Fig. 3.

It is of particular interest to note that this nuclear abnormality, induced by two similarly acting chemotherapeutic agents, resembles the projections of the nuclear envelope which were recently demonstrated to be a naturally occurring attribute of the Burkitt lymphoma cells⁴.

More detailed studies are at present under way in an attempt to elucidate the mode of formation of this phenomenon as well as its functional significance in the cell.

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PHYSIOLOGY

Predominantly Electrochemical Nature of Biological Power-producing Reactions

THE food taken in by a human being on a normal diet is equivalent, if all is converted to heat, to about 3×10^6 cal/24 h. If this energy was spent at a constant rate, with 100 per cent efficiency of conversion to mechanical work, the power provided would correspond to about 160 W.

For calculating the actual power available to the human organism there are, in principle, only two ways of converting the energy of chemical reactions to mechanical work. The first of these is that of the heat engine, and

the efficiency for this conversion is given by the well known Carnot cycle fraction

$$\frac{T_{\text{high}} - T_{\text{low}}}{T_{\text{high}}}$$

where the T s are, in °K, the high and low points of the temperature of the "working fluid". For a human organism at room temperature, this fraction has a value of about 1/60, so that if the principle of the heat engine is assumed in estimating the fraction of the energy conversion of the chemical reaction between food and oxygen to water and carbon dioxide available to power a human organism, the (average) power would correspond to $160 \times 1/60 \approx 2.5$ W.

This value is much less than that which the human organism is able to make available to itself, because the circulatory system alone operates under a roughly constant power of about 10 W.

It seems, therefore, that at least a substantial part of the energy conversion of the human organism must take place by the (less well known) principle of the electrochemical conversion of the energy of chemical reactions to work, in which the Carnot efficiency expression does not limit the degree of this conversion ("cold combustion").

This simply made conclusion seems to have a broad significance. Thus it has often been stated that electron transfer reactions play a part in certain biological processes. It has not yet been accepted that only the electrochemical path of conversion of the energy of chemical reactions to mechanical work is consistent with the observed efficiency in the use of chemical energy in the body. This is possibly because of the lack of availability in English of books on more recently discussed electrode-kinetic principles.

In the normal concept of the electrochemical engine, an electric motor receives energy after electrochemical interfacial reactions in a fuel cell have occurred, and is assumed to convert this to mechanical work at nearly 100 per cent efficiency. The existence of an analogue of this conversion of electric energy to mechanical power is indicated in the electrical activity of muscle function.

Thus the present work supports electrochemical reaction mechanisms as those by which biological cells feed on organic materials and oxygen. A model of biological cell action which is similar to that of an electrochemical fuel cell was formulated by Del Duca and Fuscoe¹.

It is noteworthy that if a biological organism converts the energy of the reaction between organic compounds and oxygen to available mechanical energy by an electrochemical mechanism, heat may be evolved or absorbed in the reaction. If the entropy of the overall reaction (ΔS) is sufficiently positive, a net cooling effect during production of energy by the organism could occur (and would so occur if the sum of the overpotentials associated with the hypothetical electrochemical processes of the biological cell were less than $T\Delta S$). An organism could conceivably then extract some electrical energy from the heat energy of its surroundings.

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