■ This is a very informative and important article about the human body as a machine and also as a chemical apparatus.

NEW IDEAS ABOUT THE HUMAN BODY

Over the centuries, man, when contemplating his own body, has alternately gained and lost conceit. Once he was inclined to think of himself as one of the lords of creation, ranking just a little lower than a god. When he began to compare himself carefully with other living creatures, he reluctantly came to the conclusion that he was a close relative of the ape.

Gradually, in the light of modern science, man has come to look upon his body variously as an energy-and-heat producing engine, as a chemical plant and as an electronic apparatus.

Let us examine the validity of these conceptions. Obviously, there are many resemblances between the human body and an engine. What is food but fuel, and what is the intestinal tract but the furnace of a living boiler? To be sure, man has no visible cylinders and no pumping pistons, but the experimental evidence indicates that food is converted into energy just as coal or wood is. The heat value of food is even measurable in calories, like the heat value of any other fuel.

An ounce of sugar "burned" in the body yields just as much heat (or energy) as it does when buried in a suitably constructed oven. A steam-power plant has its fuel storage bins; so has the body — it stores sugar and other fuel in the muscles and the liver.

The machine-like nature of man is especially striking when an analogy is made with the internal combustion engine. In the body, food is turned into sugar and the sugar into alcohol, whereupon the alcohol is exploded in the muscle cells.

There are millions upon millions of cells, and the charge of alcohol received by each of them is infini-

tesimal — so we do not hear the explosions. But the human engine is chugging just the same, and at almost the same rate of efficiency as the non-human. In fact, one scientist has found that a good Yale crew and a good internal combustion engine both have an efficiency rating of about 23 percent.

Engineers can push the machine analogy even further. They see ball-and-socket joints where the arms meet the shoulder and where the thighbones meet the pelvis; they see powerful crunching levers in the jaws, a fairly good pivot where the skull sits atop the spine, muscles ingeniously contrived so that they can both push and pull. There is no question that the lungs are bellows, though they oxygenate the blood and blow on fire. And there is no question that the heart beats 2,500 million times without failure or repair.

And what can be more mechanized than artificial organs doing outside the body what the lungs, kidneys and heart do inside? One scientist cultivates human marrow outside the body by means of an apparatus which serves as a lung, a kidney and a circulating system.

Artificial kidneys have been devised to cleanse the blood of wastes which diseased kidneys cannot remove. Weary human hearts have been rested while external mechanical hearts circulated the body's blood (sometimes with the aid of artificial lungs).

Even the laws of hydraulics are applicable to the body — up to a point. The 10 pints of blood that the heart keeps in circulation (additional blood is held in reserve in the liver, the spleen and other organs) is a stream which, like other liquids in motion, obeys rigid physical principles. This stream is a river of life, in the sense that, if we drain it off, we die; it is also a sewer, in the sense that it carries poisonous wastes to the kidneys to be disposed of.

But this is one of the points at which the comparison between the human body and a machine begins to exhibit its limitations. Let us assume that into the hydraulic contrivance which is

the blood stream we inject a foreign substance — a serum, or a vaccine. What happens? No laws of mechanics provide an answer; we must go to chemistry.

What happens is that, with amazing swiftness, antibodies are marshaled to destroy the invaders. A battle is waged. The weapons are chemical weapons. Thus, one kind of antibody, called *opsonin*, makes invading bacteria taste good, whereupon the transformed bacteria are devoured by elements of the blood called *phagocytes*. Another chemical, *agglutinin*, causes the bacteria to clump so that they can be devoured in wholesale lots.

As a hydraulic machine, the blood stream will stand much tampering, but there are definite physical and chemical limits beyond which this tampering cannot go. Overheat the blood and you rave; chill it and you become blissfully indifferent even to death. Take away its oxygen, and the mind loses its reasoning power. Decrease its calcium by half, and convulsions result — followed by coma and death. Double the calcium, and the blood thickens so that it can hardly flow.

