and
$$\left|\left(\frac{\partial w_{\mu\chi}}{\partial z_\omega}\right)_0\right| = \left(\frac{\partial \overline{w}_{\mu\chi}}{\partial z_\omega}\right)_0,$$
so that it follows from (23) that
$$\sum_\omega \left(\frac{\partial \overline{w}_{\mu\chi}}{\partial z_\omega}\right) \leqq \theta < \tfrac{1}{2}(1+\theta). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (27)$$

If the positive number Γ is small enough, $\overline{h}_\varrho(x_\tau, y_{\mu\nu})$ is analytical for $|x_\tau| \leqq \Gamma$, $|y_{\mu\nu}| \leqq \Gamma$. If the positive number $K \leqq \Gamma$ is small enough, then $\overline{q}_\varphi(z_\tau)$ and $\overline{w}_{\mu\chi}(z_\tau)$ are analytical for $|z_\tau| \leqq K$ and we have for $|z_\tau| \leqq K$
$$|\overline{q}_\varphi(z_\tau)| \leqq \Gamma \text{ and } |\overline{w}_{\mu\chi}(z_\tau)| < \tfrac{1}{2}(1+\theta)K \quad . \quad . \quad . \quad . \qquad (28)$$
by (27). Put
$$b_\nu(x_\chi) = A\left\{-1 + \prod_\chi \left(1 - \frac{2x_\chi}{(1+\theta)K}\right)^{-1}\right\}.$$

If $|z_\tau| \leqq K$, then (28) holds and $b_\nu(\overline{w}_{\mu\chi}(z_\tau))$ is therefore analytical. I choose the positive number A so small that
$$|b_\nu(\overline{w}_{\mu\chi})(z_t)| \leqq \Gamma \text{ for } |z_\tau| \leqq K.$$

Hence the function $\overline{h}_\varrho\{\overline{q}_\varphi(z_\tau), b_\nu(\overline{w}_{\mu\chi}(z_\tau))\}$ is analytical for $|z_\tau| \leqq K$ and therefore $\ll M \prod_\tau \left(1 - \frac{z_\tau}{K}\right)^{-1}$, if M is large enough. I choose the positive integer $N \geqq \Omega$ so large that
$$BM\left(\frac{1+\theta}{2}\right)^{N+1} < A \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (29)$$

and further $H \geqq \frac{2}{(1+\theta)K}$ so large that the inequalities
$$|F_\nu(\zeta_\varphi)| \leqq A\, H^{\zeta_1 + \ldots + \zeta_t} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (30)$$
hold for $\nu = 1, 2, \ldots, n$ and for any system $(\zeta_1, \ldots, \zeta_t)$ of positive degree $\leqq N$. It is sufficient to prove that the inequalities (30) hold for $\nu = 1, 2, \ldots, n$ and for any system $(\zeta_1, \ldots, \zeta_t)$ of positive degree. In fact, then the power series obtained for $f_\nu(x_\tau)$ converges for $|x_\tau| < \frac{1}{H}$.

I may assume that $(\zeta_1, \ldots, \zeta_t)$ has a degree $\alpha \geqq N+1$ and that (30) has already been proved, if $(\zeta_1, \ldots, \zeta_t)$ is replaced by a system of positive degree $< \alpha$. We find for the function $j_\nu(x_\tau)$ defined by (20)
$$j_\nu(x_\tau) \ll A\{-1 + \prod_\tau (1 - Hx_\tau)^{-1}\} = b_\nu\{\tfrac{1}{2}(1+\theta)KHx_\tau\}.$$

Hence it follows from $\frac{1}{2}(1+\theta)KH \geqq 1$ that
$$j_\nu(w_{\mu\chi}(z_\tau)) \ll b_\nu\{\tfrac{1}{2}(1+\theta)KH\overline{w}_{\mu\chi}(z_\tau)\} \ll b_\nu(\overline{w}_{\mu\chi}(v_\tau)),$$
where $v_\tau = \frac{1}{2}(1+\theta)KH\,z_\tau$, and that
$$\overline{q}_\varphi(z_\tau) \ll \overline{q}_\varphi(v_\tau).$$

