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ON THE CONDITIONS THAT
INFLUENCE THE ATTAIN-
MENT OF THE PHYSIOLOGICAL
IDEAL.

INTRODUCTORY LECTURE,

14th October 1890.

BY

WILLIAM RUTHERFORD, M.D., F.R.S.,

Professor of the Institutes of Medicine, University of Edinburgh.

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OF THE CONDITIONS THAT
ATTEND THE ATTAIN-
MENT OF THE PHYSIOLOGICAL
WELL-being

IN LABORATORY LESSONS
AND

LECTURES BY WILLIAM ROBERT FORD, M.D., F.R.S.
AND

JOHN COOPER, M.D., F.R.S.
THE VARIOUS PARTS OF THE WORK

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*On the Conditions that Influence the
Attainment of the Physiological
Ideal.*



GENTLEMEN,

In opening the course of lectures on Physiology I would to-day ask your attention to a brief discussion of the Conditions that influence the Attainment of the Physiological Ideal.

The human body—like any other complex organism—has to take its origin in a cellular germ, which, though apparently simple, is in reality of great molecular complexity, endowed with wonderful properties and possibilities.

Through many complicated trains of events the daily repeated mystery of development obeys the laws of organic nature, and fashions our complex body, with its bony framework; its joints and ligaments deftly knitted together; its muscles and tendons beautifully arranged to move its bony levers or to propel fluids within its hollow viscera; its complex apparatus for

nutrition ; its nerve threads for swift messages between its several parts ; its wonderful organs of sense to enable it to receive impressions from its environment ; and its central nervous system, where the incomprehensible phenomena of consciousness are evolved.

The full powers of the organism are attained only by slow degrees. The segmentation-cell with its wonderful potential powers derived from both parents, develops under the influence of a suitable environment into layers of cells from which all the tissues and organs gradually arise, obeying in their development occult morphological laws by which they are guided to organic results of the greatest complexity, yet of symmetry and remarkable suitability for the purposes they have to serve. The scientific triumphs of a Forth Bridge are not so wonderful as those of organic Nature in the living structures she has gradually evolved, and which she day after day rears anew. One of her greatest marvels is—that while life maintains the appearance of immortality in the constant succession of similar individuals, the individuals themselves live only for a time, and pass away. There is the inevitable procession of youth ascending the stair of life—of manhood at its summit—and of the aged descending

to the close of their day. It is indeed as Shakespeare says:—

“ Everything that grows,
Holds in perfection but a little moment.”

“ Men like plants increase,
Wax in their youthful sap, at height decrease, and
Wave their proud state out of memory.”

It is daily evident to all of us that in the procession of life the *physiological ideal* is frequently not attained, and even when attained, it frequently happens that it is not maintained for the natural period of time. Every man would attain the physiological ideal if he could; every man would like to maintain it; but the conditions that affect its attainment and its maintenance are complex; some are beyond control, some are not understood and realised, some are neglected, some are despised.

The physiological ideal can only be attained when inheritance is favourable—when there is a perfect development of the organism and all its powers—when there is sufficient stability of tissue—when the powers of the organism are adequately exerted, but economically and well directed—and especially when the intellect is well trained for the exercise of its full powers, and when by education, the brain is adequately stored with knowledge.

Even for an animal such as a dog or a horse, the physiological ideal, *viewed from our standpoint*, is not attained, unless the animal is educated to be an intelligent and docile servant; much more therefore in the case of man, the physiological ideal is not attained, unless his brain is sufficiently educated, and the nature of the education adapted to the nature of the work it is called upon to discharge.

The primary conditions that affect the attainment of the physiological ideal are:—*Inheritance, Evolution, and Stability.*

Heredity is one of the greatest wonders, and one of the greatest mysteries of living nature. It is indeed wonderful, that the minute sperm and germ corpuscles should, after their union and interaction, develop into the complex organism. It is wonderful that two such minute particles from the male and female, should have the power of transmitting to all the tissues and organs of the body, the qualities of both parents—not merely the qualities they potentially possessed at birth—but new qualities acquired during life; and it is scarcely less wonderful, that they should have the power of transmitting qualities observed in ancestors and remote relatives, but which were not revealed in the immediate parents.