But if we compare the human body to a furnace, we find that the laws of thermodynamics are not fully applicable. Heat is like water in that, when a hot mass cools, it falls from a high to a low place — *i.e.*, the temperature level changes. In a machine, the bigger the drop in heat or water level, the more energy released and work done.

But the healthy body works in another way. Its temperature always remains at around 98.6° F., no matter how much beefsteak or how many potatoes we put away. We expend more calories to fell a tree than to perform ordinary office work, yet our temperature is kept constant by the well regulated evaporation of water from the skin.

A major flaw in the concept of man as a machine began to be apparent with the discovery of vitamins and their functions. When it was found that a table might groan with food while the men who ate it could nonetheless be starving to death — that is, succumbing

to such deficiency diseases as pellagra and scurvy — it was clear enough that the human organism was something more than an energy-producing engine. It was also a chemical system in extremely delicate balance — a balance that could be upset by the daily lack of no more than enough vital substance to cover a pinhead.

Now this chemical-balance concept is being strongly fortified and extended by discoveries about hormones and the functioning of the glands which produce them.

Some of the most important work in this field as been done by Dr. Hans Selye of the University of Montreal. Convinced that all disease is the result of something that impinges on the body from outside and thus upsets the internal balance, Dr. Selye has subjected thousands of rats to the kinds of assault that human beings must endure — worry, fright, overwork, poisoning, chilling to the freezing point. Autopsies on the rats have always revealed damage to the adrenal glands.

The adrenals bear the brunt of any assault from the outside because they are chiefly responsible for maintaining the body's chemical balance. They keep sugar and salt at the proper level. Their cortex, or "bark," secretes some 20 chemicals which are the body's principal defenders. One is cortisone.

Thus it is easy to see why doctors have been able to achieve such startling results when they administer cortisone to sufferers from various degenerative diseases. When the body's adrenal glands have stopped providing adequate supplies of cortisone, but it is supplied from outside, the delicate balance of body chemistry is restored.

With ACTH it is the same. ACTH is obtained from the pituitary, which lies in the middle of the head and controls all the other glands. The adrenals, which lie over the kidneys, obey the commands of the anterior lobe of the pituitary — the same lobe which supplies ACTH. When the pituitary is removed or disabled, the adrenals shrivel. Transplant a new pituitary — or admi-

nister ACTH — and the adrenals come to life again.

Taking the hormone functions into account, we must modify our conception of man as a machine even more. The body is a chemical whole of incredibly fine balance; moreover, it possesses the amazing ability to repair itself, which is more than can be said of any machine. When the body ceases to be able to repair itself, it must get help from outside. But whether the job is done from outside or inside, it is largely done with chemicals, of which the most potent are minerals, vitamins and hormones.

Those who are engine-minded and hate to give up the machine analogy may cogently argue that these chemicals do no more than those which are added to gasoline to prevent automobile engines from "knocking." After all, what are the symptoms of disease but palpable knockings? They may also point to the recent development of electronic computers — contrivances which, employing as many as 2,000 vacuum tubes (just like those in radio sets), can solve in a few minutes problems which would keep a mathematician busy for months. All in all, these machines behave in a very common way; they not only do something which closely corresponds to "thinking," but they have memories and they throw tantrums.

Manifestly, the conception of man as a machine will never die completely. Nor, for that matter, should it, for it is a most convenient way of explaining what happens when, for example, we drive a nail or write a letter.

Physical anthropologists, anatomists and most evolutionists are now aware of the obvious *deficiencies of the machine theory* but, for the sake of convenience, they are likely to keep on thinking of the human body in machine terms.

A curious thing is that, when they do think in these terms, they are inclined to hold the body up to scorn. They say it is badly designed to perform some of its most important functions. In an evolutionary sense, it is built of second-hand parts,

parts which should have been junked long ago.

The trouble began, it seems, when man, in the course of evolution, first stood on his hind legs. As a result of standing, his intestines have sagged, which accounts for the commonness of *hernias*. An engineer certainly would not have put the whole weight of the body on the curved back and on two inadequate feet, nor would he have made the heart strain itself by pumping blood vertically against gravity.

