The American Therapist.

A MONTHLY RECORD OF MODERN THERAPEUTICS,

WITH PRACTICAL SUGGESTIONS RELATING TO THE CLINICAL APPLICATIONS OF DRUGS.

VOL. IV. NEW YORK, OCTOBER 15th, 1895. No. 4.

THE AMERICAN THERAPIST.

A Monthly Record of Modern Therapeutics,

WITH PRACTICAL SUGGESTIONS RELATING TO THE CLINICAL APPLICATIONS OF DRUGS.

JOHN AULDE, M. D., - - - - EDITOR.
1338 WALNUT ST., PHILADELPHIA, PA.

CONTRIBUTIONS are solicited from all parts of the world. Translations will be made without expense to the author, and when necessary to elucidate the text, appropriate illustrations supplied free of charge. Articles contributed exclusively to this Journal will be liberally paid for, or reprints furnished, provided a request for the same accompanies the manuscript.

Subscription Price, - - $1.00 per annum.

PUBLICATION OFFICE, 25 BEEKMAN STREET, NEW YORK.

Address all communications to
THE AMERICAN THERAPIST,
P. O. Box 1170. New York City.

Vol. IV. OCTOBER 15th, 1895. No. 4.

CELL METABOLISM AND BRAIN BUILDING.

By PROF. ELMER GATES,

of the School and Laboratory of Psychology and Mind-Art, of the Pennsylvania Museum.

Automatic metabolism is known to exist only in connection with feeling, that is, with the power to respond to certain (not all) external stimuli. It is probable that automatic metabolism in its *simplest* form reacts to but one stimulus, *viz.*, the chemical or electro-chemical. But in this simplest form it responds to food-stimuli—it feels. There are many things it does not feel, and it does not respond to them, but to the appropriate stimulus it responds by internally initiated movement, and this differs in *degree*, not in *kind*, from the highest orders of intellection. A non-living organic compound does not respond to a stimulus by an internally initiated *adaptive* movement—it does not crawl away from a hot needle, etc. I do not, of course, attempt to say that even "matter" may not be alive—the gradation of life and not life may have no abrupt line of demarkation, but you will allow me to class bodies into animate and inanimate by the test that the inanimate do not *adaptively* respond by means of energy stored up by metabolism. Mental functioning is but adaptive responses to stimuli by means of the stored energy of metabolism.

Hence, I call mind, or preferably, mentation, the distinguishing feature of animal bodies. A cell of lowest form *feels* stimuli and responds—feeling is a mental characteristic. Self-initiated locomotion is mental characteristic. Death of feeling with the cessation of automatic metabolism is a mental characteristic; hence, I make mentation co-extensive with vitality. I have given no reasons for so doing; I simply state my conclusion. "Physical" labor, so-called, is mental labor; it is the *mind* that gets *tired;* it is *feeling* that is *tired;* if it were not for the feeling, there would be no fatigue. It is not the "body," but the *mind* which throws the shovel of dirt just so far and no farther; it is the *mind* that balances the rope-walker; and this mind of ours is made up of mentations, not merely of the cerebral cortex and subcortical ganglia, but of the mentations of the cells of the whole body. The muscle-cell feels its stimuli and responds adaptively; so does the liver-cell, etc. These cells *feel* stimuli, and feeling, however simple, is *mental*, not physical.

As a matter of fact, muscular movement is known to be directly connected with cortical memory enregistrations. Every muscular feeling of pressure or movement enregisters its "memory-structure" in that part of the cortex near the fissure of Rolando. True, such muscle-memories soon become sub-conscious and automatic and even reflex, but that does not remove the phenomenon of muscular movement from the category of mentation—it changes it from conscious to sub-conscious mentation. Sub-conscious mentations are generally too *quick* to enter consciousness.

Now, the lowest order of cortical enregistrations are those made by the simplest sense-impressions that are capable of producing a consciousness, *i. e.*, a sensation. If the impression does not produce a sensation, no enregistration takes place; but if the stimulus is *felt*, then the feeling is *remembered*, and that memory is located in some part of the cortex. If it be a touch-memory, it has its location; if a taste-memory, a different location; if a sight-memory, still another location, and so on. Memories of muscular movements consist of touch-memories, pressure-memories, memories of the energy of muscular movement, "joint-feeling," sight-memories, etc.

