for instance, we may impart strength and readiness of action to the anterior lobe of the brain; and yet, by neglecting the due exercise of the affections and moral sentiments, allow the middle and posterior lobes to become enfeebled by inaction, and, as a consequence, these powers themselves to be impaired in health and vigour. Physiologically speaking, it would be as unreasonable to expect the moral feelings to be strengthened by a cultivation thus restricted to intellect alone, as to expect any improvement in hearing from the exclusive exercise of vision. For the same reason, it would be absurd to expect the improvement of *all* the moral feelings, or of *all* the intellectual powers, from exercise restricted to any one or only a few of their number. As all of them are capable of independent action, it is clear that each must be cultivated individually when we wish to promote its development. The sense of justice may be roused into activity at the same time as the feeling of compassion; but they may also act separately, and the activity of the one is far from necessarily implying that of the other. Pity may even be carried so far as for the moment to weaken and impede the operation of conscience, and the reverse. Hence it is a mere delusion to imagine that we take the surest way to invigorate our moral nature, when we simply inculcate intellectually the duty of being honest, kind, and pious. We must be *trained to the habitual practice* of integrity, benevolence, and veneration in our daily life, and see them made the daily standards of conduct of all around us, before these sentiments can acquire the predominant sway which the Creator manifestly designed them to exercise.

I venture thus earnestly to insist upon the necessity of keeping constantly in view the true relation in which each faculty of the mind stands to its individual cerebral organ, because ignorance or neglect of it has been the source, not only of much suffering and bad health, but of most of the errors which have long impaired the practical efficiency of education as a means of human improvement. Hence, instead of the moral faculties being invigorated, and the social affections cherished by their generous and well-regulated exercise upon their appropriate objects, systematic cultivation is still in a great measure restricted to one or two of our inferior propensities,—emulation and the love of gain,—and to such of the intellectual faculties as seem most likely to minister to their gratification. The necessary result is, that neither morally nor intellectually has education yielded the rich fruits which might be obtained from it under a better system of cultivation.

As regards health, also, the frequent consequence of this error has been, that, from limiting mental activity to the excessive exercise of only a few faculties, these few have, under the powerful stimulus of competition and personal ambition, been roused to inordinate action, and occasionally become diseased, while the others, which might have guided or controlled them, have been rendered, by inaction, comparatively powerless. This is the real explanation of Tissot's remark in a former chapter, that the health of the mind and brain is most apt to give way where the former is intently occupied on a very limited range of objects; for what is this but saying in other words that the health of the mind gives way most readily where a few only of its powers are in constant and excessive activity? On the same principle, the experienced insufficiency of mere intellectual education to improve the moral condition of man is easily explained; for where intellect alone is exercised and the moral powers are left uncultivated, what else can be rationally expected but that the latter and their organs should become weakened by inaction?

In the sickroom, too, many evils have arisen from overlooking the intimate relation subsisting between cerebral and mental activity. In fevers in which nervous sensibility is much excited, and tranquillity and repose of mind are almost indispensable to recovery, it is no uncommon thing to find the attendants indulging in open or whispered conversations, every word of which is calculated to stir up some waking faculty, or give rise to some false impression upon the senses, which may be painfully and hurtfully brooded over in silence by the patient, till the excitement of mind breaks forth in irrepressible delirium, or in wandering thoughts having no relation to the scene or circumstances in which he is placed. This error is thoughtlessly committed by the friends or attendants, under the mistaken belief that so long as no great noise is made, and the conversation is not addressed to the patient himself, and he is not allowed to take any part in it, no harm can result, because he makes no active exertion. But a more correct acquaintance with the connexion subsisting between the mind and its corporeal organs would at once reveal the hidden danger, and prevent even the most inconsiderate from acting in a way so likely to defeat the best efforts of the physician. From the same mistaken view, it is a common practice with many people to admit visiters into the presence of the sick, even where tranquillity has been most strictly enjoined. The intruders are warned, perhaps "not to speak, but only to look," and no suspicion is entertained that the mere presentment of an object, connected with the patient, it may be, by many old associations, is sure to excite to activity, not only the senses and powers of preception, but many of our strongest feelings and habits of thought. I have seen mischief done in this way by those who would willingly have made any sacrifice for the relief of the sufferer, and who were themselves most distressed on being made aware how much their conduct was really opposed to the fulfilment of their dearest wishes.

From the same disregard of the dependence of the health of the nervous system upon the due exercise of all the powers of the mind, emotional and social as well as intellectual, it was long but most erroneously considered sufficient in the treatment of the insane, to place them in secure confinement, without any provision whatever being made for their occupation or amusement, for the gratification of their affections and moral feelings, or for strengthening their reason by friendly intercourse. And when, in such unnatural circumstances —circumstances often sufficient in themselves to shake the healthiest minds—recoveries were few and far between, the unfortunate result was ignorantly ascribed entirely to the mysterious and intractable nature of the disease, and no effort was made to amend it. At last, however, a brighter day has dawned, and it is beginning to be generally understood, that, in insanity, as in other diseases, the laws which preside over the vital functions continue to operate, and that, during derangement as well as when the mind is sound, the regulated activity of every bodily organ exercises a great influence upon its health. As a consequence of this admission, efforts are now made to provide for the insane the means not only of bodily exercise and occupation in the open air, but also of intellectual, moral, and social enjoyment. Severity and neglect are happily laid aside as inconsistent with this purpose, and the unhappy lunatic, formerly controlled by brute force, now finds himself the object of a systematic kindness, and intelligent and active sympathy, the tendency of which is to contribute powerfully towards his recovery, by at once soothing the morbid irritability of his troubled spirit, and securing for him all the enjoyment which he can derive from gratified feelings and affections.

Keeping in view, then, the independent action of the different faculties, and the relation of each to its own cerebral organ, the first of the *functional* conditions of the health of the brain and nervous system, to which it concerns us to direct our attention, is that which points to *the direct exercise of every faculty and its cerebral organ* as indispensable to its free development and vigorous

action. But as this principle is of the highest practical importance, and is habitually lost sight of in moral education and in social life, I cannot refrain from enlarging somewhat further upon it, even at the risk of being tedious.

The principle on which I insist is indeed so much in accordance with the dictates of common sense, that it has long been acted upon in some departments of education, not so much from its importance being recognised, as from an almost instinctive perception of its propriety. When we wish, for example, to train the muscles to the graceful and rapid evolutions of fencing, we do not content ourselves with merely giving directions; but our chief attention is employed in making the *muscles themselves* go through the evolutions, till, by frequent repetition and correction, they acquire the requisite quickness and precision of action. In like manner, when we wish to teach music, we do not merely address the understanding and explain the qualities of sounds, but we train the ear to their attentive discrimination, and the hand to the reproduction of the motions which call them into existence. We follow this plan, because the laws of organization require direct practice, and we feel instinctively that we can succeed only by obeying them. Now, the purely mental faculties being connected during life with material organs, are subjected to precisely the same law; and, therefore, if we wish to improve the reasoning powers, we must exercise them regularly in tracing the causes and relations of things. And, on the same principle, if our aim be to develope the sentiments of Attachment, Benevolence, Justice or Respect, we must exercise each of them directly and for its own sake, and not content ourselves with teaching precepts, which address themselves to the understanding alone; and which, therefore, may be learned with the greatest accuracy, without necessarily imparting even a shadow of increased vigour to any one of the moral emotions just named.

Such being the constitution which God has given us, it ought never to be forgotten, that in education it is the brain, or organ of mind, and not the abstract immaterial principle, which requires cultivation, and that hence *education operates invariably in subjection to the laws of organization*. In improving the *external* senses, we admit this principle readily enough; but whenever we come to the *internal* faculties of thought and feeling, it is either denied or neglected. With gross inconsistency, we admit that the superior quickness of touch, sight, and hearing, consequent upon judicious exercise, is always referrible to increased facility of action in their appropriate organs; but when we explain, on the same principle, the superior development of the reasoning powers, or the greater warmth of feeling produced by similar exercise in the social or moral feelings and other internal faculties, few are inclined to listen to our proposition, or allow to it half the weight or attention which its importance requires, although every fact in philosophy and experience concurs in supporting it. We observe the mental powers of feeling and of thought unfold themselves in infancy and youth, in exact accordance with the progress of the organization; we see them perverted or suspended by the sudden inroad of disease, and as suddenly restored; nay, we sometimes observe every previous acquirement obliterated from the adult mind by fever or by accident, leaving education to be commenced anew, as if it had never been; and yet with all these evidences of the organic influence, it is still a novelty in education to propose that the established laws of physiology, as applied to the brain, should be considered as our best and surest guide; and scarcely a volume can be pointed out in which it is even hinted that these laws have the slightest influence over mental or moral improvement.

Were a general acquaintance with the laws of organization to be held as an indispensable part of a liberal education, we should then be able to inculcate, with tenfold force and success, the necessity of actively exercising every faculty, whether of thought, feeling, or motion, directly *on its own objects*, and at once to explode the mistake of supposing that any organ or function may be efficiently exercised through the medium of another, and that, to produce high moral feeling, it is sufficient to address ourselves to the intellect alone. The merest savage, following the footsteps of Nature, would pity the philosopher who should seriously assure him that, to cultivate acuteness of hearing or of vision, it was sufficient to be told how to listen or to look. The savage goes more directly and surely to work. If he wants physical strength, agility, and swiftness of foot, he sets himself to develope the muscular system of his child by ample muscular exercise, by constant repetition of the movements and acts he wishes him to perform, and by causing him to run, to leap, or to swim; and he rests in the well-founded hope of accomplishing his purpose. Following the same rule when he seeks acuteness of hearing, he does not merely tell his child how to listen, but he lays him with his ear to the ground, and teaches him, by practice, to distinguish the qualities of sounds. If he wishes him to excel in hunting, in fishing, in lying in ambush, or in scenting the approach of an enemy, he expects to be successful only in proportion as he finds occasion to employ him in the practice of these pursuits. If he wishes to inculcate courage in battle, contempt of pain, endurance of fatigue, obedience to chiefs, or revenge upon enemies, he does not satisfy himself with mere precept, but resorts at once to *practice*, and by subjecting his child to hardship and privations, exposing him to danger, and exacting from him unhesitating submission to authority, he succeeds in eliciting all the qualities essential for the circumstances under which he lives, and without the possession of which he would neither be safe from his enemies nor respected by his friends.

With this experience before our eyes, then, let us, who pretend to superior wisdom and civilization, shew ourselves also consistent, and ready to receive instruction from whatever quarter it may come. As God has given us bones, and muscles, and bloodvessels, and nerves, for the purpose of being used, let us not despise the gift, but consent at once to turn them to account, and to reap health and vigour as the reward which He has associated with moderate labour. As He has given us lungs to breathe with, and blood to circulate, let us abandon the folly of shutting ourselves up with so little intermission, engaged in motionless study and sedentary occupations,—and consent to inhale copiously and freely that wholesome atmosphere which His benevolence has spread around us. As He has given us appetites and organs of digestion, let us profit by His bounty, and earn their enjoyment by healthful exercise. As He has given us a moral and a social nature, which is invigorated by activity, and impaired by solitude and restraint, let us cultivate good feeling, and act towards each other on principles of kindness, justice, forbearance, and mutual assistance; and as He has given us intellect, let us exercise it in seeking a knowledge of His works and of His laws, and in tracing out the relation in which we stand towards him, towards our fellow-men, and towards the various objects of the external world: and, in perfect faith and sincerity, let us rely upon His promise, that, in so doing, we shall have a rich reward—a reward a thousand times more pure, more permanent, and more delightful, than we can ever hope to experience in following our own blind devices, regardless of His will and intentions towards us.*

* Those of my readers who wish to pursue the inquiry, and to trace the relations in which Man stands to his Creator, to his fellow-creatures, to himself, and to the external world, will find a clear and comprehensive guide, in a small volume, entitled "The Constitution of Man, considered in relation to External Objects. By GEORGE COMBE." In this work, of which upwards of 50,000 copies have got into circulation

So little, however, are even educated men familiar with the influence and laws of the organization, that, even in our best directed establishments, as well as in private families, cultivation is still in a great measure confined to intellect alone; and the *direct* exercise and training of the moral and religious sentiments and affections are rarely thought of as essential to their full and vigorous development. Moral precepts are, no doubt, offered in abundance; but these, as we have seen, address themselves chiefly to the intellect. We must not be satisfied with merely exclaiming, "Be kind, just, and affectionate," when perhaps at the very moment we are counteracting the effect of the advice by our own opposite conduct. "*She told me not to lie*," said Guy Rivers, in speaking of his mother, "*and she set me the example herself by frequently deceiving my father and teaching me to disobey and deceive him.*" Conduct like this is more common in real life than is supposed, although generally less flagrant in degree. Parents, indeed, too often forget that the sentiments *feel* and *do not reason*, and that, consequently, even a stupid child may, by the instinctive operation of its moral nature, at once detect and revolt at the immorality of practices, the true character of which its *reason* is unable to penetrate or expose. It is one of the most effectual methods of cultivating and exciting the moral sentiments in children, to set before them the manifestations of these in our habitual conduct, and we should be most careful never to practise before them that which we do not wish them to imitate. If we first chide a child for seeking to indulge its sense of taste, and attempt to impress it with the impropriety of cultivating the animal appetites by devouring sweetmeats and delicacies, and, on sitting down to dinner the next moment, begin to expatiate with delight on the excellence, richness, and flavour of the dishes of which we are partaking, what is the child to think or to do? Seeing practice and precept thus set in opposition, what weight can it possibly attach to the mere verbal injunction? Again, what improving influence can that parent exert over the moral conduct of his child who, verbally recommending kindness, openness, and justice, *tricks* the child into the confession of faults, and then basely punishes it, having previously promised forgiveness? And how is openness best encouraged—by practising it in conduct, or by neglecting it in practice but praising it in words? Is it to be cultivated by thrusting suspicions in the face of honest intentions? Or what kind of moral education is that which says, *Do as I bid you, and I will give you sweetmeats or money, or I will tell your mamma how good you were*; holding out the lowest and most selfish propensities as the motives to moral conduct! Did space permit I might indeed pursue the whole round of moral and religious duties, and ask similar questions at each. But it is needless. These examples will suffice; and I give them not as generally applicable, but simply as individual instances which have come within the sphere of my own knowledge, and which bear directly upon the principle under discussion.