Heredity affects the physiological conditions, and the pathological tendencies of all the tissues and organs of the body, and its operation has been to some extent recognised from the earliest times, and is conspicuously referred to in the Second Commandment.

The influence of heredity chiefly determines the bodily stature, the conformation of the features, the size of the head and hands, the complexion and quality of the skin, the colour of the hair and iris. Its influence on the condition of internal organs is not less remarkable. Peculiar states of the digestive, the circulatory, and the pulmonary systems, and indeed of all the organs of nutrition, are apt to be continued by descent. The hereditary tendency of peculiar states of the vision is also remarkable; colour-blindness has been traced through five generations, and the persistence of short-sightedness is scarcely less remarkable. The manner in which a person walks, the quality of his voice, his tastes, his temperament, his mental abilities, and indeed all his mental features, may be continued by descent.

The influence of heredity is even more evident in different races and nationalities, than in the smaller families of mankind; for, amidst large numbers of the descendants of a common stock,

the exceptions to the law sink into comparative insignificance.

But the most striking illustration of the law is to be seen in the effects of selective breeding of animals and plants, where the conditions can be perfectly ascertained, and disturbing influences excluded.

Side by side with the great *Law of Inheritance*, that "like begets like," there is the great *Law of Variation*. Nature is ever varied. Through all the ages she has probably never produced two living forms perfectly identical. There is an infinite variety of species of plant and animal with their different features and different habits. Their forms, their colours, their movements, their manners, their signs, their life-histories, are all infinitely varied. No two leaves of the forest are identical. No two individuals of the same species, the same race, the same family, are identical. Even twin offspring, conceived at the same moment, and exposed *in utero* to precisely the same conditions, are never identical. The individuality of every living being is always distinct; were it otherwise, life would become unspeakably dull from the depressing effects of monotony.

By the infinite variety, both of the physical and mental features of man, we are constantly

interested and stimulated, and we have in addition, the exhilarating effect of the variety in plants and animals, and indeed in all Nature. We are constantly forgetful of our deep indebtedness to Nature for her variety. What would become of our University if all men were cast in the same mould? What would become of the great lever of competition if all the intending members of this class had identical qualities and identical powers. The struggle for the prize, which in past years has sifted men, as surely as the struggle for existence has sifted species, would be at an end. Insipid monotony would replace the sparks that fly about as we sharpen each other for the battle of life, and we would be driven to feel that life is scarcely worth living.

In the process of development of any organism, the main feature is always the fulfilment of the law that "like produces like." It is by that law that the Protozoa are reproduced as certainly now as in long ages that are past. By that law, we can predict the continuance of our race, and can foretell that the last decade of the twentieth century will probably find the human form and the human mind similar to what they now are.

But, although the main result of development is the attainment of a specific form with specific qualities, there is ever variation ;

the offspring, although inheriting qualities from both parents—now more from the male, now more from the female—is never a simple admixture of the two, but has always acquired features that distinguish it from all other individuals. The countless multiplication of cells whereby our various organs are developed, although it leads to similar morphological and physiological results in different individuals, does not produce results that are identical.

There is ever variation, and although the variations may be small, they may nevertheless be highly important and significant.

The production of endless variation, significant of Nature's vast fertility of resource, is not only the result of a tendency to variation in the molecular constitution and action of cell protoplasm, but also results from the collateral influence of environment, such as variations in the nutrition of the child before and after birth, and all the different influences that may be brought to bear on the life of the individual during childhood, adolescence, and manhood.

Therefore, to the innate tendency of Nature to produce variety in living forms, *environment* is superadded with its manifold influences tending to modify the varieties produced by Nature, and tending independently to produce *artificial variations*.

But the environment is not always, so to speak, striving to induce variation. On the contrary, when the individual is suitably adapted to an environment with favourable conditions, the main result is *stability of form and of life*.

Now, as Darwin has shown, when variation is in a favourable direction, *evolution* is the result, but when its direction is unfavourable, *involution* is the consequence.