When the cosmic stimulus (of pressure, light, heat, etc.), affects the same organs (mind-organs), energy is transformed (and released), in that sense-organ, and a motion travels along the centripetal nerve, passing often one or more ganglia where other transformations may occur, and impinges through the white brain-fibres upon the terminal process or ending of such a fibre in the cortex, *i. e.*, upon a brain-cell. If this transmitted motion is too short in *duration* and too weak in *energy*, there will be but a slight effect upon the cell or cells acted upon. But if of sufficient strength and duration, then the form of motion received from the sense-organ produces *feeling* in that brain cell—the natural cell-consciousness of that little organism aroused by its appropriate stimulus. I don't mean that *I* feel that cell-feeling in one of my own brain-cells, but the cell *feels* it. I do not become conscious of its consciousness, so to speak; but when the cell *feels* its appropriate stimulus (which, for a sound memory cell is not a sound wave, but that form of energy which reaches the cell through the white brain-fibre, an energy totally unlike sound), how does it feel? It feels by the *modus operandi* of metabolism; it mentates; it responds to this feeling and acts. The result of that act produces what we call our own consciousness of that sensation—in my own nomenclature, we *perceive* the *sensation* and the result is a percept memory. If we did not perceive it, it would not have been a sensation. Hence, the first step in brain-building is the enregistration of percept-memories of the simplest sensation of the senses, of *all* of the senses and of all of the possible typical sensations of each sense.

Our educational systems leave out many senses and a majority of the possible classes of sensations of each sense; hence, many cortical areas are *fallow* of first-grade brain-tissues. Our educational systems do not register these percept-memories taxically, or in naturally related groups, but chaotically in the extreme. In the same hour, sight-percepts of various grades and all other kinds of percepts are promiscuously jumbled together, and they are not systematically reiterated the next day and the next until a finished and associatively integrated structure results.

But this is a *long* subject; this conception of and the data on which it is based ought to reorganize kindergarten instruction.

The brain-cell feels the stimuli transmitted to it from the sense-organ, and the cell responds and we perceive a sensation. The action of this transmitted energy upon the cell is multiform. I will mention only that of the *metabolism*, which is the necessary concomitant to cell-feeling. This transmitted energy produces a *chemical change* in the brain-cell, and deposition of matter takes place and the cell *grows*. It has, by that chemical change, acquired an additional supply of substance and new molecular compounds and arrangements. These new compounds place new structure in that cell, new mind organs with which to function. Repetition of that *feeling*, of that *same* sensation, by that same cell, simply augments the quantity of that *kind* of deposition of new substance in the cell—if reiterated from day to day for several days a perfect percept memory will have been created. Now, we can put much or little matter in that cell for that percept-memory; we can build as much of that kind of a memory as we desire. We do much besides, but I will not now describe the other phenomena?

If I vary the intensity of the stimulus, I will vary the rate of deposition or growth—the rate of the nutritive metabolism of that cell—the rate of the blood supply to the cell, etc., all of which I have proven experimentally.

Now, if I change the stimulus in quality, but not enough, to bring a new brain-cell into activity, then the cell will feel that stimulus differently and will produce a different response. A different part of the cell will grow and another *new structure* will be acquired by that cell, it will acquire more mind. The discrimination of different qualities in such a sensation will produce differentiations in that newly acquired cell-growth. As the cell, by repetition of its functions, acquires growth, its nutritive processes will increase in number and size. Now, so far as morphology is concerned, muscle-memory cells differ but slightly from sound-memory cells, or sight-memory cells, and so on; but chemically, there are also slight differences—they stain differently with the *same* reagents. Other differences I will now point out.

When all the percept-memories have been enregistered and developed, as you will observe, there is no distinction in *kind* between *muscular* effort and *mental* effort; muscular effort *is* mental effort. But there is a distinction between muscle-memory cells and sound-memory cells and taste-memory cells, and so on—a morphological distinction, a chemical distinction and a topographical distinction. The internal anatomy of these cells differ also, as I have fully convinced myself, but I cannot without careful repetition of my new and better apparatus give an intelligent description of what I mean.