In the practical training of the young, it is of consequence to keep in mind that the moral sentiments, in common with the intellect, are dependent on organization for their means of activity during life, and consequently are more successfully cultivated by being habitually employed in regulating the every-day affairs of life, than by waiting for great occasions on which they may be exercised with unusual vigour. Benevolence, no doubt, is vividly excited by the aspect of great misery and unhappiness, and impels strongly to the relief of the suffering object; but this is not its most common or its most useful field. In ordinary life, it finds ample scope in charity to our neighbours, and in contributing to the happiness of our family circle, and of our associates and dependents. Benevolence is much better occupied in adding a gleam of enjoyment, in removing little sources of irritation, in promoting concord among relatives, and in other kind offices of a similar nature, than in giving alms indiscriminately to all who demand them, or even in relieving occasional distress, where this is held, as it too often is, to dispense with all obligation to habitual forbearance and Christian good-will in the private relations of life. But how little is this most important faculty directly attended to or cultivated, in the way we see done with the faculties necessary for the practice of drawing or music, which, by incessant exercise, procured at a great sacrifice of time, money, and labour, are brought into such a state of activity as ever after to enable their possessors to derive delight from their exercise, where the talents are possessed in any considerable degree! And what might we not expect from the systematic training of the higher sentiments on a similar plan, in improving society and exalting the happiness of the race? But it is evident that the objects of Benevolence are our fellow-creatures; and consequently, if we restrict our intercourse and our sympathies to the limits of our own drawing-rooms, and take no interest in the progress of the race or of the individuals composing it, we leave our best faculties in abeyance, and reap the reward of bodily debility, weariness, and monotony of mind.

Conscientiousness is another moral faculty that requires direct cultivation, and that rarely receives it. It holds the balance between man and man, and is excited by the presentment of any difference of right between individuals, of any injustice, or of any temptation offered by the other faculties, which may lead us to encroach on the rights of other men. It gives a strong sense of duty, with which it is agreeable to act in conformity, but which it is painful and injurious to oppose. It gives weight and force to the impulses of the other sentiments, and, joined with intellect and the feeling of devotion, gives that faith in the beneficence and equity of the Deity, and in the immutablity of all His laws, that forms the strongest encouragement to virtuous conduct and temporary self-denial. But seclusion and privacy afford no scope for such an exercise of conscientiousness; and hence an additional proof that Providence intended every one to live in society, engage in the active duties of life, and act justly amidst the conflicting interests of others!

I need not follow out this exposition in detail. The preceding illustrations will suffice to explain the *principle*; and to exceed this limit would withdraw attention too much from the matters more directly before us.

For the same reason that every faculty ought to be exercised directly upon its own objects, the exclusive use of book-education as a means of conveying instruction is manifestly unnatural as well as inefficient. If allowed to handle and examine a new object, a child will pursue the investigation with pleasure, and in five minutes will acquire a more correct knowledge than by a whole hour's reading about its qualities without seeing it. In the one instance, its perceptive powers are stimulated by the direct presence of the qualities of which they are destined to take cognizance; while, in the other, they are roused only through the imperfect medium of artificial language, and the child has to *create* the object in its own mind before he can take notice of its qualities. When we recollect the different ideas which the same written language suggests to different *mature* minds, we may form some conception of the impossibility of a child making progress in this way, and of the weariness and ennui which the thankless effort must always induce; and yet at the present day, in nineteen out of twenty schools, all the knowledge that is

within the last few years, a general view is taken of the human constitution, and of the laws which regulate the organic, moral, and intellectual nature of man. The sources of most of the evils which afflict the human family are successfully traced to violations of those laws, and shewn to be, to a great extent, within our own control; so that practical usefulness, and not mere speculation, is the characteristic of the volume.

offered is through the medium of books and language alone!

It is well remarked by M. Duppa, in his excellent little work on the education of the peasantry in England, that "it is the habit of accurately observing the actual nature of objects, as perceivable by the senses, and distinctly marking their differences, which in after-life renders a man intelligent and judicious. There are few whose natural faculties are so dull as to be unable to perceive a distinction when pointed out to them, or when their notice is directed towards it,—for instance, that one thing is long, another short; that one is round, another flat, one green and another black. But how few are there who, when minutely questioned, can give a clear or circumstantial description of any object they have been conversant with, or in what particular that object differs from another! And why is this? Because they have not the habit of accurate observation of things; and they have not that habit, *because in modern education a child's observation at the moment when all is new and observation most active, is wilfully drawn away from things to the signs of things; and the boy who might easily have been made to distinguish the nature and properties of the different objects around him, has only learned to distinguish one letter from another.*" (P. 27.)

It is but another proof of the harmony of design in all the works of the Creator, that this method of directly cultivating the observing powers cannot be adequately fulfilled without a certain amount of muscular exertion and of daily exposure to the open air, in going about to collect and examine the varied objects of interest with which creation abounds. In other words, we cannot benefit the perceptive faculties, without at the same time benefitting the muscular system and the organs of respiration, circulation, and digestion; and this grand recommendation in the eye of reason,—pursuing study in the field of nature, instead of in books alone,—is actually, though not avowedly, the circumstance which retards its adoption in ordinary education. To take the scholar out of the school-room to look at the works of God is thought to be encouraging idleness and a love of pleasure, and therefore it is denied!

What, therefore, is wanted is a system of education which shall not only give full play to the intellectual faculties, but also make ample provision for the direct exercise of the physical and moral powers and domestic affections. While we cultivate the intellect, let us never forget that our moral nature is of still greater importance in fitting us for the duties of life. And while we cherish both the intellectual and moral faculties, let us also bear in mind that both act by means of a physical organization, the well-being of which is indispensable to their health and soundness, and to our happiness; and that, therefore, due provision must be made for its active employment either in useful labour or in daily exercise. The details of such a system do not fall under the scope of a treatise like this; and I must, for the present, content myself with the exposition of the general principle.*

During infirm health, a serious obstacle to entering upon the regular exertion here recommended is often present, and arises from a feeling in the patient, against which he cannot be too much on his guard. Where the nervous system is weak, and where it, of course, requires most to be strengthened, there is often a retiring sensitiveness of disposition, leading its possessor rather to avoid than to seek intercourse with society. Feeling the irksomeness of present exertion, the nervous invalid is apt to form the secret resolution to live in solitude *till the mind shall become stronger*, and then to seek society when it will no longer be a burden. Unhappily, however, this feeling leads only to delusion, and the wished-for result becomes every day more distant the longer retirement and indolence are persevered in. It is by activity, and not by repose, that strength is to be acquired. We do not expect to increase bodily strength by lying in bed, but by stirring about; and, in like manner, we shall never succeed in strengthening the nervous system by indulging in solitude and mental indolence. Many are led astray by the false expectation of acquiring strength without using the natural means from which alone strength can be procured.

Another practical principle immediately connected with the proper exercise of the mental faculties and their cerebral organs, and the influence of which has not been sufficiently appreciated in educational management, is that which inculcates judicious *repetition* as indispensable to obtaining *durable* results. The manner in which the repetition of a functional act operates in improving the condition of the organ, may be understood from the explanation formerly given of the influence of exercise upon nutrition (see p. 41). At present it will be sufficient to remark, that to induce strength and facility of action in the organs of the mind, *practice*, or the repetition of the effort, is as essential as it is in the organs of motion. The idea or feeling must not only be communicated, but it must be reproduced and represented in different forms, till all the faculties concerned in understanding it come to work efficiently together in the conception of it, and till a sufficient impression be made upon the organ of mind for the latter to retain it. This is, in truth, the reason why in some parts of this exposition I have ventured upon an extent of repetition, which I should have been the first to condemn and avoid had the subject been less important, or more familiar to the reader. From overlooking this necessity of repetition, we often blame servants for not doing a thing every day, because they were *once* told to do so. The organic laws, however, teach us that we are presumptuous in expecting the formation of a habit from a single act, and that we must reproduce the associated activity of the requisite faculties many times before the result will certainly follow, just as we must repeat the movement in dancing or skating many times before we become master of it. In like manner, we find, on turning to a new subject, that however well we may understand it by one perusal, we do not fully master it, except by dwelling upon it again and again. Repetition is, in fact, the principle by which the division of labour, so well understood in England, leads to such admirable perfection of work, where practical skill, neatness of hand, or high finish, is required; and in the rapid solution of complicated arithmetical questions in many of our common schools, we witness its effects in the operations of mind, quite as remarkably as in those belonging to the mechanical arts.

Repetition is thus necessary to make a durable impression on the brain; and, according to this principle, it follows, that, in learning a language or science, six successive months of application will be more effectual in fixing it in the mind, and making it a part of its furniture, than double or triple the time, if the lessons are interrupted by long intervals. Hence it is a great error to begin any study, and then break off to *finish* at a later period. The *ennui* is thus doubled, and the success greatly diminished. The best way is to begin at the proper age, and to persevere till the end is attained. This accustoms the mind to sound exertion, and not to

* In the *Reports on the Training of Pauper Children*, submitted to the Secretary of State by the Poor Law Commissioners in 1841, the reader will find a vast amount of evidence, of the most instructive kind, illustrative of the principles inculcated in these pages. The whole of it being derived from actual and extensive experience in intellectual and moral training, it possesses a force and value which no unprejudiced and intelligent mind can resist. As regards the prevention of crime, and the general improvement of the poor and working classes in character and social comfort, I consider these Reports to be the most important contribution which the public has received for many years. In Mr Simpson's able work on National Education, the reader will also find an eloquent exposition of the general subject of popular education.

fits of attention. Hence the mischief of long vacations, and hence the evil of beginning studies before the age at which they can be understood, as in teaching the abstract rules of grammar to children; to succeed in which implies in them a power of thinking, and an amount of general knowledge, which they cannot possess.

In physical education, we are quite alive to the advantages of repetition and practice. We know that if practice in dancing, fencing, skating, and riding, be persevered in for a sufficient length of time to give the muscles the requisite promptitude and harmony of action, the power will be ever afterwards retained, although little called into use; whereas, if we stop short of this point, we may reiterate practice by fits and starts, without any proportional advancement. The same principle applies equally to the moral and intellectual powers, because these operate by means of material organs.

The necessity of being in private what we wish to appear in public, springs from the same rule. If we wish to be polite, just, kind, and sociable, we must habitually act under the influence of the corresponding sentiments in the domestic circle and in every-day life, as well as in the company of strangers and on great occasions. It is the daily practice which gives ready activity to the sentiments, and marks the character. If we indulge in vulgarities of speech and behaviour at home, and put on politeness merely for the reception of strangers, the former will shine through the mask which is intended to hide them; because the habitual association to which the organs and faculties have been accustomed, cannot thus be controlled. As well may we hope to excel in elegant and graceful dancing, by the daily practice of every awkward attitude. In the one case, as in the other, the organs must not only be associated in action by the command of the will, but also be habituated to the association by the frequency of the practice; a fact which exposes the ignorant folly of those parents who habitually act with rudeness and caprice towards their children, and then chide the latter for unpolite behaviour towards strangers.

The same principle, of repetition being necessary to make a durable impression on the brain and constitute a mental habit, also explains the manner in which natural endowments are modified by external situation. Taking the average of mankind, the limits to which this modification may be carried are not narrow. Place a child, for example, of *average* propensities, sentiments, and intellect, among a class of people—thieves—in whom the selfish faculties are exclusively exercised; by whom gain is worshipped as the end of life, and cunning and cheating as the means; and among whom is never heard one word of disapprobation or moral indignation against either crime or selfishness; and its lower faculties will be exclusively exercised and increased in strength, while the higher will be left unemployed and become weak. A child so situate will consequently not only act as those around him do, but insensibly grow up resembling them in disposition and character; because, by the law of repetition, the organs of the selfish qualities will have acquired proportionally greater aptitude and vigour, just as do the muscles of the fencer or dancer. But suppose the same individual placed *from infancy* in the society of a superiorly endowed moral and intellectual circle; the moral faculties will then be habitually excited, and their organs invigorated by repetition, till a greater aptitude, or, in other words, a higher moral character, will be formed. There are, of course, limits set to this modification by the natural endowments of the individual; but where the original dispositions are not strongly marked, the range is still a wide one.

In carrying repetition into effect, the times and circumstances under which it ought to be practised also deserve the most serious consideration. On these I shall accordingly offer a few remarks.

It seems to be a law of the animal economy, that two classes of functions cannot be called into vigorous action at the same time, without one or other, or both, sooner or later sustaining injury. Hence the important rule, *never to enter upon continued mental exertion, or to rouse deep feeling, immediately after a full meal*, as the activity of the brain is sure to interfere with that of the stomach, and disorder its functions. Even in a perfectly healthy person, unwelcome news, sudden anxiety, or mental excitement, occurring after eating, will put an entire stop to digestion, and cause the stomach to loathe at the sight of food. In accordance with this, we learn by experience, that the worst forms of indigestion and nervous depression are those which arise from excessive application of mind or turmoil of feeling, conjoined with unrestrained indulgence in the pleasures of the table. In such circumstances, the stomach and brain react upon and disturb each other, till all the horrors of nervous disease make their unwelcome appearance, and render life miserable. Literary men and hard students know this fact from sad experience; but, as they are not aware of the incompatibility of the two processes, of active thinking and active digestion going on at the same time, it is extremely difficult to give them a sense of their danger, and to convince them that an hour or an hour and a half after a meal is more profitably spent in easy relaxation than in the labour of composition. As regards the lower animals, indeed, we are careful enough to observe this organic law; for we do not allow our horses or dogs to be actively exercised till digestion is in some degree completed.