It is part of the Law of Inheritance that qualities acquired by variation tend to be transmitted to the offspring; and it is mainly by the operation of this principle that races of civilised men and breeds of tame animals have been rendered possible.

Every one is familiar with the great variations that have been induced in flowers and fruits by careful cultivation. These results were impossible if the acquired qualities were not transmitted by descent.

Every one, too, is familiar with the invaluable results that have been attained by artificial selection in the breeding of animals, and by the development of good qualities that may be induced by suitable diet, domestication, and careful training.

In the civilisation of human races, nobody

expects that in one generation, a race of savages can attain all the qualities pertaining to high civilisation. Several generations are required; each succeeding generation inheriting some measure of advantage from the condition of brain established in the preceding. With the help of such inheritance, the process of civilisation proceeds more easily, and it is indeed essential for the attainment of the highest result.

I have already casually alluded to the *Inheritance of Mental Qualities*. The production of races of tame animals, and of civilised races of men, brings up that question again, and the importance and deep significance of it requires a more detailed reference.

The hereditary transmission of *mental qualities* is quite as certain as the inheritance of facial feature, colour of hair, and bodily stature.

There is no mental quality more certainly hereditary than that of the *imaginative power* which leads to the production of poetry, music, and painting. Its hereditary character is readily seen on comparing different races of men. In the Jewish race there was, amongst other qualities, an evident development of musical but more especially of poetical talent. The poetical imagination so conspicuous in Jewish writings

has had a far greater influence on the thought of our time, and on the history of the world, than is commonly suspected.

In the Celtic race there is a similar development, probably as conspicuous now amidst the mountains of Wales and Scotland, and the green fields of Ireland, as in times far distant.

The Greek and Latin races showed a similar, though a far greater, development. The poetry, sculpture, and architecture of the Greeks, and their love of philosophical speculation, testify to their imaginative talents.

Evidence of the same mental feature is also prominent in Italy, where poetry, music, painting, sculpture, and architecture have so abounded, that Italy by the imaginative genius of its people has become the greatest art treasure-house of the world.

In the Teutonic race there has been since the earliest times a development of musical talent scarcely less marked than in the Italian, but combined with a mental insight far deeper, which has enabled the Teutonic race to produce the musical genius of Bach and Mozart, of Handel and Haydn, of Beethoven and Wagner, who have given to the world its greatest musical creations.

In the Anglo-Saxon race musical genius has

been much less, but poetical genius much more developed than in the German, so that Britain has given to the world the poetry of Shakespeare and Milton, Byron and Shelley, Burns and Browning.

The mental features of the Greeks were so characteristic that probably no one has doubted that the quality of brain which produced them descended from father to son.

The mental features of the Indian race to-day closely resemble what they appear to have been many centuries ago; and the description given by Cæsar of the mental characteristics of the Gauls still applies to the French nation.

The hereditary transmission of mental talent has also been proved by statistics collected by Francis Galton, which you will find in his work on "Hereditary Genius." He found that in 300 families where one or both parents had special mental powers, there were nearly 1,000 eminent members, of whom 415 merited the title "illustrious." In the Bach family high musical talent ran for generations, and the family of which our Prime Minister is a descendant has been distinguished since the days of Elizabeth. If you examine any biographical dictionary of the distinguished men of this country, you will find evidence that a large number of them are

descendants of those who were members of learned professions. It is unnecessary to give further illustrations of the inheritance of mental quality, for everyday experience confirms it.

The principle is eloquently expressed by Goethe in *Iphigenia* :—

“ How blest is he who his progenitors
 With pride remembers, to the listener tells
 The story of their greatness, of their deeds,
 And, silently rejoicing, sees himself
 The latest link of this illustrious chain !
 For seldom does the self-same stock produce
 The monster and the demigod : a line
 Of good or evil ushers in at last
 The glory or the terror of the world.”

There seems no reasonable explanation of the inheritance of special mental talent save that which regards mental manifestation as so entirely conditioned by the brain, that practically it virtually comes to this, that thought is a function of the brain.