In this manner we obtain
$$h_\varrho\{q_\varphi(z_\tau), j_\nu(w_{\mu\chi}(z_\tau))\} \ll \overline{h}_\varrho\{\overline{q}_\varphi(v_\tau), b_\nu(\overline{w}_{\mu\chi}(v_\tau))\} \ll M\prod_\tau\left(1 - \frac{v_\tau}{K}\right)^{-1} = M\prod_\tau\{1 - \tfrac{1}{2}(1+\theta)Hz_\tau\}^{-1}.$$

The coefficient of $z_1^{\zeta_1} \ldots z_t^{\zeta_t}$ in the expansion of the left-hand side is $u_\varrho(\zeta_\varphi)$, so that the absolute value of this number is
$$\leqq M(\tfrac{1}{2}(1+\theta)H)^\alpha < \frac{A}{B}H^\alpha$$
by (29) and $\alpha \geqq N+1$. Hence (30) follows from (26), which proves the theorem.

Physiology. — *Body temperature as a variable factor in the energy balance of the organism.* By G. VAN RIJNBERK.

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The significance of the glycogen in the liver, and of the subcutaneous fat, for the material, and energetic, balances of the organism is evident: both are to be considered as depots where material, and energetic, reserves are stored. When composing the balance sheet of the material ingesta and egesta it is necessary to consider the possibility of changes in body weight, an increase, or decrease, of which can explain apparent deviations from metabolic equilibrium. When balancing the energetic income against the output of energy, it is also necessary to take into account any changes in body weight which may have occurred in the course of the experiment. A shortage of energetic output may depend on the fact that part of the chemical energy obtained from the food has been retained within the body as storage material. Conversely, an apparent surplus of energetic egesta may be occasioned by the fact that this storage material has been called upon to furnish energy. This elementary fact is known to any investigator composing such balance sheets.

As far as I know, less attention seems to have been given to body temperature as a variable factor in the energy balance, despite the fact that an appreciable movement of heat is necessary for any change in body temperature.

Assuming the specific heat of the human body as a whole to equal 0.8, a change in body temperature of one degree Centigrade will, if the body weight be 70 kilograms, correspond to

$$1 \times 70 \times 0.8 \text{ Calories} = 56 \text{ Cal.}$$

In the following, the theoretical significance of this fact will be illustrated by means of a few examples.

1. Increase of body mass.

In the course of growth the body weight of an individual will increase from, say, 6 kilograms, when a young child, to 70 kilograms. If all the food taken was at room temperature (20 degrees Cent.), then the heat needed to bring the additional 64 kg to body temperature (37 degrees Cent.) will have been equal to

$$17 \times 64 \times 0.8 \text{ Cal.} = 870.4 \text{ Cal.}$$

2. Increase of body temperature through muscular activity.

The temperature of the body shows a more or less marked increase in all cases where mechanical work is performed. Let us take a simple case of the kind usually found in textbooks.

An amount of work equal to 222×10^3 kilogrammeters, performed in two hours, led to a rise of body temperature amounting to 0.72 degrees Cent. Assuming the body weight to have been 70 kg, this means that the heat produced by the muscular work has in part been used to increase the temperature of the body, the amount of heat in question being equal to

$$0.72 \times 70 \times 0.80 \text{ Cal.} = 40 \text{ Cal.}$$

Now 40 Calories are equivalent to 17080 kgm, or one thirteenth (8 per cent.) of the total work done. Of course, these 40 Cal. do not remain in the body, the rise in body temperature being transient. When investigating the heat output of a subject performing mechanical work by means of a calorimeter, these 40 calories will eventually be found back in the calorimeter, as soon as the body temperature has again fallen to its original level; consequently, they will, in time, appear among the egesta. If the duration of the experiment should be too short, however, the heat output would be less than the amount of heat really generated.