It may be said that mechanics, labourers, and others, hurry away to work immediately after meals without any apparent injury; and that, in the United States, the practice of hastily swallowing dinner and instantly returning to business is almost universal. My answer to this objection is simply, that experience proves the fact, that digestion goes on better when exertion is refrained from and repose is enjoyed; and that the tendency to sleep and inactivity which besets most animals after a full meal shews repose to be, in such circumstances, the intention of nature. It must be observed, also, that the bad effects of immediate exertion are not among those which ensue instantly, or are felt from day to day. They may shew themselves only at the end of months or years, when the influence has, as it were, accumulated by repetition. Although, therefore, the system possesses a certain power of resistance, and many persons seem to escape even for years, it cannot be doubted that opposition to the law of nature will eventually prove injurious. The extreme prevalence of dyspeptic complaints and of insanity among the Americans, is doubtless partly owing to the very practice which is supposed by some to be harmless to them. Dr Caldwell of Lexington, who has devoted much time and talent to the diffusion of sound knowledge and the improvement of the race, and whose opportunities of observation have been very extensive, expressly states, that "dyspepsia and madness prevail more extensively in the United States than among the people of any other nation. Of the amount of our dyspeptics," he says, "no estimate can be formed; but IT IS IMMENSE. Whether we inquire into cities, towns, villages, or country places, among the rich, the poor, or those in moderate circumstances, we find dyspepsia more or less prevalent throughout the land."* It is clear from this testimony, which is confirmed by many other observers, that the people of the United States form no exception to the general law of Nature, and that they *do* suffer for their hurried eating and neglect of repose after meals.

The time best adapted for mental exertion falls next to be considered. Nature has allotted the darkness of night for repose, and for the restoration, by sleep, of the exhausted energies of mind and body. If study or composition be ardently engaged in towards that period of the day, the increased action in the brain which al-

* Caldwell's Discourse on Physical Education, p. 87.

ways accompanies activity of mind requires a long time to subside; and, if the individual be at all of an irritable habit of body, he will be sleepless for hours after going to bed, or perhaps be tormented by unpleasant dreams. If, notwithstanding, the practice be continued the want of refreshing repose will ultimately induce a state of morbid irritability of the nervous system, not far distant from insanity. It is, therefore, of great advantage to engage in severer studies early in the day, and devote two or three of the hours which precede bed-time, to lighter reading, music, or amusing conversation. The vascular excitement previously induced in the head by study has then time to subside, and sound refreshing sleep is much more certainly obtained. This rule is of great consequence to those who are obliged to undergo much mental labour, and it will be found that many of our most prolific writers,—of those especially who write much and yet preserve their health,—are among those who have, either from knowledge or from inclination, devoted their mornings to study and their evenings to relaxation, and who also indulge in ample exercise. Such was Sir Walter Scott's distribution of his time, and such I know to be that of one of our ablest living writers.

There are, no doubt, individuals so happily constituted, and whose natural sphere is so essentially that of activity, that they are able to think and work early and late, for years in succession, with very little sleep, and with little regard to diet and regimen; but they are so obviously exceptions to the general rule, that we cannot for a moment hold them up as models for imitation; and even they would enjoy their astonishing gifts with greater security, were they to conform more completely to the laws of their organization.

Periodicity, or the tendency to resume the same mode of action at stated times, is peculiarly the characteristic of the nervous system; and on this account *regularity* is of great consequence in exercising the moral and intellectual powers. All nervous diseases have a marked tendency to observe regular periods, and the natural inclination to sleep at the approach of night is but another instance of the same fact. It is this principle of our nature which promotes the formation of what are called habits. If we repeat any kind of mental effort every day at the same hour, we at last find ourselves entering upon it, without premeditation, when the time approaches; and, in like manner, if we arrange our studies in accordance with this law, and take up each regularly in the same order, a natural aptitude is soon produced, which renders application more easy than by taking up the subjects as accident may direct. Nay, the tendency to periodical and associated activity occasionally becomes in the course of time so great, that the faculties seem to go through their operations almost without conscious effort, while their facility of action becomes so prodigiously increased as to give unerring certainty where at first great difficulty was experienced.*

In thus acquiring readiness and forming habits, we merely turn to account that organic law which associates increased aptitude, animation, and vigour, with regular exercise. It is not the soul or abstract principle of mind which is thus changed, but simply the organic medium through which it is destined to act: and when we compare the rapid and easy eloquence of the practised orator with the slow and embarrassed utterance which distinguished him at the outset of his career, we have merely a counterpart, in the organ of mind, of what is effected in the organs of motion, when the easy and graceful movements of the practised dancer, writer, or pianoforte player, take the place of his earliest and rudest attempts.

The reader will now be prepared to understand the difference between *the manner* in which, and *the subjects* on which, the various faculties of the mind ought to be exercised. In ordinary education, the former has been, in a great measure, left to the determination of chance or caprice, although it is, in reality, of even greater importance, as concerns the results, than the right selection of the subjects to be taught. The exposition which I have given of the physiological conditions under which the different mental powers act, will, however, tend to prevent the continuance of this error, and lend considerable aid towards a choice of subjects more in accordance with the moral and intellectual nature of man. Hitherto, reading, writing, and arithmetic, have been almost the only branches taught to the working classes; and even the more comprehensive scheme of Mechanics' Institutions embraces the education of the perceptive faculties only, and makes no direct provision for the training of the higher intellectual and moral powers, which, nevertheless, are intended to be the guides of our conduct, and the sources of our happiness.

It would require a separate volume to discuss satisfactorily the whole subject of education, and to decide upon the relative importance of different branches of knowledge for different ages, sexes, professions, and classes of society. I must therefore wholly abstain, at present, from the consideration of the latter branch of the inquiry, and content myself with remarking, that in every case, without exception, whatever the kind of education to be given, it is still of the utmost practical consequence, that in *the manner of communicating it* we should act in accordance with the physiological laws which preside over the operations of the mind. Whatever we attempt to teach, whether merely reading and writing, or the higher truths of intellectual and moral science, our success will depend, in a great measure, on the extent to which we act in obedience to the laws of physiology *in our mode of teaching*; and for this simple reason, I cannot regard any teacher or parent as fully and conscientiously qualified for his duties, unless he has made himself acquainted with the nature and general laws of the animal economy, and with the direct relation in which these stand to the principles of education. But having already greatly exceeded my limits, I must leave the further consideration of this part of the subject to some future opportunity.

It may be remarked, that in the preceding pages I have made scarcely any allusion to the doctrines of phrenology. My reasons are simply, that, for the object I had in view, a special reference to them was not necessary, and that, in a work written for the general reader and for practical purposes, I was naturally anxious to avoid every contested point. Accordingly, in limiting myself to the statement that different parts of the brain perform different functions, without specifying those connected with any particular part, farther than that they are all concerned in the mental operations, I am not venturing beyond what most eminent anatomists and physiologists, in the past or present times, have taught before me. My own sentiments on the subject have been long before the public, and I am bound to say that every day's experience increases my conviction of the truth of phrenology, and deepens my sense of its practical value. Every real improvement made in education serves to bring the public a step nearer a just appreciation of both the truth and extreme importance of phrenology to the parent and educationist, as well as to the physician and philosopher. Phrenology being true, every real improvement in intellectual teaching and in moral training must rest on a phrenological basis, whether that basis be recognised or not. Hence some

* These remarks are curiously confirmed by an anecdote of Silvio Pellico, which I read in the Foreign Quarterly Review (No. xxii. p. 478), when this sheet was first passing through the press. When first imprisoned, Pellico was "allowed the use of a copy of Dante and the Bible. Of the former, he used to commit a canto to memory every day, till at last the exercise *became so mechanical that it ceased to afford any interruption to the train of melancholy thought.*" I need scarcely point out the coincidence between this and the remarks in the text.

of the most remarkable advances lately made by practical and reflecting educationists as the results of their experience, prove to be merely excellent illustrations of principles long since established by the phrenologists. I therefore speak advisedly when I repeat, that every step made in advance by purely practical men, will serve to render the truth and merits of phrenology more plain and acceptable to the public mind. Already hostile prejudices are rapidly disappearing, and ere many years they will have become a matter of history, and phrenology take that place which, as the true philosophy of mind and of man, it is entitled to occupy. The dislike with which it is still regarded by many intelligent persons who remain unacquainted with its doctrines, arises in a great measure from its being supposed by them to be opposed to *all* their previously acquired facts and opinions. This, however, is a great and pernicious mistake; for whatever is true in human nature is also true in phrenology; and consequently the facts gathered from life by the shrewd observer of mankind are either identical or in absolute harmony with the facts of phrenology. The chief difference is, that while common observation leaves its results so unconnected and confused as to deprive them of much of their practical value, phrenology affords principles of arrangement by which its facts naturally assume a systematic form, and become highly available for use.

CHAPTER XIV.

INFLUENCE OF THE NERVOUS SYSTEM UPON THE GENERAL HEALTH.

Remarks on the ganglionic system of nerves—their influence on the functions of organic life—their action involuntary—but may be influenced by the state of the mind.—The nature of the nervous energy and its influence on health—obscurity on some points of the subject.—Proofs of the reality of this influence on the healthy action of the functions—its influence in disturbing digestion—on sickness during a campaign—and on the health of recruits.—Curative influence of cheerfulness and confidence—curious case of this by Sir H. Davy.—Influence of mind on health shewn in the American delegates.—Preservative effects of cheerful activity of mind in expeditions to the northern regions.—Its influence on discipline, efficiency, and happiness in the navy amusingly illustrated by Captain Hall.

Having now examined the relation subsisting between the nervous system and the functions of animal life, and shewn how far the health of the brain depends upon the well regulated exercise of the mental faculties, I shall next advert to the influence of the nervous system upon the general health. But before doing so, it will be proper, for the sake of greater clearness, to subjoin a few remarks on the nature and uses of the *involuntary or ganglionic* system of nerves, as distinguished from those of the *cerebral and spinal* system.

The ganglionic nerves, unlike those of animal life, have no direct connexion with the brain, medulla oblongata, or spinal marrow, but arise from a number of distinct nervous masses or *ganglions* of a round, oval, or irregular form, situated in the neck, chest, and abdomen, in front of the vertebral column, and connected with each other by means of small nervous filaments. Other filaments connect the ganglionic nerves with those of animal life, but their principal branches are distributed to the heart, the lungs, the digestive and abdominal organs, the glands, and other parts concerned in nutrition and the support of life.

The action of the ganglionic nerves is entirely involuntary, and in this respect differs from that of the cerebral and spinal nerves. By means of the latter, we can at pleasure excite, direct, or arrest the motions of the ordinary muscles. But we have no such control over the muscles placed under the influence of the ganglionic nerves. The heart, for instance, continues to beat whether we wish it or not, and its action goes on during sleep, when our senses are buried in oblivion, with the same regularity as when we are wide awake. In like manner, when digestion is going on, the muscular coat of the stomach and intestines contracts, not only without the will being able to prevent or accelerate it, but without our being in the least conscious of either its contraction or relaxation.

In the healthy state, the ganglionic nerves also differ from those of the cerebro-spinal system in being devoid of sensation; and hence we have no consciousness of the action of any of the organs to which they are distributed. We are not only not aware of what is going on in the heart, the liver, the stomach, or the lungs, but we have no perception even of their existence, and the heart itself has been wounded without any consciousness of the fact on the part of the individual. In disease, however, when the ganglionic nerves become morbidly irritable, sensations of a disagreeable kind are apt to arise, and sometimes of such a nature as to convey to the mind a dim consciousness of the existence of the affected organ. I have myself experienced something of this kind for several weeks in an unpleasant consciousness of the different action of the two sides of the heart.

Even the mere explanation of the names by which the two portions of the nervous system are designated, marks out sufficiently for our present purpose the principal points of difference betwixt them. Thus the one set of nerves is called *cerebral* and *spinal*, from its origin in the brain and spinal marrow. The other is called *ganglionic*, from taking its rise from ganglions. The one is called the *animal* system, from its connection with functions peculiar to animals alone. The other is called *organic* or *vegetative*, from its presiding over the functions of respiration, circulation, and nutrition, which are common to both animals and vegetables. The one is called the *voluntary* system, from its subservience to the commands of the will, and consequently being suspended during sleep. The other is spoken of as the *involuntary* system, because its action cannot be controlled by the will, and it goes on whether we are asleep or awake. In addition to all these designations, the latter is also frequently termed the *sympathetic* system of nerves, from its being supposed to be the medium through which all the important organs of the body affect, or sympathize with, each other.

But although the will has no direct power over the nerves of organic life, experience shews that the state of the mind exercises no small indirect influence over them and the organs on which they are ramified. Of this we have demonstrative proof in the sudden quickening of the action of the heart on a joyful surprise; in the excessive palpitations excited by alarm and anxiety; in the sobbing and sighing and disturbed respiration attendant on grief and affliction; and in the sickness of stomach, loathing, faintness and swooning, so often seen to follow violent mental emotion.

As, then, the fact is undeniable, that both the animal and the organic portions of the nervous system exercise a powerful influence on the action of all our bodily organs, it becomes a matter of some importance to ascertain in what manner that influence operates, and under what conditions it may be rendered beneficial to health, and consequently to the increase of our happiness. The subject has not yet been examined with all the care which its importance requires, but a general notice of it will give the reader some idea of its real interest.

The nervous energy is considered by many to be identical with electricity, and this opinion is countenanced to some extent by the fact, that muscular contraction and other results arising from nervous action can also be produced by means of electricity. But in reality the subject is still involved in great obscurity, and our researches must be greatly extended before we shall be able to determine positively in what manner the ner-

vous system produces its effects on the living functions, or what is the exact nature of the influence which it exerts. Instead, therefore, of attempting to use language apparently logical and scientific, but in reality still indeterminate and apt to mislead, I shall adopt the popular form of expression, and speak of the nervous energy as if it were known to be, what many suppose, a fluid or influence of a peculiar nature, conveyed from the brain towards all parts of the body by means of the nerves, as blood is from the heart, by means of the bloodvessels. For all practical purposes, this language will be more generally intelligible than any other, and all risk of error may be avoided if the reader will bear in mind, that, in using it, I do not profess to explain either what the nervous energy really is, what conditions are indispensable for its production, or in what precise way it produces the results which are observed to follow its action. All that is essential for our purpose is to be aware, *first*, that an active influence of some kind is brought into operation by the nervous system, and, *secondly*, that the effects produced by it upon the different organs and functions of the body vary according to the mode in which, and extent to which, that influence is exerted. Both of these points may be examined and turned to practical account, whatever theory we may adopt to explain them.