The startling mental features one may find in any asylum for the insane brings into painful prominence the dependence of mental quality on brain function ; and numerous statistics conclusively prove the hereditary transmission of various forms of insanity. Since these statistics prove the hereditary character of abnormal mental features, they of course furnish at the same

time a powerful argument for the transmissibility of mental qualities that are normal.

But many recoil from the conclusion that *genius* can be inherited. To such thinkers, genius is something specially heaven-born that occasionally descends like a fluttering dove and alights on the head of some favoured person. Such theory will never explain why genius should have so frequently selected persons of somewhat unstable mind.

Those who cling to the shadowy garment of such a theory would tauntingly ask for evidence of poetical genius either in the parents or descendants of Robert Burns, in whom genius appeared like the flash of a meteor, seeming to come out of darkness and to vanish into it again. The life of poor Burns was such that one might well ask why he should have been selected for the display of genius, and one might with equal reason ask the same question regarding Byron and King David.

In dealing with difficult and obscure questions, one must beware of the snares and pitfalls that waylay the thinker who would draw general conclusions from isolated cases which may prove exceptions to the rule.

The special development of poetical genius in certain races of mankind, is a far greater argu-

ment for its hereditary transmission than any which could be advanced against it from the study of a few isolated cases.

But since I have mentioned Burns, I may say, that you have only to read his beautiful poem of "The Cottar's Saturday Night," to discover that he was descended from parents who were strongly religious. The religious attitude of mind is always allied to the emotional. Poetical feeling is always emotional; and if you read the life of Burns, you will find that when he wrote the idyl I have named, he had frequently to stop, overcome with emotion, while he painted in words the picture of piety, now so celebrated.

You will probably find no better explanation of the appearance of poetical genius in Burns than this, that it was the result of a natural variation in the condition of the brain, probably led up to by a hereditary line of tendency in that direction.

The non-transmission of genius by descent, of which there are not a few illustrations, is probably due to the instability of brain tissue with which great genius, especially if emotional, is sometimes associated, and also to the nervous exhaustion which may be induced by the great brain efforts to which brilliant genius has been led by the fascination induced by its own mental creations.

In such speculations you will be obliged to conclude that the *degree of stability* in the brain plasm is a great factor in determining the continuance of any variation.

Perhaps it is as well that the Architect of Nature should thus have ordered it. It is as well that great geniuses should not be too common, otherwise our mind might be too much dazzled, our attention too much diverted from the prosaic affairs of life.

But now, gentlemen, although we may say with Goethe,—

“How blest is he who his progenitors
With pride remembers,”

we must not overlook the fact that many a man who has risen to greatness has not referred to his progenitors with any particular pride. When Thomas Carlyle came to this University, he was only the son of a stone mason. Had he been a snob, he would have concealed his pedigree; but his deep insight into Nature and her processes, led him to see that he really owed his greatness to his progenitors, and that the success which he achieved in the world of learning might have been theirs, had circumstances given them the advantage of the intellectual environment which a University affords. When he left his estate to the students of our University, so that mayhap

some youth of humble origin like himself, might be helped on his way, he testified to the value of a University environment in evolving the mind.

I remember, that when our great tercentenary celebration came to a close, men from all parts of the world found suitable expression for the feeling of universal friendship in the words of a Scottish peasant who had never been a day within a University. It struck me that if Burns had heard his "Auld Langsyne" used as the hymn of friendship by members of our race from all parts of the world, he would have felt that sooner or latter all men acknowledge great sentiments without respect to the social position of those who utter them.

I have no doubt that in this room, where men are assembled from all parts of the world, there are many who cannot point to the greatness of their progenitors, and some on that account may be disposed to think it scarcely worth their while to make any special effort. That is just the very feeling to be guarded against. No man knows what the powers of his brain may enable him to accomplish, until he makes his utmost effort to develop them. No man can foretell the result of sustained effort to develop brain power in the stimulating environment of a University.