3. Rise of body temperature after heat puncture.

Assuming the average body temperature of the rabbit to be 39 degrees Cent., its body weight 3 kg, and the temperature attained in the experiment 42 degrees Cent., then the amount of heat which was needed to produce this rise in body temperature equals

$$3 \times 3 \times 0.8 \text{ Cal.} = 7.2 \text{ Cal.}$$

The quantity of heat used for this additional rise in body temperature is relitively very large, since it amounts to 2.4 Cal. per kg body weight, or hardly less than the normal total heat production of a rabbit, per hour and kg. In those cases where the temperature reaches its maximum in two hours, reckoned from the time at which it starts to rise, the heat used to increase the body temperature alone will necessitate an increase of the heat production of nearly 50 per cent. In those cases where the maximum temperature is reached in one hour, the normal heat production will have to be nearly doubled to account for the rise in temperature alone.

4. Daily fluctuations of body temperature.

In man, the daily variations of body temperature may attain an amplitude of about 1.2 degrees Cent., for an early-morning minimum of 36°3 and a maximum of 37°5 in the evening. For an individual weighing 70 kg the amount of heat involved in this is equal to

$$1.2 \times 70 \times 0.8 \text{ Cal.} = 67.2 \text{ Cal.}$$

It is a well-known fact that the intensity of metabolism, determined from the amount of carbon dioxide exhaled, runs parallel to the temperature of the body. But the output of heat, measured calorimetrically, does not keep pace with these. It seems reasonable to explain the difference between the amount of heat produced (as apparent from the production of carbon dioxide) and the amount discharged on the assumption that the difference is levelled out by the variations in body temperature.

The examples given may suffice. They show clearly that the amount of heat involved in changes of body temperature is relatively high. This heat may be considered as a kind of thermic storage material. The diagram given below may serve to make our meaning clear.

DIAGRAM.

Ingesta.	Metabolism.	Egesta.
1. material ingesta;	3. building up of living matter: anabolism; 4. breaking down of living matter: catabolism;	7. material egesta; 8. energetic egesta: a. contained in excreta;
2. energetic ingesta.	5. rise of energy level: ectropy; 6. fall of energy level: entropy.	b. heat (radiation, &c.); c. mechanical work.

Positive or negative storage:

(material)		(energetic)
9. increase } of body 10. decrease } weight	11. increase } of energy 12. decrease } store	a. bound chemical energy; b. caloric energy (body temperature).

Legenda.

1. material intake, considered from a strictly material point of view;
2. material intake, considered as a source of energy only;
3. increase of the amount of living matter through assimilation of food;
4. decrease of the amount of living matter through dissimilation;
5. increase of the energy level of the organism through storage of bound energy;
6. decrease of the energy level of the organism through liberation of hitherto bound energy. This may occur:
   a. through generation of heat, without motion or secretion (muscle tone, functional activity of central nervous system, &c.);
   b. through generation of heat, accompanied by motion or secretion;
7. material losses (excreta, carbon dioxide, water), considered from a strictly material point of view;
8. a. material losses, considering the small amount of bound energy they still possess;
   b. heat discharged (conduction, convection, evaporation);
   c. energy discharged as mechanical work;

9, 10. gain or loss of body weight;

11, 12. rise or fall of the energy level of the organism, viz.
   a. through modification of the amount of bound (chemical) energy, running parallel to 9. and 10.;
   b. through fluctuations of the body temperature, considered as a measure of the caloric stores of the organism.

Fall of body temperature means a lowering of the energy level of the body, considered as a thermo-energetic system; rise of body temperature means an increase of this level.

One restriction should be made. The retaining by the body of a given amount of heat, leading to a rise of body temperature, has in the foregoing been considered as a positive storage. The fact should be stressed, however, that, in the case considered under 11b this kind of storage is far less important for the economy of the body than the storage of chemically bound energy. Fat and glycogen are stable and lasting energy stores, which can be kept indefinitely, and which can be drawn upon at any time. The increase of the energy level expressing itself as a temporary rise in body temperature, on the other hand, is very unstable; the surplus heat tends to flow away, as it should, the body striving to regain the temperature level characteristic for the species in question.

The possibility remains, however, that the extra store of heat is not quite lost to the body, inasmuch as, during the flowing away of the surplus heat, the generation of heat can be lessened to some extent at least.