All, then, that need be said here of the nature of the nervous energy is, that it is an influence of a peculiar kind, originating in and conveyed by nervous matter, and that, like the blood, it is essential to the vital action of every animal organ. When I move the hand in writing, the muscles of the arm are called into play by an influence transmitted to them from the brain, by means of the nerves. This stimulus is so indispensable, that, if the communication between the brain and the muscles be cut off, by dividing or tying the nerve, no effort of the mind will longer suffice to excite them to action. In like manner, if the nerves of the lungs and stomach be cut through, so as to interrupt the flow of nervous influence, respiration and digestion will cease, although in every other respect their respective organs remain uninjured.

Changes in the quality or amount of the nervous influence transmitted from the brain to any organ have thus a direct power of modifying its function. If, from the peculiar state of the brain accompanying mental distress, for example, the nervous influence sent to the stomach be impaired, the tone of that organ will be also impaired, and digestion become imperfect; whereas if, in consequence of pleasing excitement, the nervous stimulus be increased, a corresponding activity will be communicated to the stomach, and digestion will be facilitated, as is experienced after a dinner in pleasant society. But if, by a violent burst of passion, or grief, the brain be inordinately and disagreeably excited, so as to send forth a stimulus vitiated in quality, the stomach which receives it will partake in the disorder. Hence the sudden loathing and sickness so often induced by unexpected bad news, vexation, or alarm.

Something analogous to this is still more visibly exhibited in the case of the muscles. If the mind be active and decided, the muscles, receiving a strong stimulus, move with readiness and force; but if the cerebral activity be impaired by bilious depression, muscular action becomes slow, infirm, and indolent; whereas if the brain be excited by strong passion, and the stimulus be impetuous, the movements instantly become energetic and decided; and if the excitement be carried still farther, the regulated muscular contraction passes the limits of health, and becomes involuntary and convulsive.

As the kind of nervous influence depends on the condition of the brain, that which springs from a brain of which all the parts are in sound and vigorous action is the most salubrious. Mental indolence and high mental excitement are alike inimical to bodily health; and consequently our great aim ought to be to secure for every mental power, moral as well as intellectual, that equal and regular exercise from which alone the proper nervous stimulus can spring.

It is indeed interesting to observe the various effects of the nervous influence, according to the faculties in predominant action at the time it is produced. If the higher feelings have the ascendancy, and the more selfish propensities be merely active enough to give force to the character, without setting the mind at war with itself, the nervous influence is the most grateful and efficient which can be imagined for sustaining the healthy co-operation of the whole body. This result follows, because the Creator evidently designed such a state of mind to be the best and happiest for man himself, and therefore took care to surround him with every motive to induce him to enter into it.

If, however, the lower feelings be in great activity, and filled with designs and emotions repulsive to the moral sentiments, so that the faculties are ranked in opposition to each other; or if the mind be oppressed with grief, anxiety, or remorse; the stimulus which it communicates will be far from beneficial, because no longer in accordance with the conditions designed by the Creator. It is in such circumstances, accordingly, that bad health is so often seen to arise from the state of the mind, and that suffering is produced which no art can relieve till the primary cause has ceased to exist.

Similar results follow over-exercise of intellect and inactivity of the feelings. From the concentration of vital action in the brain, the stomach and other organs are unprovided with the requisite nervous stimulus, and become impaired in their functions; and hence the dyspeptic and hypochondriacal symptoms which so often render life a burden to literary men. Persons so situate, when advised to attend to diet, often answer that it is in vain, and that, while at some times nothing can be digested, at other times, perhaps within a few hours or days, nothing comes amiss—the power of digestion varying thus quickly, according to their mental condition. Whereas, when indigestion arises from a primary affection of the stomach, the least deviation in the way of indulgence proves injurious. In both instances, attention to diet is beneficial; but in the one it is less rigidly important than in the other.

The influence of the brain on the digestive organs is so direct, that sickness and vomiting are among the earliest symptoms of many affections of the head, and of wounds and injuries of the brain; while violent emotions, intense grief, or sudden bad news, sometimes arrest at once the process of digestion, and produce squeamishness or loathing of food, although, an instant before, the appetite was keen. Narcotics, the direct action of which is on the brain, have a similar effect on the stomach.

The influence of the mind and brain over the action of the heart and lungs is familiar to every one. The sighing, palpitation, and fainting, so often witnessed as consequences of emotions of the mind, are evidences which nobody can resist. Death itself is not a rare result of such excitement in delicately organized persons.

This law of our constitution, whereby the regulated activity of both intellect and feeling is made essential to sound bodily health, seems to me one of the most beautiful arrangements of an all-wise and beneficent Creator.

If we shun the society of our fellow-creatures, and shrink from taking a share in the active duties of life, mental indolence and physical debility beset our path. But if, by engaging in the business of life, and taking an active interest in the advancement of society, we duly exercise our various powers of perception, thought, and feeling, we promote the health of the whole corporeal system, invigorate the mind itself, and at the same time experience the highest mental gratification of which a human being is susceptible,—that of having fulfilled the end and object of our existence, in the

active discharge of our duties to God, to our fellow-men, and to ourselves. If we neglect the exercise of our faculties, or deprive them of their objects, we weaken the organization, give rise to distressing diseases, and at the same time experience the bitterest feelings that can afflict human nature —ennui and melancholy. The harmony thus shewn to exist between the moral and physical world, is but another example of the numerous inducements to that right conduct and activity, in pursuing which the Creator has evidently destined us to find terrestrial happiness.

The reader will now understand why the state of the mind is so influential in the production and progress of disease. In the army this principle has often been exemplified in a very striking manner, and on so large a scale as to put its influence beyond a doubt. Sir George Ballingall mentions, in his lectures on Military Surgery, that the proportion of sick in garrison in a healthy country, and under favourable circumstances, is about five per cent.; but that, during a campaign, the usual average is nearer ten per cent. So marked, however, are the preservative effects of cheerfulness and the excitement of success, that, according to Vaidy, the French army cantoned in Bavaria, after the battle of Austerlitz, had only 100 sick in a division of 8000 men, being little more than *one* in the hundred. When, on the other hand, an army is subjected to privations, or "*is discouraged by defeat or want of confidence in its chiefs*," the proportion of sick is "*often fearfully increased.*"*

The same principle explains why it is so important for the physician to carry the feelings of the patient along with him in his curative measures. It is well known, for example, that those who live in constant apprehension of fever, cholera, or any other ailment, are generally among its first victims when exposed to its causes. The reason is obvious. The depressing nervous influence resulting from the painful activity of the selfish feelings, affects all the organs of the body, and places them on the brink of disease, even before any external cause is in operation; and hence the easy inroad which the latter makes when it comes into play.

The influence of the state of the mind on health is well exemplified in recruits for the army. According to Mr Henry Marshall, regret for having enlisted, and separation from friends, make them brood over the inconveniences attending their new mode of life, and their health suffers in consequence. These causes, combined with the fatigue of drill and the restraints of discipline, have so much influence, that "growing lads" frequently falls victims to them. The recruit, if not very robust, "loses that active fortitude which is required to fit him to bear up against difficulties, and falls into a gloomy state of mind, that is soon followed by deteriorated bodily health; he loses his appetite, becomes emaciated, a slight cough supervenes, and, after frequent admission into hospital, he at last dies of diseased lungs. This is an outline of the history of many a young lad who enlists in the army."† In France, where the conscription is compulsory, and many are of course serving against their will, the agency of depression of mind is still more marked and fatal. In the seven years extending from 1820 to 1826, both inclusive, it appears from the returns that the French army lost ninety-seven men from pure nostalgia or home-sickness, an affection which is rarely fatal in this country.

So efficacious, on the other hand, is a more cheerful state of mind, from the more healthful nervous influence which it diffuses through the frame, that surprising recoveries occasionally happen, which can be ascribed to no other cause but this. A singular but instructive instance fell under the observation of Sir Humphrey Davy, when, early in life, he was assisting Dr Beddoes in his experiments on the inhalation of nitrous oxide. Dr Beddoes having inferred that the oxide must be a specific for palsy, a patient was selected for trial, and placed under the care of Davy. Previously to administering the gas, Davy inserted a small thermometer under the tongue of the patient to ascertain the temperature. The paralytic man, wholly ignorant of the process to which he was to submit, but deeply impressed by Dr Beddoes with the certainty of its success, no sooner felt the thermometer between his teeth than he concluded the talisman was in operation, and, in a burst of enthusiasm declared that he already experienced the effects of its benign influence throughout his whole body. The opportunity was too tempting to be lost. Davy did nothing more, but desired his patient to return on the following day. The same ceremony was repeated; the same result followed; and at *the end of a fortnight he was dismissed cured*,—no remedy of any kind except the thermometer having ever been used.* Quacks profit largely by taking advantage of this principle of our nature: and regular practitioners would do well to bestow more pains than they do in assisting their treatment by well-directed moral influence. Baglivi was deeply impressed with this sentiment when he said, "I can scarcely express how much the conversation of the physician influences even the life of his patient, and modifies his complaints; for a physician powerful in speech, and skilled in addressing the feelings of a patient, adds so much to the power of his remedies, and excites so much confidence in his treatment, as frequently to overcome dangerous diseases with very feeble remedies, which more learned doctors, languid and indifferent in speech, could not have cured with the best remedies that man could produce."

Another remarkable instance occurred during the siege of Breda in 1625. When the garrison was on the point of surrendering from the ravages of scurvy, a few phials of sham-medicine introduced by the Prince of Orange's orders, as the most valuable and infallible specific, and, given in drops as such, produced astonishing effects: "*Such as had not moved their limbs for months before, were seen walking in the streets, sound, straight, and whole*; and many who declared they had been rendered worse by all former remedies, recovered in a few days, to their inexpressible joy."†

Every one, indeed, who has either attended invalids, or been an invalid himself, must often have remarked, that the visit of a kind and intelligent friend is highly useful in dispelling uneasy sensations, and in promoting recovery by increased cheerfulness and hope. The true reason of this is simply, that such intercourse interests the feelings, and affords an agreeable stimulus to several of the largest organs of the brain, and thereby conduces to the diffusion of a healthier and more abundant nervous energy over the whole system. The extent of good which a man of kindly feelings, and a ready command of his ideas and language, may do in this way, is much beyond what is generally believed; and if this holds in debility arising from general causes, in which the nervous system is affected not exclusively but only as a part of the body, it must hold infinitely more in nervous debility and in nervous disease; for then the moral management is truly the medical remedy, and differs from the latter only in this, that its administration depends on the physician, and not on the apothecary,—on the friend, and not on the indifferent attendant.

In his excellent little treatise on Physical Education, Dr Caldwell justly remarks that the influence of a regulated and well-balanced activity in the moral and intellectual faculties on the general health, compared with that of active and boisterous passions, is like the salutary effect of mild and wholesome nourishment contrasted with the fiery potency of alcohol. The former is eminently conducive to life, health, and enjoyment, while

* Medico-Chirurgical Review, No. xxxvi. p. 430.

† Marshall on the Enlisting and Discharging of Soldiers, p 5.

* Paris's Life of Davy, p. 51.

† F. V. Mye, De Morbis et Symptomatibus, &c., quoted by Dr Johnston in his treatise on Derangements of the Liver, &c., p. 206.

the latter is as eminently opposed to them all. Of this truth Dr Caldwell gives an interesting example from the history of his own country. Of the fifty-six delegates who signed the Declaration of Independence, almost all were men of well-regulated and active minds, not marked by any excess of passion. Two of them died early from accidents. The aggregate years of the remaining fifty-four were 3609, giving to each an average of sixty-six years and nine months; thus affording a striking evidence of the salutary influence of the mind on health. From the same absence of active passion in mathematicians, the average duration of life in twenty of them, taken promiscuously by Dr Caldwell, extended to seventy-five years, while, in an equal number of *poets*, whose vocation greatly depends on excitability of feeling, the average was so low as fifty-seven.*

The powerfully stimulating effect of healthy mental excitement on the bodily functions, is familiar to every one, and is duly noticed in the works of the novelist and poet. In nine cases out of ten, a visit to a watering-place, or a journey through an interesting country, does good more by the beneficial excitement which it gives to the mind and brain, than by all the other circumstances put together. It is indeed greatly to the credit of the medical departments of both army and navy, that the influence of the mind in preserving and restoring health is more correctly appreciated and provided for than it is even in private practice. In the late expeditions of discovery to the Northern Regions, the utmost attention was bestowed by the enlightened commanders to keep up a healthful vivacity of intellect and feeling among their men, by constant occupation, intellectual instruction, the representation of plays, masquerades, and other amusing and exciting exertions; and there cannot be a doubt, that their remarkable immunity from disease was in no small degree owing to these admirable arrangements. From this is obvious the immense importance which attaches to the selection of a humane and considerate, as well as scientific commander.

In the second volume of Captain Basil Hall's first series of Fragments of Voyages and Travels, the reader will find a chapter on "*the effects of being well commanded*," which illustrates, very amusingly, many of the principles explained in the preceding pages. "People," he says, "who have no acquaintance with the intricacies of naval discipline, can scarcely comprehend how vast a difference is made in the efficiency of a man-of-war, by the character of the commander."—"Early in the year 1805, we were made abundantly sensible of the truth of this remark, by an important change which took place in the highest office on board. From a state of languid inefficiency, we started in a single moment into the most vigorous activity, and from being almost the laughing-stock of the fleet, for the clumsiness of our gait, and the want of success which attended our cumbrous exertions, we soon outstripped them all, not only in activity, but in the useful result of our services."—(P. 2.)

The new captain was a man who knew his profession, and possessed that decision of character which makes its weight instinctively felt. Between certain disgrace and punishment to offenders, and "high favour to those who took pains to do right, the ship was speedily brought into proper trim. Every thing now seemed alive, and moved smartly; no time ran to waste; even the indolent and the ill-disposed found their best interest in working well. The decks became cleaner than they had ever been before; the people dressed themselves more tidily; the sails looked better furled; the yards better squared; *the complaints of inattention and drunkenness grew daily less frequent, and an air of general happiness, as well as new-born energy, spread itself over the whole ship.*"—"So magical indeed was the effect of this change, that I dare swear we should then have engaged and beaten an enemy, whom it might not have been considered by any means prudent to have brought to action a week before."—(P. 17.)