No man can undo his inheritance. He may be rich or poor in the brain quality he has inherited, he cannot help it; but if he honestly observe the conditions that affect the attainment of the physiological ideal, and daily urge himself to attain it, he may discover that his inheritance is better than he supposed! and he is sure to discover that although brain *quality* is inherited, *knowledge* is not. Knowledge does not come by intuition, but by brain effort, and we have sometimes observed that the son of a distinguished man may tend to suppose that he does not require to exert himself. He may suppose that his father's reputation will cover his own ignorance, and float him in the world. Rude awakenings from such pleasant dreams are not unknown. The parable of the talents is often overlooked; men constantly forget that where the inheritance is great, the account they render should be the greater.

How is the highest physiological ideal to be attained by those who choose intellectual work as their chief vocation in life. How is the mental power to be developed to its utmost? How is the brain to be fully stored with knowledge? When the muscles are duly exercised during the growing period of life, they grow more rapidly in all cases; but in most persons a

limit is soon reached beyond which the growth induced artificially will not proceed. The growth, so to speak, refuses to proceed further than the inherited tendency to muscular development, would carry it in the particular individual. But in a few cases, there is a variation in the sense of a tendency to muscular development, which is only revealed when the favouring influence of muscular exercise is superadded. In the heart, one may find a striking illustration of the manner in which Nature strives to accomplish her task. When disease increases the resistance to the expulsion of the blood, it generally happens that the muscular wall of the heart grows thicker to render the force of its contractions adequate to maintain the circulation.

In the brain the phenomena are similar, but far more striking. No organ of the body is so plastic, and in none other is there such possibility of development. When the brain is regularly and sufficiently urged to effort, it grows larger, and strives to accomplish the work it is called upon to discharge.

In most individuals it behaves as muscles commonly do, and refuses to grow beyond a moderate limit; but in some cases it responds to continued effort by growing larger even after middle age. This tendency to a con-

tinued growth of brain substance is probably hereditary, but it may not be evident in the parent, unless he has been subjected to the same brain stimulation as his descendant.

No man can foretell whether his brain substance will go on growing under the influence of effort until he systematically and persistently makes the effort. Some are inclined to doubt this continued brain growth, and allege that it is impossible, because the organ is surrounded by a resistant bony case. It is, however, none the less a fact, and no doubt some of you will in future years be able to confirm the truth of what I say.

But while the brain has a wonderful plasticity and power of growth, it is vain to compel it to perform any kind of work. Although every man has a moderate amount of imaginative power, no man can compel himself to become a poet, or a musician, or a painter, unless Nature has by suitable variation given him a condition of brain favourable to the exercise of the particular talent. Therefore every man must find out the directions in which his brain capabilities lie, so that his mental efforts may not be misdirected and of little avail. One of the most remarkable facts in life is the inability of many men to perceive the direction and the extent of their mental powers.

The degree of stability in the molecular constitution of the brain tissue is an all-important factor in the process of education. There is scarcely a subject more interesting than that of *Tissue Stability*. If the molecular stability of a tissue is normal, the tissue lasts its due time, and discharges its function normally. Every tissue may show signs of molecular instability. It is seen in the teeth when they undergo disintegration. In certain diseased states, dental instability becomes very marked, and creates much distress and inconvenience. Instability of epidermic tissue leads to a brittleness of the nails and hair, and atrophy of the hair bulbs. It is seen in muscle when it undergoes fatty degeneration, and in the bones when they tend to become soft. But no organ is so liable as the *brain* to variation in molecular stability. The brain, indeed, gives indications regarding stability more delicate than the most sensitive thermometer gives indications of temperature. When the molecular constitution of the brain tissue has a normal degree of stability, the impressions produced on it by sights, or sounds, or thoughts, are firmly retained. But if from natural or artificial causes the brain cells become unstable, memory impressions soon fade, become confused, or disappear. Therefore the weak unstable brain is