It must be admitted that the engineering of man is not all that it might be, and that the human body contains many obsolete devices. The reason is that when a living organism starts evolving, old parts may degenerate, but they are not entirely discarded. New ones are added to the old, or superimposed. In the corners of our eyes, for instance, we have the remnant of an extra eyelid. In the top of the head is buried the pineal gland — a rudimentary third eye. And then there is the famous *vermiform appendix*, an entirely useless part which should have been scrapped long ago.

The brain is a good example of the way nature piles up second-hand parts and superimposes new ones. Actually, we have a *dozen brains*, bequests of our remote ancestors.

Only the great *forebrain* with which we do our thinking and the highly convoluted cortex of the cerebrum are relatively new. And nobody has yet found out exactly how all this rather unsightly mass of gray matter works. This much is certain: The brain is an electro-chemical contrivance and neither an engine nor an entirely automatic computer. *No combination of mechanical parts and electronic tubes will ever duplicate its acts of creation.*

But isn't it probable that the brain will develop still further and that man's mental powers will improve? No species of animal is so unstable as man; a score of different types of human beings have come and gone. There is no reason to suppose that we are the last word in machines or nicely balanced electro-chemical

systems. Probably we are only preliminary sketches, hints of something better to come.

If this is the case, it may take another 500,000 years to produce our superhuman successor. He will probably be free from our sinus troubles, our *appendicitis, our hernias, our weak backs, our fallen arches.* He conceivably could have a brain 25 percent larger than ours.

Sir Arthur Keith bids us look at present-day woman if we would have a preview of the new-model human being. "The smooth-browed condition is already achieved by the female of our species," he says. *"We poor males have lagged behind our wives."* Men still have the over-hanging brows of Peking Man, Rhodesian Man and Neanderthal Man, although by now it is greatly reduced. In this respect, Sir Arthur believes that *women are about half a million years ahead of men.*

The man of the future will probably have a small, receding face, because powerful jaws and powerful chewing muscles are no longer necessary. He will probably have one less lumbar vertebra than we have, so that his weight will be better distributed. No doubt there will be corresponding changes in the pelvis. Hands are likely to remain as they are, but our feet, with their arches that tend to fall and their almost useless little toes, are destined to be greatly improved. On the eventual appearance of such mechanical refinements, most physical anthropologists and evolutionists are agreed.

Here prediction must end, because man is more than a machine. What his electro-chemical future may be no one can even divine. *And his evolutionary future depends more on electro-chemistry than it does on mechanics.* Above all it depends on his hormones. If some of his 20-odd ductless glands mutate, there is no telling what may happen. A more active pituitary would make a giant of him, a more active thyroid would make him more energetic and restless, and more active adrenals would alter his emotional life.

It is evident that if we cannot make up our minds

about man — whether he is a machine or a piece of chemical apparatus — it is because scientists have not yet succeeded in telling us what life it. If we knew what life is we could tell better what kind of a contrivance man is. — *By Waldemar Kaempffert in N. Y. Times, Sept.* 10, 1950 *magazine (condensed).*

AN EXPLANATION

Do you ever try to give explanations? Do you ever *listen* to explanations? Some people are always trying to explain things — why they're late, why they forgot, why they failed, etc. Too much "explaining" is often an "alibi."

But many times, the explainers are just wasting their time and their breath. Why? There are other people who simply do not listen to explanations. When these "other people" are one's boss or best friend, or wife or husband or children, then you can really have a situation on your hands.

One of the biggest mistakes that we can make as human beings, I think, is to deliberately cut ourselves off from other human beings — by refusing to listen to the explanations of others.

How quickly, how easily, how definitely we just clamp our hands over our ears and shout: "No, I don't want to hear any explanations."

What a tragedy — this is how so many *former* good friends today find themselves *so lonely,* yes, even in the very midst of the so-called "population explosion" with its dire predictions for the future. — *by Paul Sheehan in Philippines Herald.*