Captain Hall gives other examples of the same principle, and remarks that, in this way, the simple fact of Nelson joining the fleet off Trafalgar, was almost equivalent to double manning every ship in the line. The explanation which he gives of the "mysterious agency" by which the genius of a commanding officer imparts a portion of its spirit to every one under his orders, is perfectly philosophical. "When a person of talents is placed under an able commander, he feels confident that nothing he does will be passed without notice, and consequently that his exertions must tell to his advantage, exactly in proportion as their utility makes itself felt. This consciousness will, of course, stimulate him to fresh endeavours to excel; and, from thus feeling sure that his conduct is duly appreciated, he has an immediate motive to bring his whole strength into play,—an exercise which must ever produce good results."

But "suppose the case differently put, and let the superior in station be the inferior in abilities or experience, or not so zealous in the execution of his duty as the men he commands. The situation of the inferior is now far from being so independent, or so well calculated to draw forth his powers, as it was in the first case. The subordinate officer has no longer the same animated stimulus to exertion; for, his labours being generally unnoticed, or their results unappreciated, he is left without much encouragement to proceed in fresh endeavours to excel; *while his faculties, instead of improving, through generous exercise, are often deteriorated by the languid manner in which they are brought into play.*"—(P. 6.)

Captain Hall justly observes, that the influence of the commander on men of moderate talents is still more striking, as they stand more in need of a stimulus to duty. "If a commander has skill enough to enlist the sympathies of those placed under his orders, they will feel insensibly drawn on to make common cause with him, and will afterwards exert themselves strenuously to maintain that degree of importance derived from this implied companionship in ability, which they could hardly hope to reach single-handed."—"The invariable effect of these efforts is to improve the character. Such training will certainly not make a clever man out of a stupid one; but it may often render a discontented or useless man of service to himself and the state; and, instead of his continuing a wretched and hopeless being, may convert him into one who is happy and confident of success."

"I suspect, however, that no one who has not been an eye-witness of the condition of a ship under the command of an ignorant, trifling, or otherwise inefficient captain, can have any notion of the mischievous effects of his misrule, or rather of his no rule. Perhaps in the long-run, almost every degree of consistent severity is preferable to the uncertain, higgledy-piggledy kind of discipline on board a man-of-war, in what is called slack-order. The moderately gifted persons feeling that, in these circumstances, they have no chance of notice by any exertions of their own, speedily degenerate into a sort of vegetables, so incapable of any useful exertion, that they infest the ship like the fungus called the dry-rot. This chaotic period is the holiday season of the scamps and skulkers, who then fancy their game the surest. These fellows certainly succeed in working as little as possible, and in making those about them unhappy; but, after all, without any great accession to their own comfort."

"This system," continues Captain Hall, "discourages the cheerful and willing workers by the oppression of its injustice—a feeling which speedily takes away or deadens some of the best motives to improvement." Such a captain, unwilling to see that he himself is in fault,

* Caldwell on Physical Education, p. 84–6.

ascribes the evil to others; and, "by his unfair censure of those who, in fact, are the most deserving of commendation, he scatters *the seeds of discouragement over all the different classes exposed to his unskilful handling, and every thing falls into confusion worse confounded.*"—(P. 10.) The loss of the French frigate Medusa, on the coast of Africa, in 1817, and the tremendous suffering which instantly ensued from the state of anarchy and uproar which took place among the crew, are well known to have arisen entirely from the insufficiency and headstrong conceit of a weak and ignorant commander, and afford a strong contrast to the admirable coolness and high-toned moral feeling displayed on the similar occasion of the wreck of the Alceste, on her return from China with Lord Amherst, and which also made a deep impression, but of a widely different description, on the public mind.

From the above quotations, the influence which the qualities of the commander may exert on the health as well as the discipline of those under his orders, may easily be inferred. So important, indeed, are cheerfulness and confidence, as conditions of health, that if two ships were to be sent out to circumnavigate the globe, each equal to the other in every respect, except the one being under the direction of a humane, vivacious, and considerate man, and the other of a lymphatic, selfish, and tyrannical commander, though both were equal in talent, it is quite certain that the fate of the crews would be widely different, and that sickness would prevail much more in the one than in the other.

CHAPTER XV.

APPLICATION OF THE PRECEDING PRINCIPLES TO THE ORIGIN AND PREVENTION OF BAD HEALTH.

Causes of bad health.—Not always the result of moral or immoral conduct—nor of accident—but of the infringement of the laws of organization.—Proofs from past history.—Diminished mortality from increase of knowledge, and better fulfilment of the conditions of health.—The expeditions of Anson and Cook contrasted.—Gratifying results of the sanatory arrangements of Ross, Parry, and Franklin.—Mortality among the Convicts at Milbank Penitentiary and Woolwich a contrast to these.—Pulmonary diseases in the Channel fleet, from ignorance of physiology.—Causes of late improvement.—Conditions of wealthier and poorer classes compared.—Good done by the apprehension of Cholera.—Influence of habit.—Advantage of knowing the true sources of bad health.—Evils of ignorance exemplified in the recruiting service.—General remarks.

The reader will now be prepared to take a correct view of a question on which it especially interests us to have true and precise notions. I allude to *the real origin of bad health*. On this point, very vague and contradictory opinions are prevalent; and, as our conduct in life must necessarily be closely dependent on our views in regard to this subject, I cannot do better, before concluding, than devote a chapter to its consideration.

Setting aside, for the present, hereditary tendencies to disease (which must have begun at first with some progenitor from ordinary causes, and which, therefore, are not really unconnected with the inquiry), bad health may be regarded in one of three different lights: First, As having no necessary connection with our conduct, but as being the result of circumstances entirely beyond our knowledge and control, and sent by a superintending Providence, not to urge us to more rational care, but to soften our hearts, and warn us from sin; Secondly, As the result of accident alone, or of external influences which we can appreciate, but from which it is impossible to withdraw ourselves; or, Thirdly, As, in every instance, the result of the direct infringement of one or more of the laws or conditions decreed by the Creator to be essential to the well-being and activity of every bodily organ, and the knowledge and observance of which are, to a great extent, within our own power.

According as one or other of these views shall be adopted, the most opposite practical results will follow. If the *first* be received as the truth, and health and sickness be viewed as dispensed without reference to our bodily conduct, but solely as a means of reclaiming us from sin, attention to moral and religious improvement alone will be our best protection, and any attempt to avert bad health, by studying and obeying the laws which regulate the bodily functions, will be entirely useless. If, again, the *second* principle be correct, and disease arise from accident and from influences beyond our control, then neither our moral nor our bodily conduct will avail us as a protection, and our only resource will be humble resignation to the will of God. But if the *third* be true, and the human frame be constructed by the Creator on principles calculated to carry on life for seventy years, and if *de facto* a large proportion of the race perish before attaining ten years of age, chiefly from infringing the conditions on which the due performance of the various vital functions depends, it then becomes an object of great interest to us to study the structure of our organs, to discover the laws which regulate their functions, and to yield to those laws that implicit obedience from which alone health can spring.

That the strictest obervance of the moral laws and the purest devotion of which human nature is capable, are insufficient to secure health to the body, without a simultaneous observance of the organic laws, is too clearly proved by the instances already adduced, and by the history of mankind, to require any demonstration here. The biographies of the pious and excellent furnish abundant examples to the contrary; while the annals of crime afford numerous instances of men of the most depraved characters enjoying unbroken health. If, indeed, the organic conditions be fulfilled, the upright man will enjoy a serenity of health which the criminal can never know; but the moral observance alone will not avail him, if he at the same time neglect the organic laws.*

In regard to the second proposition, a little reflection will satisfy every intelligent mind that it is equally untenable, and that disease is not always the result of accident or of circumstances which cannot be modified. There are causes of bad health against which even the most stupid and prejudiced take some precautions, and with success; and the whole art of medicine would be a grosser delusion than ever romancer believed it to be, if health were not influenced by circumstances within our control. All our remedies, and all our attention to diet, clothing, and regimen, are indications of the contrary persuasion. There are, indeed, agencies from which we shall probably never be able entirely to protect ourselves. Such are variations in the state of the atmosphere, epidemic and contagious causes, and necessary exposure, in pursuance of higher duties, to known unhealthy influences; but allowing for all these, ample scope remains within which man may, by an extension of his knowledge and industry, provide himself with safeguards far beyond what he has ever yet made use of, or has ever dreamed of discovering.

The third view, or that which ascribes bad health to the infringement of some one or more of the organic laws, thus presents itself as the only one in accordance with observation and past experience; and, after the full exposition I have already given of the conditions of health of various important organs, I trust that little farther proof of this will be required. At the same time, as the principle is full of practical value, I shall take a short review of some additional facts which go far to establish its accuracy.

* I may again refer to Mr George Combe's "Constitution of Man" for a consistent and intelligible view of the relation subsisting between the organic and the moral and intellectual laws.

Considering that the human frame is constructed to endure, in many cases, for sixty, seventy, or eighty years, it must seem extraordinary to a reflecting mind, that, taking the whole of the deaths in England and Wales for 1838, so large a proportion as 443 out of every 1000 should occur under the age of ten years; and that in Manchester, Salford, and suburbs, the proportion of deaths under the same age should rise to the enormous amount of 602.4 per 1000.* It is impossible to suppose that such a rate of mortality was assigned by the Creator as the unavoidable fate of man; for, by the gradual improvement of society and a closer observance of the organic laws, the proportion of deaths in early life is now much smaller than it was some years ago. We have already seen that so recently as about the middle of last century, when the pauper infants of London were received and brought up in the workhouses, amidst impure air, crowding, and want of proper food, not above one in twenty-four lived to be a year old; so that out of 2800 annually received into them, 2690 died. But when the conditions of health came to be a little better understood, and an act of Parliament was obtained obliging the parish officers to send the infants to nurse in the country, this frightful mortality was reduced to 450, instead of upwards of 2600! Can evidence stronger than this be required to prove that bad health frequently arises from causes which man may often be able to discover and remove, and which, therefore, it is his bounden duty to investigate and avoid by every means which Providence has placed within his reach?

The different rates of mortality in crowded cities and country districts, as exhibited in the instructive returns of the Registrar-General, equally demonstrate the influence of bad air, crowding, and imperfect food, in abridging life. Even in the best managed communities, the number not only of the sick of all ages, but of those who are cut off in early youth, is so prodigious as to shew that we are far from having arrived at the maximum of health of which the race is susceptible; while the advances we have already made give us every reason to hope that, by perseverance and the extension of our knowledge, we may continue to improve for many centuries to come.

The progress of knowledge and the increasing ascendency of reason have already delivered us from many scourges which were regarded by our forefathers as unavoidable dispensations of an inscrutable Providence. In the days of the ancient Romans, their capital and territories were frequently almost depopulated by visitations of plague and pestilence, from which the present generation is, by a stricter observance of the conditions of health, entirely exempted. In London, in like manner, the same contempt of cleanliness, ventilation, and comfort, which was so fatal to the Romans, produced similar results, and swept off its thousands and tens of thousands, till a fortunate disaster,—the great fire,—came in the place of knowledge, and, by destroying the crowded lanes and other sources of impurity, which man had shewn himself so little solicitous to remove, procured for its inhabitants a perfect and permanent immunity from one of the deadliest forms of disease,—and taught them the grand practical truth, that such awful visitations are not wanton inflictions of a vengeful Providence, but the direct consequences of the neglect of those conditions by which the various vital functions are regulated, and by conforming to which alone health can be preserved. Accordingly, by greater attention to proper food, cleanliness, and pure air, London, with its gigantic population, now flourishes in comparative security, and scarcely feels the ravages of an epidemic which has inflicted a blow on some less fortunate cities, the effects of which will be long remembered.

* Registrar's Second Annual Report, 8vo edit. p. 58.

Smallpox is another scourge which annually carried off its thousands, and from which modern science bids fair to protect us; although half a century ago, any one who might have ventured to express such an expectation, would have been ridiculed for his credulity. Even before Jenner's immortal discovery of vaccination, the improvement of medical science consequent on increased knowledge of the structure and functions of the human body, had greatly mitigated the fatality of smallpox. Formerly the patients were shut up, loaded with bedclothes, in heated rooms from which every particle of fresh air was excluded; and stimulants were administered, as if on purpose to hasten the fate of the sick. But sounder views of the wants of the animal economy at last prevailed; and, by the admission of fresh air, the removal of every thing heating or stimulating, and the administration of cooling drinks and other appropriate remedies, thousands were preserved whose lives would have been lost under the mistaken guidance of the older physicians.

So lately as the middle of last century, ague was so prevalent in many parts of Britain where it is now never seen, that our ancestors looked upon an attack of it as a kind of necessary evil, from which they could never hope to be delivered. In this instance also, farther experience has shewn that Providence was not in fault. By draining the land, removing dunghills, building better houses in better situations, and obtaining better food and warmer clothing, it appears that generations now succeed each other, living on the very same soil, without a single case of ague ever occurring, where, a century ago, every man, woman, and child, were almost sure to suffer from it at one time or other of their lives; thus again shewing how much man may do for the preservation of health and the improvement of his condition, when his conduct is directed by knowledge and sound principles.

If we wish for a still more admirable proof of the same practical truth, we have only to compare the condition of our seamen in maritime expeditions undertaken a century ago, with their lot in the present day;—the expedition against Carthagena, or that of Anson, for instance, with those of Cook, Parry, and Ross; or the health enjoyed by the crew of the Valorous, with that of the seamen in the other vessels lying in the same harbour.