continually forgetting its impressions ; it is continually losing what it learned, and like Sisyphus, has to roll the stone up the hill again and again. This instability of brain tissue leads to great loss of time by rendering frequent repetition necessary. It leads to poverty of attainment, because the impressions are evanescent, and it leads to inaccuracy because the impressions become indefinite and therefore confused and unreliable. The most sensitive photographic film is not more sensitive than the brain plasm ; but owing to its nature it is far more stable. In protoplasm there is always a tendency to instability, because the living molecules must of necessity undergo continual change. Gentlemen, you may depend upon it that in study no factor will affect your progress so much as the *stability of brain tissue*. If it is stable, you will without serious difficulty produce the results you desire ; without it, your efforts will be vain ; the sufficient retention of knowledge will be impossible, the physiological ideal will never be attained. It is before all things necessary that the conditions of life which tend to produce stability of nerve tissue be rigidly attended to. The man who fails, or refuses to attend to them, finds in the future nothing but cause for bitter regret. The student who desires to do himself full justice in the

development of his brain power must rigidly conserve his energy. He must resolve in his student days to live an ascetic life, exercising his muscles duly but not too much, and devoting the whole remainder of his force to mental effort. That is the only method by which the student need hope to attain the complete success he desires.

Gentlemen, you will find that in striving to work out your own highest evolution, and in striving to gain sufficient knowledge, continued effort is needed. If you would climb the steep path that leads to a knowledge of many sciences, you must have endurance, and you must be determined to overcome the obstacles that impede the ascent. Most of you have the advantage of youth—an inestimable advantage when new facts are being acquired. The growing condition of brain cells renders them specially receptive of impressions, so that the acquisition of new facts is far easier than in after-life. Therefore in youth one should, if possible, lay a broad foundation of all the various kinds of knowledge required in later life. How gladly would some of us turn back the wheel of time and recover the advantage of youth. The young brain tends to glow with enthusiasm, and with a vivid imagination. All things seem possible,

the horizon is far distant and reaches the infinite. It has the warm ruddy tint of morning, unlike the leaden grey of later years. The young mind is hopeful, and readily forms mental ideals that sustain it in effort, and help it on to its highest attainment.

But while our chief aim is to enable every student to evolve his highest brain power and to accumulate accurate knowledge, it is very necessary to remember that the physiological ideal may not be attained if brain effort be too intense and too incessant. In these days of rapidly advancing science, we are all apt to overdo it. Brain work always involves the expenditure of energy; the deeper and more complicated the thought, the greater the amount of energy expended. It requires no little energy even to read and assimilate; it requires far more to produce new ideas and new combinations. In anxiety to acquire knowledge and to discharge our duties, we may be carried beyond the physiological limit. Undue fatigue sets in; thought becomes dull and depressed; the tendency to involution appears, and deterioration may be the consequence. In such case the only resource is to lighten the brain efforts, and to rest, so that the brain plasm may recover stability and its normal action. There is always an element of danger

in severe mental work, especially if it is continued into hours necessary for rest. The brain may become somewhat anæmic, and its control over thought diminished. In such condition, "variation" has passed to the disadvantageous side, that leads to involution.

But the mind that has an honest desire to work out its highest evolution is not permanently overcome by the difficulties thus apt to arise; it returns again to the task, and strives anew to reach the ideal by honest effort.

Gentlemen, I beg you all to be diligent in the studies on which we are entering. Be regular in attendance on all your classes and practical work. Don't offend the brain and do yourselves injustice by trying to study in spurts, and to rapidly cram up knowledge, for that is not the way in which permanent impressions are gained. Be accurate; people soon lose confidence in an inaccurate man, and he eventually loses confidence in himself. If you get a false idea, it is an impression that has to be effaced. Unfortunately the false impression is often provokingly persistent, and may long be the first to present itself to the memory, and so hamper the judgment. Therefore, above all things, strive to be accurate.

Physiology is a difficult science. It could not

be otherwise with an organism so complicated as ours. There is much that is definitely ascertained, but much more that is still matter of speculation. Therefore judgment is needed to discriminate between the known, the doubtful, and the unknown.

Although I begin to-day my twenty-seventh session as a teacher of medical science, I find the feeling of responsibility increasing rather than diminishing. The position of the teacher is ever exacting, and if he strives to give instruction and illustration in an elaborate science like Physiology he has no light task. But the labours of the teacher are always lightened when he finds that his pupils give a ready response by earnest and well-sustained effort in study. We give you our best effort, and we ask the same from you.