As a cell grows by repetition of function, the pigment of the cytoplasm increases in quantity and alters in quality. The plumose panicles (dendrons), increase, *not with age*, but with the functioningp erformed by these cells. They do not increase in number and size if that functioning is prevented, as my experiments prove.

I have not time to consider second stage brain-building now. I have explained how the cells grow by percept enregistration.

Just as a percept consists of an integration of two or more sense-impressions, so an integration of two or more percept-memories constitutes an integrant of the second order—let us call it (provisionally) coquition. A coquition, let us say, for want of a better term, consists of an integration of two or more percepts. And let us call an integrative association of two or more coquitions, an image, and so on, to higher stages.

I have never taught that a conscious mental effort creates a new brain-cell. I have taught what my experiments clearly prove, that each kind of a mental activity produces definite *structural changes* in certain brain-cells, increasing their size, the number of dendrons and the complexity of the cell's internal structure, both morphologically and anatomically, and also chemically. Cells in the sight-areas of a dog killed at birth compared with the same kind of cells in a dog killed nine months after birth, show a certain natural growth in the number of cells capable of being seen by the microscope, but the advent of the new cells may be simply the development of incipient cells into a sufficient growth capable of being stained —the cells may have been there from birth, though I doubt it. Such a dog deprived of light for a month after birth does *not* exhibit so many cells; and such a dog specially trained by brain-builing methods exhibits a *far greater* number of cells than one not so trained. The conclusion is in favor of the theory that new cells are formed. My next experiments, I think, will *settle* this question. It forms no part of my system of teaching and is not essential to any of the conclusions I have announced in my article in the July *Monist*, or elsewhere, or to my theories of the science of mind and the art of mentation. Can I build more tissue in the brain? Yes. I can put more structures *on* and *in* every cell. I can put a greater number of functioning cells in every area of the brain. If they are not actually new cells, the practical result is the same, for if not thus builded and developed these cells, if they exist, were useless. These immature, dormant germs or beginnings of cells do not produce or aid in producing thought. Millions of them might remain in a square inch of one cortical cell-layer without having one single memory enregistered in one or all of them. If, in that area, I put well-developed, structurally-complex, normally functioning cells, then I build brains and give that person more mind. It matters not practically, whether I put a *new* cell in that area, or develop neuroblasts that would have otherwise have remained dormant, and atrophied, into actively mentating cells.

If I put in the brain areas numbers of such functioning cells that would not have been placed there by the usual education and experience, then I can say that I can give pupils more mind with which to get an education—and this is jnst what I can do.

But I think it can be proven that simple neuroblastic cells—the common type out of which all kinds of nerve-cells have evolved—can be developed into a grey-matter cell, and finally a brain-cell with neuron and dendron, etc. In the neuroblastic stage, and as the terminal of a white fibre, the cell has not acquired any of the morphological or chemical characters of a memory-cell. It can be developed by repetition of its appropriate stimulus into a brain-cell of *great complexity*, and this complexity will be different according as that stimulus has been applied in quantity and quality, etc. We can *neglect* to develop them in certain brain areas, can over-develop in others, can give prominence to what areas we please, and thus *put in* or *omit* active, full grown cells just as we elect. This is brain-building in one of its aspects. There is ample and conclusive evidence that *new* structures can be put in a cell, and that any person can be given a greater number of brain-cells (not neuroblasts) than he would otherwise have procured by usual modes of life and education.

A neuroblast is not a brain-cell any more than a a sperm-cell is a man—not so much so—because the neuroblast can be developed into widely different memory structures of the same class, *e. g.*, the different staining of the same cells by the same reagent, when the rabbits were in one case compelled to live in red light only, and in another case, in green light only. These different rays produced different depositions in the same class of cells. The nervous system is quite plastic—like the salamander renewing its leg —the grey cells can renew their processes.