Anson set sail from England on 13th September 1740, in the Centurion, of 60 guns and 400 men, accompanied by the Gloucester, of 50 guns and 300 men; the Pearl, of 40 guns and 250 men; the Wager, of 28 guns and 160 men; the Tryal sloop, of 8 guns and 100 men, and two victuallers, one of 400, and the other of 200 tons. They had a long run to Madeira, and thence to the coast of Brazil, where they arrived on the 18th December; but, by this time, the crews were remarkably sickly, so that many died, and great numbers were confined to their hammocks. The commodore now ordered "six air-scuttles to be cut in each ship, to admit *more air between the decks*," and took other measures to correct the "noisome stench on board," and destroy the vermin, which nuisances had become "very loathsome;" "and, besides being *most intolerably offensive*, they were doubtless, *in some sort*, productive of the sickness under which we had laboured." Such is the mild language used by the chaplain Mr Walter, in communicating these appalling truths! On anchoring at St Catharine's, 80 patients were sent on shore from the Centurion alone, of whom 28 soon died, and the number of sick increased to 96. Although this was nothing compared to what took place afterwards, it is nevertheless worthy of remark, for as yet they had suffered no privations or unusual hardships, except from contrary winds. The causes of disease lay entirely within themselves.

After a stormy and tedious navigation of three months round Cape Horn, scurvy carried off 43 more in the month of April, and double that number in May 1741.

Those who remained alive now became more dispirited and melancholy than ever; which "*general dejection added to the virulence of the disease, and the mortality increased to a frightful degree.*" On 9th June, when in sight of Juan Fernandez, the debility of the people was so great, that, 200 being already dead, the lieutenant could muster only two quarter-masters and six foremast men able for duty in the middle watch; so that had it not been for the assistance of the officers, servants, &c. they would have been unable to reach the island,—to such a condition was a crew of 400 men reduced in the course of a few months!

I have noticed the cutting of holes for the admission of air between decks, and the dejection of the men. The narrative proceeds to say, that the commodore's principal attention was now devoted to getting the sick on shore, as they were dying fast on board, "the distemper being doubtless considerably augmented *by the stench and filthiness in which they lay, for few could be spared to look after them, which rendered the ship extremely loathsome between decks.*" The officers suffered least, as being the best fed and best lodged. Within a year, out of upwards of 1200 men, composing the crews of the squadron, who had sailed from England, only 335 remained alive.

The fate of the Spanish squadron, which sailed nearly at the same time, was still more horrible. The Esperanza, of 50 guns, lost 392 out of 450 men, and the other ships almost as large a proportion. It is true that, in doubling Cape Horn, they encountered the severest weather and the greatest privations, and that their deplorable fate was aggravated by these causes. But when we look to the conduct of later navigators, in circumstances equally trying, it is impossible to resist the gratifying conviction, that mortality like this forms no part of the designs of a beneficent Providence, and that, for the best of purposes, our safety is placed, to a great extent, within the limits of our own power. The late memorable expeditions of Parry, of Franklin, and more especially of Ross, who, with few resources, spent upwards of four years in the desolate regions of the north, with scarcely any loss of life, are examples pregnant with meaning to all who are interested in the future progress of man.

It may be said that the climate and situation of the two parties were dissimilar. In some respects, the objection is well founded, but Cook's second voyage round the world, in 1772, affords a parallel presenting so many points of resemblance to that of Anson, that no one can reasonably object to their comparison. On this occasion, the vessels selected were the Resolution, carrying 112 men, and the Adventure, with a crew of 81. Enlightened by former experience, Cook spared no pains to effect his equipment in the completest manner, and to lay in such stores of clothing and provisions as he knew to be useful in preserving the health of those under his command. Among these were malt, sour krout, portable broth, sugar, and wheat. Care was taken to expose the men to wet as little as possible, to make them shift themselves after being wet, and to *keep their persons, hammocks, bedding, and clothes, perfectly clean and dry.* Equal attention was paid to keep the ship clean and dry between decks; once or twice a-week it was aired with fires; and a fire was also frequently made at the bottom of the well, which was of great use in purifying the air in the lower parts of the ship. To the last precaution too great attention cannot be paid; as the least neglect occasions a putrid and disagreeable smell below, which nothing but fires can remove. Fresh water, vegetables, and fresh provisions, were also eagerly sought for at every opportunity; and these it was Captain Cook's practice to oblige his people to make use of, by his own example and authority. The results of these measures we shall now see.

The two ships sailed on 13th July 1772. Towards the end of August, when advancing towards the south, the rain poured down, not in drops but in streams; and the wind at the same time being variable and rough, the people were obliged to attend so constantly upon the deck, that few of them escaped being completely soaked:" but although rain is a great promoter of sickness in warm climates, the airing by fires between decks, and the other precautions, were so effectual, that, on arriving at the Cape of Good Hope, *only one man was on the sick list;* whereas we have seen that, after a similar voyage, the Centurion arrived on the coast of Brazil with 80 sick, of whom 28 soon died. As we proceed, the contrast becomes still more striking. On 22d November, Cook sailed from the Cape in search of a southern continent. On the 29th, a violent storm, attended with hail and rain, came on and caused the loss of most of their live stock; and a sudden transition took place from warm and mild to extremely cold and wet weather, which was severely felt by the people. On 10th December they met with islands of ice; and, from that time till the middle of March, continued their search for land with unremitting diligence, amidst cold, hardships, and dangers, such as we can form a very imperfect idea of; and, at last, on 26th March, *after being* 117 *days at sea*, during which they had sailed 3660 leagues, they came to anchor in Dusky Bay, New Zealand. "After so long a voyage," says Dr Kippis, from whose life of Cook these particulars are taken, "in a high southern latitude, it might certainly have been expected that many of Captain Cook's people would be ill of scurvy. This, however, was not the case. So salutary were the effects of the sweetwort and several articles of provision, and *especially of the frequent airings and sweetening of the ship*, that there was only one man on board who could be said to be much afflicted with the disease; and even in that man, it was chiefly occasioned by a bad habit of body, and a complication of other disorders."

Can any thing be conceived more demonstrative of the advantages to be derived from investigating and obeying the laws of health, than these splendid results, when contrasted with those on board of the Centurion? In the Resolution, cheerful activity, cleanliness, dry pure air, adequate clothing, and a suitable regimen, were found to carry man unscathed through hardships and exposure which, in the Centurion, from neglect of the same protective means, were severe enough to sweep off a large proportion of her crew. And, as if on purpose to place the efficacy of these measures beyond a doubt, it appears, that, in the month of July 1773, the Adventure had many sick, and twenty of her best men incapable of duty from scurvy and flux, when the Resolution, with a larger crew, had only three men sick, and only one of them from scurvy. This difference in the state of health of the two ships was distinctly traced to the crew of the Adventure having eaten few or no vegetables when in Queen Charlotte's Sound; while, on board of the Resolution, Cook was most particular in enforcing attention to this part of their dietetic regimen.

By this admirable care and unwearied watchfulness on the part of Cook and his officers, the Resolution performed a voyage of THREE years and eighteen days, *through all climates*, from 52° north to 71° south, with the loss of only ONE man by disease out of 112! And in his last voyage, so efficaciously were the same means put in practice, that his ship was brought home after an absence of FOUR years, without the loss of a single man by disease! Lord Nelson is said to have been equally successful, and to have spent three years on the West India station without one life having been lost by disease.*

Similar results were obtained by the able commanders of our more recent expeditions to the Northern Regions. The Fury and Hecla were, at one time, no less than *twenty-seven months entirely dependent on their own*

* Sir George Ballingall's Lect. on Milit. Surg. p. 73.

resources, before scurvy began to make its appearance; and at the end of 28½ months both ships returned home (in September 1823) with the loss of only five men,—a result which, a century ago, could hardly have occurred, and which, even at the present day, is a remarkble indication of the talent and humanity of the officers by whom it was effected.

Nothing, in fact, could have been better devised than the means practised in these expeditions to preserve the health of the people; and did my limits permit it, I might illustrate almost every principle in this volume by a reference to its actual efficacy as displayed in these voyages. Not only were the conditions of health attended to as regarded the skin, the muscles, the bones, the lungs, and the digestive organs; but the health of the all-important nervous system was sedulously provided for by the constant and cheerful occupation of the people in their various duties and amusements; and so judiciously were these planned, that a spirit of life and activity extremely favourable to the preservation of health was constantly kept up, and had, no doubt, great influence in producing that concord and unity of feeling among them, which were so conspicuous amidst all their privations.

If, from these encouraging examples of the preservative power of knowledge applied under skilful guidance, we turn, for a contrast, to the extraordinary prevalence of disease at the Milbank Penitentiary in 1823–4, we shall see the opposite side of the picture, and discover how much misery may result from the unintentional neglect of sound physiological principle in some of our civil institutions. At the time spoken of, intractable affections of the bowels, and other insidious forms of disease, were so general in the penitentiary, that few of the prisoners escaped, and a Parliamentary inquiry into their causes was ordered. Great discrepancy of opinion prevailed, as usual, among the witnesses, from each giving utterance rather to his own impressions than to opinions founded on any philosophical examination of the circumstances. But evidence enough was brought forward to shew that several great errors had been committed. In the *first* place, the penitentiary itself was built, at an enormous expense, in a *low damp situation*, rather under than above the level of the highest tides in the river, so that ventilation or the supply of dry pure air is always imperfect, and the atmosphere at night is often heavy and damp, as on all low grounds in the neighbourhood of rivers and half-covered mud. To this great and permanent source of debility were added, *secondly*, a very low and inadequate diet; and, *thirdly*, the influence of constant mental depression, arising partly from the local situation of the prisoners, and partly from the monotonous confinement and labour under too scanty a supply of food. In such circumstances, it was certainly not wonderful that a low state of health, and latterly scurvy and bowel-complaints, should make such general havoc.

That much of the sickness was justly attributable to these causes, is shewn by the perfect immunity enjoyed for some years, both by the officers of the penitentiary and by about thirty of the prisoners, who, from being employed in the kitchen and offices of the establishment, were less subjected than the rest to the debilitating influence; and also by the rapid convalescence of almost every one out of 635, on being removed to Woolwich and to the Regent's Park, and supplied with a more nourishing diet. On more minute inquiry, indeed, it appeared that, instead of the bad health having begun all at once in 1823, as at first supposed, bowel-complaints had been extremely prevalent from the first opening of the penitentiary in 1816, and had continued to be so, though in rather a less degree, down to that time; so that the causes, instead of being altogether of sudden origin, must have been inherent in it from the beginning, and only became aggravated by the farther reduction of diet, which took place some months previously, and by the inclemency of the weather.

Dr Latham gives striking evidence of the state of the mind exerting a powerful effect on the health of the prisoners. Speaking of the women who were sent on board of one of the hulks at Woolwich, he says, that individuals were pardoned, from time to time, for good conduct, and that recently pardons had become very numerous, as a kind of atonement for the bad health to which they had been subjected. But, as all had nearly an equal claim, "every one pleased herself with believing that she would be the next who would be set at liberty. Whenever, therefore, an individual was pardoned, all the rest *were thrown into an agony of the bitterest disappointment, and were at the same time overtaken by disease*. It was not a mere nervous or hysterical ailment, but *some actual form of real disease, such as they had before suffered*, and requiring the strictest medical treatment for its relief."* Examples like these, let it be again and again repeated, shew the extent to which health is in our own power, when we choose to fulfil the conditions on which alone it can be obtained.

In the spring of 1841, great mortality also took place among the convicts confined in the hulks at Woolwich, owing, it was said, to some imprudent changes in their management. In one week in April, eleven inquests were held, but as I have not been able to obtain any authentic particulars regarding the causes of death, I am unable to say whether the current reports of mismanagement are correct. But, whatever may have been the causes, it is obvious that a heavy responsibility will rest upon the public authorities, if it shall be proven that the increased sickness and mortality arose from either ignorant or inconsiderate neglect of the laws of health.

In looking forward to a still greater diminution of disease in the human family, it is cheering to fix attention on what has been already accomplished by the hand of authority. Had the same individuals who circumnavigated the globe with Cook, or braved the northern winters with Ross and Parry, been left for an equal number of years to undergo the ordinary vicissitudes of life at home, unrestrained in their inclinations and conduct by the constantly operating and beneficent influence of a superior mind, it is morally certain that disease and death would have made greater havoc among them than actually occurred amidst physical privations and sufferings much greater than they were likely to have ever encountered at home. This renders obvious the pressing necessity of diffusing widely among society that species of knowledge which has proved so beneficial in the hands of those who were fortunate enough to possess it. If human health and happiness be thus effectually promoted by increased attention to the conditions which regulate the vital and animal functions, nothing can be more useful than to communicate to every intelligent being such a measure of knowledge as will enable him to do for his own safety and improvement that which Government now does for those whose services it requires.

With these successful and cheering results of knowledge, it will be instructive to contrast another instance of the fatal effects of ignorance in a situation where knowledge might have been effectual in preserving life and sparing suffering. I shall take the example from an early publication of Dr James Johnson,† who has devoted no small attention to the subject of health and the causes by which it is effected, and whose work contains much valuable matter connected with hygiène, as well as with the history and cure of disease. In treating of exercise, and the evils of its excess, Dr Johnson says—"I shall exemplify this reasoning by an instructive lesson. During the late war, it was observed, that, in its earlier periods, fever, fluxes, and scurvy, made the

* Account of the disease lately prevalent at the General Penitentiary, by Dr Latham, p. 192.

† On the Influence of the Atmosphere on the Health and Functions of the Human Frame, &c. 8vo, 2d edition, p. 198.

greatest havoc; while in its middle and ulterior periods, these diseases almost disappeared, and pneumonia (inflammation of the lungs), with its too frequent consequence, PHTHISIS, became infinitely more prevalent and fatal. The facts were apparent to all, but the causes few could divine. Some of our chemical wise-acres attributed the pneumonic diathesis to the lime-juice served out; but this hypothesis need not detain us, for I think a more rational explanation can be offered. As the period of warfare was lengthened out, discipline gradually became more perfect, and at length attained its acme. Every evolution was now performed with a rapidity and precision that seemed the effect almost of magic. All machinery and apparatus were not only so arranged as to give human power its greatest force and facility of application, but human strength was put to its ultimatum of exertion, and every muscular fibre of the frame called into furious action, during each manœuvre of navigation or war. Thus, in exercising the great guns, the heaviest pieces of artillery were made to fly out and in, or wheel round, with almost the celerity of a musket in the hands of a fugleman. The most ponderous anchors were torn from their beds with astonishing velocity; while the men were often seen lying about the decks breathless and exhausted after such ultra human exertions!

"But reefing and furling sails were still worse. Here, as in all other operations, there was a constant struggle against time. The instant that the word "*aloft*" was given, the men flew up the shrouds with such agility, that by the time they were on the yards, the respirations were nearer fifty than fifteen in a minute! In this state of anhelation they bent across the yards, and exerted every atom of muscular energy in dragging up the sails and securing the reef-lines, while the thorax was strained and compressed up against the unyielding wood! What were the consequences? The air-cells were frequently torn, blood extravasated; and the origins of cough and hemoptoës continually laid. The lungs were now in a proper state for receiving the impression of aërial vicissitudes; and constant exposure to night air, to rain, and every inclemency of the season, soon *evolved the long black catalogue of pulmonic and phthisical maladies, which swept off our men in vast numbers, to the no small surprise of the officers, who could not divine the cause of this new and destructive enemy.*

"But it was not the lungs alone that suffered here. The central organ of circulation bore a part of the onus, and a host of anomalous and otherwise inexplicable symptoms were produced, which completely puzzled the naval practitioners, who rarely suspected any lesion of the heart. These last affections both aggravated, and were in their turn aggravated by, the depressing passions engendered during the long confinement on ship-board, and separation from friends and native home."

I need hardly stop to point out to what extent the fatal results above mentioned might have been prevented, had the officers been possessed even of a superficial acquaintance with the laws of respiration and of muscular action. A perusal of the chapters on these subjects will enable the reader to judge for himself, and to determine whether the cause of the destruction was really difficult to be divined. It is impossible indeed to read such details considerately, without coming to the conclusion that a general acquaintance with the constitution of the human body ought to be rendered imperative on every one who is entrusted in any way with the direction of, or command over, any of his fellow-creatures. Where so much is necessarily left to individual discretion, the possession of knowledge in aid of sound sense is the only security against abuses, which it is possible to obtain. In many situations, a general knowledge of the laws of the animal economy would be of the greatest use, not only to the instructors of youth and the guardians of public institutions, but also to the officers of the army and navy. Independently of all other considerations, it would open up to them a field of interesting study and observation in every country and under every climate, which could not fail to procure for them a large amount of pleasure and instruction. Dr Johnson, it may be mentioned, had the Channel and North Sea fleets chiefly in view in his remarks.

It was very common at one time to eulogize the simple food and hardy habits of the poor and labouring classes as eminently conducive to health, when contrasted with the debilitating effects of the cares and luxuries of the rich. Experience, however, unfortunately reverses the picture, and shews, by arithmetical arguments, that the excess of work and the privations to which the poor are habitually exposed, produce a much higher rate of mortality among them, especially in seasons of scarcity or commercial depression, than among the richer classes of society. In evidence of this fact, I may refer to a table recently published by M. Casper of Berlin, and shewing the influence of wealth and poverty respectively upon the duration of human life. He takes from the register of deaths in the Almanack of Gotha a thousand names belonging to the families of princes and dukes, and from the official returns of the population of Berlin, a thousand names of persons who had lived upon charity, and whose deaths had been carefully registered. Of a thousand rich and poor there were existing, says M. Casper:—

	Rich.	Poor.		Rich.	Poor.
At the age of 5 years,	943	655	At the age of 55 years,	464	283
.... 10 ..	938	598	.... 60 ..	398	226
.... 15 ..	911	584	.... 65 ..	318	172
.... 20 ..	886	666	.... 70 ..	235	117
.... 25 ..	852	553	.... 75 ..	139	65
.... 30 ..	796	527	.... 80 ..	57	21
.... 35 ..	753	486	... 85 ..	29	9
.... 40 ..	693	446	.... 90 ..	25	4
... 45 ..	624	396	.... 95 ..	1	2
.... 50 ..	557	338	.... 100 ..	0	0

Considerable inaccuracies obviously vitiate the commencement of this table; but even after making a very liberal allowance for unintentional errors, it cannot be denied that the chances of life are greatly in favour of the rich. This difference, indeed, is observable even in the army and navy, in both of which it is ascertained that the officers suffer less than the men from changes of climate, and from the fatigues and calamities of war.

In strict accordance with these facts, it appears, from late returns, that the mortality among the children of the poorer classes in Paris is nearly double that occurring among those in more affluent circumstances; while, in the wealthier departments of France, the average of life is twelve years greater than in those which are poor. Similar results are observed in London, where, according to Dr Granville's tables, only 542 infants out of every 1000 births among the *poor* survive their second year; and both in Paris and in London, the mortality in the quarters inhabited by the working-classes, is proved to be nearly double that which occurs in those inhabited by the more wealthy. The influence of impoverished diet, defective clothing, and unfavourable moral position, is further strikingly exhibited among the children of soldiers, of whom, according to Mr Marshall, only a very small proportion reach the age of manhood; most of them being stunted in their growth, scrofulous in constitution and bad in morals.*

If such, then, be the disproportion which occurs between the rates of mortality in the different classes of society in Great Britain, it suggests some most important considerations, the first of which is the simple question, Whether that condition of the lower orders can be regarded as eminently prosperous or natural, which subjects them to be cut off by death so many years before

* Marshall on Enlisting, &c., p. 16.

the term allotted to those by whom they are employed? It also illustrates, strikingly, what I have said about bad health being more frequently *the result of gradual causes long in unperceived operation*, than of any sudden or accidental exposure; and proves that a mode of life or degree of labour is not to be rashly pronounced harmless, merely because its injurious effects are not immediately seen, and because years may elapse before it breaks down the constitution. It is blindness to the existence of this principle which still misleads mankind, and renders them insensible to the agency of numerous hurtful influences, from which, by a little exertion, they might easily be relieved.

Much angry discussion has taken place at different times as to the reality of the mischief inflicted by the protracted and unremitting exertion required in our factories and spinning-mills, where an unerring test might easily be found. If those who contend that the times of labour are not too long for either the children or the adults, could produce evidence to shew that, among operative cotton and flax spinners, for example, the average of life is equally high as among the apparently more favoured classes, there would be at once and for ever an end of the argument; while, should the result prove different, the system of labour may justly be deemed oppressive, in the precise ratio in which the mortality among the operatives exceeds that among their wealthier countrymen. No criterion can be so infallible as the one here proposed; and as the Government now possesses the means of obtaining accurate returns, it is very desirable that the fact should be tested. In the two first reports of the Registrar-General, a comparison is made between the mortality of town and country districts, which shews the superiority to be greatly in favour of the country. But as no attempt is made to separate the mortality among the manufacturing population from that of the poor generally, data are still wanting to decide the question conclusively. The French returns, however, are more specific, and they afford direct evidence of both diminished stature and an increased mortality as results of the introduction and spread of manufactures; and I wish much it were in my power to lay some of them before the reader. As it is, I can only refer to the excellent work of Villermé on the physical and moral condition of the manufacturing population of France, as a storehouse of valuable information bearing directly upon the question at issue.

Everything which tends strongly to call attention to the conditions which influence public and individual health, is calculated to do great good to the community. In this point of view, I am disposed to consider the visitation of cholera to the British Isles, some years ago, rather as one of those remarkable instances in which a beneficent Providence brings good out of evil, and converts an apparent calamity into a positive blessing, than as the public scourge which it was generally proclaimed to be. True it is that many individuals perished, and that others suffered by it in their affections and in their worldly circumstances; but I question if any thing short of the dread which cholera produced, could have combined all classes so efficiently and ardently in their efforts to discover and remove every thing in the condition of the poor and labouring portions of the community, which could prove detrimental to health. In the season of apparent danger, not only did the importance of cleanliness, ventilation, warmth, clothing, and nourishment, as preservatives of health, become manifest to minds on which nothing else could have made an impression; but their experienced efficacy gave an impetus to the exertions of the lower orders in their own behalf, which will continue to be productive of good long after the cause from which it sprung shall be forgotten.

The comparative exemption of the wealthier classes from cholera is itself sufficient to shew how much it is in the power of man, by the proper exercise of reason and the application of his knowledge, to obviate the dangers to which his health is exposed; how closely his bodily welfare is dependent on his own conduct and external situation; and how very little, comparatively, it is the result of circumstances which he cannot control or modify. In fact, every one who has investigated the subject with attention, will readily testify, that, but for the establishment of soup-kitchens, the supplies of warm clothing, and the whitewashing, cleaning, and ventilating of the houses of the poor, before and during the epidemic, a much greater number would have fallen victims to its ravages. And it is consoling to know, that even those who regard such visitations as direct inflictions of a vengeful Providence, and as nowise connected with mere neglect of the laws of health, were nevertheless not the least active in enforcing and superintending the removal of every external cause of disease, and promoting the comforts and supplying the wants of the needy and destitute; so that whatever differences in mere belief there might be, all parties were content to act as if the Creator had intended the health of the race to depend, in a very high degree, on the care which was taken to fulfil the conditions which He has decreed to be essential to the due action and preservation of the various bodily organs.

Many individuals exist, who, from hereditary deficiencies, can scarcely attain tolerable health, even with the best care; and many more are to be met with who are exposed to bad health from the hurtful nature of the professions in which they are engaged. Many suffer, also, from vicissitudes of the weather, and other causes which we may never be able entirely to guard against. But all these united are few, when compared to the number of those whose health is ruined by causes capable of removal or of modification, and to which they are now exposed from ignorance of their nature, from apathy, or from the want of the comforts and necessaries of life. If I have succeeded in calling attention to this important truth, one great object of these pages will be accomplished; and here I cannot help repeating the remark already made more than once, that *health is more frequently undermined by the gradual operation of constant though disregarded causes, than by any great or marked exposures of an accidental kind*, and is consequently more effectually to be preserved by a judicious and steady observance of the organic laws in daily life, than by exclusive attention to any particular function to the neglect of all the rest.

It may be said, that I allow nothing for the influence of habit in rendering situations and causes comparatively innocuous, which were dangerous at first. It is quite true that the human constitution possesses a power of adapting itself within certain limits to a change of circumstances; but it is not less true that sudden and extreme changes often destroy health and life before the system can adapt itself to the exigency, and that after making the most ample allowance for this sort of safety, the protection which it affords against the active causes of disease is comparatively trifling.

Where the change is sudden, as in passing from a temperate to a tropical climate, or even from very fine to very inconstant weather, the consequences to health are well known to be highly injurious. But where it is gradual and not extreme in degree, as in passing from winter to summer, health is not much endangered, because the system has time to accommodate itself to its new circumstances. Different organs predominate in activity in different climates and seasons, and time is thus required to admit of the necessary changes taking place without disturbing the general balance of the circulation. In hot countries, for example, the skin predominates greatly in activity in comparison with the kidneys; whereas, in a cold country, the case is precisely reversed. If, therefore, a sudden transition be made from the one to the other without due preparation and attention to the requisite change of dress, the rapid

change in the distribution of the blood from the surface to the internal organs, or from these to the surface, consequent on such change, is likely to be attended with danger; although the same change gradually effected would be unattended with any injurious results.

If, again, the change be from a healthy situation to one only a little less favourable, the consequences to the system will be also gradual and progressive. No immediate injury to health may be apparent, and the body may be said to adapt itself to the circumstances; but, in reality, health will be lowered and life shortened, in exact proportion to the amount of the injurious exposure and the state of the system at the time. Individuals of a peculiar constitution may live long, but the average of health and life will be positively diminished,—a fact which shews that the apparent exception is more a fallacy than a reality, and that, *cæteris paribus, the highest health and greatest vigour will always be on the side of those who make the nearest approach to the fulfilment of the organic laws.*

It is therefore a glaring perversion of logic and reason to infer that we may safely rest satisfied with a limited portion of evil, on the plea that the constitution will adapt itself to its presence. The argument ought to be turned in exactly the opposite direction. If the constitution possesses this power of adaptation to external circumstances, it becomes doubly incumbent on us to have it always surrounded with *beneficial* influences; seeing that, when the laws of health shall be fulfilled, the same tendency to adaptation will operate with equal force in permanently ameliorating the constitution. In every point of view, therefore, it is an object of much consequence to us to become acquainted with and to obey all the laws which regulate the functions of the human body.

It would be easy, were it consistent with the limits and purpose of the present volume, to shew that, although great advances have been made of late years both in physiological knowledge and in its applications to the advancement of human happiness, many of the usages current in society, and many of the practices resorted to in education, are still far from being in harmony with the laws of the human constitution; and that much good may be done by diffusing among the reflecting portion of mankind, and especially among the young, more accurate notions of the structure and uses of the various bodily organs, and of the conditions required for their healthy action. Illustrations in proof of this position, drawn from individual cases, may be cavilled at as incomplete, or regarded as accidental coincidences; but when the principle is exhibited in active operation on a large scale, minor qualifications will fall into the shade, and leave the evidence absolutely unassailable. On this account, I prefer selecting an example from the records of the army, both as being striking in its features, and as being one in which the public interest is deeply involved.

A few years ago, young growing lads were uniformly selected for the army, in preference to men of a mature age, on the supposition that, because their habits were not formed, they could more easily be converted into good soldiers than if taken a few years later. Many officers still entertain and act upon this opinion; and the period at which, by law, liability to military service commences in this country, remains fixed at eighteen years of age, although it has been raised to twenty by most of the Continental governments.

Examined physiologically, the practice of enlisting juvenile recruits seems peculiarly irrational. During growth, the conditions required for the healthy development of the body are, moderate and healthy exercise, plenty of nourishing food, abundance of sleep, and a cheerful state of mind. In making the transition from boyhood to maturity, the equilibrium of action between the different parts of the system is so much disturbed, that, under the most favourable circumstances, an unusual susceptibility of disease prevails, which renders that period of life particularly dangerous. By consulting the statistical tables prepared by Mr Finlaison, and those of the population of Paris, by Count Chabrol, already referred to, it will be seen that, in all classes of society, the rate of mortality suddenly increases from the age of fourteen, when rapid growth may be said to commence, to that of twenty-three, when it is nearly completed. In Paris, for example, the tables for the year 1820 exhibit only 395 deaths as occurring between the ages of 10 and 15; whereas those between 15 and 20, amount to no less than 703, being nearly double; while, in the five years immediately subsequent, they rise to 1339, and afterwards begin to decrease.