To the question, "Can effort create new fibres?" it can be said without doubt that it will increase the number of active fibres in a cerebral connective tract. But for practical purposes, it is not necessary to determine whether this is true or not. An undeveloped and non-transmitting fibre is useless. If these fibres are brought into use, that is what we want. I am sure that in the auro-optic tract of rabbits, special training has enabled me to increase the number of fibres that can be counted with a microscope as much as one hundred times. Whether there were undeveloped, already-formed invisible fibres there, I cannot say, but I *do not believe there were.* It may be that parallel to these fibres there were rows of cells, or primordial tracts incapable of being studied, because too much undeveloped. But practically, I can take a young dog and make a map of his brain-fibre tracts, and by brain-building I can develop any *one* of these tracts, or any combination of several of them, so that when the dog is killed and examined these tracts will be an hundred fold richer in the number of fibres than any dog not thus trained. It is the result I am after. If I can put one thousand active connective fibres in a tract where otherwise, there would only have been one hundred—and I can !—then I am satisfied. But I think I can prove the formation of new fibres, and I think I know *how* they are formed.

Nerve-fibre ceases to be formed, or to

grow, when it ceases to functionate. It is not connected with age. In old age many cells no longer functionate and they atrophy. As long as functioning takes place through a fibre, it *grows*. I think that very few fibres in the human fibre-tracts are formed after the sixth to the tenth year.

There is a normal periodicity in every human life when each class of enregistrations should be made; failing to be made then, they can never again be properly made.

418 S. Broad street, Philadelphia.

Commentary by John Aulde, M.D., Editor, The American Therapist

CELL METABOLISM.

Cell metabolism gives promise of becoming a most fascinating study. Special attention has been given to the study of cells from different points of view, namely, anatomically, physiologically, morphological and chemical, and more recently Prof. GATES has investigated the cell from the psychological standpoint. In order to grasp the vastness of this subject we must learn some of the first principles bearing upon cell metabolism. For ex-

ample, we know, or think we know that certain gastric cells perform certain peculiar and necessary functions, else digestion would prove defective. The same is true also of certain intestinal cells; it has been shown that they will take up and dispose of certain pabulum and refuse other products, facts going to show, as pointed out by EWALD, that these cells perform their own proper functions of their own volition. He teaches that they do this independent of the nervous system, although it is not beyond the range of possibilities that certain phases of cell function and cell metabolism may depend upon an undiscovered internal nerve-supply. Indeed, this supposition is not at all improbable, as the following illustration will show. Suppose a person to be in perfect health, contented and happy. Prof. GATES says the condensations of the nasal exhalations will respond in a special manner to certain reagents. Let the same person experience pain, sorrow or anger and new elements are introduced, the condensations showing abnormal conditions as determined by various reagents. And what will appear more peculiar still—indeed, almost incredible—is the fact that the different conditions, pain, sorrow and anger, are indicated by different reagents. It will be evident, therefore, that cell metabolism is a matter of the utmost significance, since such marked physical changes could not take place without corresponding, important physiological metabolism.

Prof. GATES has spent many years in studying the various stages of cell metabolism; his experiments upon dogs, rabbits and guinea-pigs run up into the thousands, and the results of his investigations, from present indications, bid fair to open a new era of scientific medicine.

It can be said of scientific medicine of to-day that it has been halted at diagnosis. For many years our German confreres have been accused of practising "Diagnosis" instead of "Medicine." It has even been intimated that an autopsy to

establish the diagnosis was often looked forward to with a livelier interest than the recovery of the patient. In addition, however, to diagnosis we do know something definite about the immediate effect of drugs. What are the remote effects of many drugs given in medicinal doses, we know absolutely nothing. And even in cases where we know the remote effects to be harmful, as in the case of potassium clorate, how many physicians consider it worth while to caution their patients against their use?

To most practitioners cell metabolism will have but a passing interest, unless we can impress upon them the great importance of this study in determining the remote as well as the immediate effect of drugs.

We cannot close these remarks without a word of comment upon the apparently normal results of cell melabolism in health, the function of cells singly and in groups as a resisting force against the invasion of disease, because these thoughts so forcibly impress upon the mind the serious import of any derangement of cell metabolism from the injudicious or reckless use of remedies, the remote effects of which are unknown.