Viewing these results in connection with the laws of the animal economy, and bearing in mind that, even in peace, military service implies broken sleep, separation from friends, and occasional exposure to fatigue and privation, we must consider it almost self-evident, that an army composed of young lads at this hazardous period of life must be sickly and inefficient, and that a large portion of the expense and trouble bestowed in enlisting and training them must be entirely thrown away. That such is actually the fact, has unfortunately been too often proved by fatal experience. Mr Marshall, in the valuable work already quoted, adduces an irresistible mass of evidence to shew that, till growth is completed, it is impossible to form any correct estimate of the probable efficiency of a recruit; as numbers of apparently promising young men are cut off by affections of the chest, and other acute diseases, before attaining maturity, and before being exposed to any unusual privations or fatigue. So literally accurate is this statement, that Coche, a high French authority referred to by Mr Marshall, mentions distinctly, that even in time of peace, when no great hardships are to be encountered, volunteers, received into the army at the age of eighteen or twenty, pass two, three, or four years of their period of service (eight years) in hospital, solely from inability to bear up against difficulties which scarcely affect those who are a few years older.

If such be the result during peace, I need hardly say that, in time of war, the practice of enlisting very young men must be not less fatal to the recruits than costly to the country. It appears, accordingly, that, in the army in Spain, sickness and inefficiency prevailed almost in proportion to the youth and the recent arrival of the soldiers. Sir James MacGrigor cites the 7th regiment as an illustration, and adds, that between 9th August 1811 and 20th May 1812 it lost 246 men; of whom 169 were recruits landed in the preceding June, while only 77 were old soldiers. The original number of this detachment of recruits was 353, so that *more than one-half died within the first eleven months.* The total number of old soldiers, on the other hand, was 1143, and of them only 77 perished in the same time! So convinced, indeed, is Sir James of growing "lads being unequal to the harassing duties of the service," that in making calculations for measures in the field, he thinks that 300 men, who had served five years, would be more effective than 1000 newly arrived, not simply from their greater experience, but chiefly from the additional stamina proceeding from maturity.*

In a note subjoined to the preceding opinion of Sir James MacGrigor, Mr Marshall says, "Numerous examples might be quoted to shew that young lads are much less able to endure the fatigue of marching than men a little more advanced in life. During the winter of 1805, a French army, which was stationed on the coast in the neighbourhood of Boulogne, marched about 400 leagues to join the Grand Army before the battle of Austerlitz, which it effected *without leaving almost any sick in the hospitals on the route.* The men of this army had served two years, and *were not under twenty-two years of age.* The result of the march of this army may be compared with that of another under different cir-

* Marshall on Enlisting, &c. p. 5.

cumstances. In the campaign of the summer of 1809, the troops cantoned in the north of Germany marched to Vienna, but, by the time they arrived at the place of their destination, *all the hospitals on the road were filled with sick. More than one half of the men* composing this army were *under twenty years of age*, the usual levy of conscripts having been anticipated. After the battle of Leipsic, Napoleon made great exertions to recruit his army, and called upon the legislative senate to give him their assistance, to which they shewed some reluctance. "Shame on you!" cried the emperor; * * * "I demand a levy of 300,000 men, but *I must have grown men;* BOYS SERVE ONLY TO ENCUMBER THE HOSPITALS AND ROADSIDES."

In similar defiance of the laws of physiology, half-grown lads were at one time preferred for the East India service, on the false supposition that their unconsolidated constitutions would more easily adapt themselves to the climate than those of men already arrived at maturity, a proposition very nearly equivalent to saying, that because a person is already enfeebled, exposure to the causes of disease will *therefore* have less effect on him than after his strength shall be restored! Palpably fallaciou as this kind of logic now appears to be, it nevertheless reigned for years with undisputed sway, and still has a few staunch supporters. Sir George Ballingall is entitled to the credit of having early and earnestly raised his voice against it, in his work on Fever and Dysentery, published on his return from India in 1819. His evidence is very striking; but so slow is the march of reason, that it was only in December 1829, that an order was issued from the Horse Guards that no recruits under *twenty* should be received for regiments serving in tropical climates; and so late as the year 1826, nearly 15 per cent. of the king's troops in Bengal were under that age.

Mr Marshall also, in touching upon this question, supports his positions by reference to facts of a very conclusive kind, and to authors whose opinions ought to have great weight. Among other evidence, he quotes the register of a regiment employed in the Burmese territory in 1824-5, from which it appears that, in 1824, the ratio of mortality among the young men who went out with the corps was 38 per cent. or 1 in every $2\frac{1}{8}$; while among the volunteers, who were considerably older, the mortality was 17 per cent., or only 1 in 6. In 1825, it was 30.5 or 1 in $3\frac{1}{3}$ among the younger class, and *only* 6 *per cent.*, or 1 in 16, *among the older*. P. 10.*

Some other instances might be quoted in proof of the greatest mortality being always among the youngest men; and I might refer to a regiment mentioned by Dr Davies, in which, when it was sent out to Bombay in 1808, there was not a single private above 22 years of age, and in which, out of 550 men, nearly 300 required medical assistance within six weeks after he joined it; but it is unnecessary, as, although individual officers still prefer young men, Government is at last awakened to their unfitness. A vague notion that growing lads do not bear fatigue, is indeed prevalent enough; but I venture to say, that if those by whom the age of enlistment was first determined had been thoroughly acquainted with the laws of physiology, and had possessed a clear preception of the conditions of healthy growth, the practice of receiving recruits at 17 or 18 years of age would never have been sanctioned, and the country would have been saved the pain and expense of sending thousands of young men to "incumber the hospitals and roadsides" of the Peninsula, or to perish under the exhausting influence of a tropical climate.

I have dwelt at some length on this subject, both because the practice which I condemn was lately in full operation, and is even yet not entirely exploded, and because from the magnitude of its results, and the clearness with which they can be traced to the direct violation of a natural law of the constitution, it affords an instructive example of the evils arising from ignorance of the structure and functions of the human body, and of the aid which might be derived from a general acquaintance with physiology, in preserving health and promoting the happiness of the race.

It was my intention to analyse, in the same way, various other practices in which public and private health is concerned; but I have already so far exceeded the limits originally proposed, that I must now draw to a conclusion, and leave the reader to determine how far I am right in believing that information of the kind now communicated will be acceptable or useful to the public.

* In availing myself of Mr Marshall's labours, I may be allowed to express my opinion of the benefit he is conferring by his statistical researches, not only on the service with which he has been so long and honourably connected, but also on the public at large. There are many practical questions deeply concerning public health, which can be fully elucidated only by such masses of facts being grouped together as shall destroy all minor inequalities, and place the operation of principles prominently in view. But to effect this object with due regard to accuracy, requires an acquaintance with details, an acuteness of observation, and a power of successful generalization, which are rarely found in combination with adequate zeal and industry. It would be very useful if similar researches were instituted in regard to the occurrences in our public hospitals.

Disease of heart & blood vessels –

Proofs of the influence which circumstances can be made to have on health

Scurvy &c

Zu Maths Phrasen

Decay cyclopaed of Med

Drainage under Repair

INDEX.

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Conditions of health of the skin.—Free circulation in its vessels, and free exhalation from its surface the chief requisites.—Cold unfavourable to both.—Mortality in infancy from cold.—Exercise indispensable—attention to clothing is important.—Bad health in youth from inadequate clothing and cold rooms, especially in schools—coldness of feet and its consequences, causes and means of prevention—mischief from abuse of warm bottles in bed—and from over-heated rooms causing increased susceptibility of cold—cautions on this subject.—Excess of clothing equally injurious.—Dress not to be tight.—Influence of cold and wet feet.—Qualities requisite in clothing.—Flannel combines most of them.—Practical proofs of the utility of flannel as a preservative of health—in warm as well as in cold climates—cautions to be observed in laying aside clothing.—Clothing to be carefully exposed to the air.—The frequent removal of impurities from the clothes and surface essential to the health of the skin.—Hence the utility of frequent changes—and of ablution and bathing.—Washing-establishments for the poor recommended—their advantage and economy shewn in Liverpool.—Necessity of removing impurities from the skin—hence usefulness of tepid and warm bath, shower-bath, and daily ablution—cold bathing and sponging with water and vinegar or salt.—Preservative and soothing influence of warm bath as a domestic comfort.—Strongly recommended for the working-classes, and much used on the continent—fear of cold after it unfounded—the reverse is the truth.—Vapour bath very useful.—In nervous disease and in depression, warm and vapour baths very salubrious.—Daily friction with hair-glove or flesh-brush of great value in both health and disease.—Sailing and riding useful by acting on the skin.—The author's case a good illustration of the influence of the skin on health.—Beneficial influence of solar light.—Important deficiency of it in the dwellings of the poor.—Noxious external agencies to be avoided.—Contagion by absorption.—Best means of preventing it.

REQUISITES OF CLOTHING

The principal requisites in clothing are, that it shall be, 1*st*, as light as possible; 2*dly*, a bad conductor of heat, so as to afford protection against sudden changes of temperature; and, *lastly*, of a sufficiently porous nature to admit of the easy passage of the insensible perspiration. Of the various kinds of clothing in common use, none presents these combined advantages in so high a degree as flannel; and consequently, as a general rule, no other material can equal it in suitableness for being worn in contact with the skin, which it is our special object to protect.

Principles of exercise.—The co-operation of an active, mental, and nervous stimulus, is the first requisite.—Advantages of this illustrated by examples—but neglected in practice and in schools.—Exercise should involve great variety of motion.—Monotonous and formal walks merely counterfeit exercise.—The constitution of the muscular system requires varied movements.—Evils from neglect of this in factory-children and in girls.—Deformity in factory-children in France from monotonous over-exertion.—Free and varied motion the best protection against deformity.—Proofs of this.—Excellent remarks of Madame Necker on female education and health.—Spinal deformity unknown among savages.—Impaired health often its first stage or precursor.—Exercise to be proportioned to age, strength, habit, and constitution.—Rules for deciding on its amount.—Effects on nutrition useful as a guide.—Times at which exercise ought to be taken—never immediately before or after meals—the early part of the day the best time—and ought to be repeated at intervals.—Different kinds of exercise.—Games.—Excursions.—Cautions regarding excursions and regarding violent exercises.—Riding—its mode of action and advantages.—Dancing.—Gymnastic and calisthenic exercises.—Reading aloud and singing.—Cases illustrative of the above principles.

surface of the body becomes cold, shrunk, and uncomfortable, and the individual is subject to annoyance and painful sensations from trifles which formerly gave pleasure. Bad digestion and deficient warmth of surface are thus proverbially complained of among literary and sedentary persons, and can be removed only by exciting the nervous and vascular functions of the skin, and diminishing those of the brain.

Such are the direct and important uses of the skin. But, in addition to the parts already noticed, there are several others which, in a purely scientific treatise, would require to be described at some length. But as they have very little influence in a practical point of view, and moreover would not be easily understood, I shall content myself with a simple allusion to two of them.

We have already seen that what are called the mucous coat and the epidermis are merely different states of an originally fluid mucus, secreted in the substance of the dermis, and mixed, on reaching its surface, with a peculiar colouring matter. This mucus, according to Breschet, is secreted by a particular apparatus composed of a principal organ, analogous to a gland, seen at *c* in the woodcut on page 12, and situate at the bottom or near the inner surface of the dermis, and of an excretory duct, seen arising from the top of the gland *c*, which traverses the dermis and pours out the mucus upon its external surface. This excretory duct differs from that by which the sweat is excreted in not being spiral, and in the woodcut the two kinds of glands and ducts may be easily distinguished from each other.

The only other structure requiring to be mentioned in connection with the skin, is that by which the colouring matter is produced. Breschet describes it

occurred in which the spread of disease was arrested, and health and character were restored, by the habits of cleanliness and self-respect thus fostered. From the very trifling expense at which this establishment is carried on, it is quite evident that a similar plan might be carried into operation in the different districts of every large town, and even in most of our country villages, with the happiest results.

But if the frequent change and washing of clothes are essential to the health of the skin by removing the sa- [illegible] deposited upon them by

This constitution of Nature, whereby a mental impulse is required to direct and excite muscular action, points to the propriety of teaching the young to observe and examine the qualities and arrangements of external objects. The most pleasing and healthful exercise may be thus secured, and every step be made to add to useful knowledge and to individual enjoyment. The botanist, the geologist, and the natural historian, experience pleasures in their walks and rambles, of which, from disuse of their eyes and observing powers, the multitude is deprived. This truth is acted upon by many teachers in Germany. In our own country, too, it is beginning to be felt, and one of the professed objects of Infant education is to correct the omission. It must not, however, be supposed that *any* kind of mental activity will give the necessary stimulus to muscular action, and that, in walking, it will do equally well to read a book or carry on a train of abstract thinking, as to seek the necessary nervous stimulus in picking up plants, hammering rocks, or engaging in games. This were a great mistake; for in such cases the nervous impulse is *opposed* rather than favourable to muscular action. Ready and pleasant men- [illegible] which accompanies easy conv

Functions -

Exhalation

watery fluid 1. Secretion

Its qty - Sanctorius 5/8 of food taken
totally skin & lungs. Own & living
54 ℥ in winter 63 in summer

Seguin - how he did this

45 ℥ average - 30 skin - 15 lungs.

Dalton found food 91 ℥ -
in summer 44 ℥ 45 1/2 ℥

Warm dry air affects both -
circulation quickened - vapor
increased - Cold moist air an opp
effect - Hot moist air incrs
the secretion not the evap
The uses of this excretion
Movement of excreted matter

Animal Heat –

To regulate animal heat

~~Ha~~grange's theory of respiration

The qty of carbonic acid shown by Magnus to be sufficient to give the carbonic acid exhaled

1/5 vol of venous blood "C

The temp is 97

Relation to ext of respiration in birds &c

– young animals

– in ~~th~~ hybernating animals

– in frogs in winter live longer in distil water

To prevent excess of heat

Individuals can bear great heat – above boiling point of water – Banks & Blagden & Fordyce remained in a room heated above 260

De la Roche vessel 100 – frog 50 temp 142 all equal