and Talbot and Murlin and Hoobler shows that the normal, recently-fed, sleeping infant produces about two and a half calories per kilogram and hour. With but two exceptions (out of 48) the underweight and atrophic infants produce more than this and the overweight infants produce less. It is suggested, therefore, that for practical purposes two and one half calories per kilogram and hour or sixty (in round numbers) calories per kilogram and twenty-four hours may be regarded as the average normal heat production of sleeping infants within this range.

10 (942)

The measurement of the surface area of adults.

By **DELAFIELD DU BOIS** (by invitation) and **EUGENE F. DU BOIS.**

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Meeh's[1] formula $K\ WT^{2/3}$ is accurate in principle only when applied to individuals of differing weights but of similar body form.

The surface area of five adults of widely different weights and forms was measured by the following method. The subject was dressed in a tight fitting suit of union underwear, the hands were covered with cotton gloves, the feet with socks and the head with a tight fitting bag of woven cotton material. The gloves were then covered with melted paraffin and over the rest of the surface strips of paper were pasted in such a manner that a stiff mould of the body was formed. This was then cut in small pieces which would lie flat. Patterns of these pieces were made by printing them on photographic paper of known area and weight. These patterns were then cut out and weighed and the surface areas of the various parts of body calculated.

Many linear measurements of the subject were taken and an effort made to find the length and average breadth of each part of the body. After numerous trials characteristic measurements of length and breadth were chosen. The products of the length and breadth when divided into the surface area as actually deter-

[1] Meeh, *Zeitschr. f. Biol.*, XV, 435.

mined, gave factors which varied but little in the five cases measured. The total surface area of the body can be estimated by multiplying the length, breadth and the proper constant for each part of the body and then adding the parts together. This new formula gave the following errors in the five cases measured: Small fat cretin +0.5 per cent.; short, stout man +1.3 per cent.; tall, thin man −3.8 per cent.; tall man of average build +0.9 per cent.; short, very fat woman +2.0 per cent.

Meeh's formula applied to these same individuals gave errors amounting to +21 per cent., +17 per cent., +7 per cent., +14 per cent. and +36 per cent. respectively. Bouchard[1] who measured a series of adults found the following errors in Meeh's formula: very thin woman −3 per cent., normal man +2 per cent., normal woman +14 per cent., large man +12 per cent., very fat man +33 per cent.

There seems to be a plus error in Meeh's formula which becomes very large in the case of fat individuals. Since Meeh's formula has been the standard for 35 years it is advisable for the present to retain it in the case of individuals who are thin or of approximately the normal build, since, in their case, the error is not great. In the case of fat people or those of unusual body shape it is preferable to make use of the proposed formula which is determined by linear measurement alone.

CONSTANTS AND MEASUREMENTS USED IN FORMULA.

Head, AB, 0.308.
A, around vertex and chin.
B, around occiput and forehead, just above eyebrows.
Arms, $F(G + H + I)$, 0.558.
F, outer end of clavicle to lower border of radius.
G, circumference of arm at level of upper border of axilla.
H, largest circumference of forearm.
I, smallest circumference of wrist.
Hands, JK, 2.22.
J, lower posterior border of radius to tip of second finger.
K, circumference of open hand at knuckles.
Trunk, $L(M + N)$, 0.703.

[1] Bouchard, "Traite de Pathologie generale," Paris, 1900, III, 200, 384.

L, suprasternal notch to upper border of pubes.
M, circumference of abdomen at level of umbilicus.
N, circumference of thorax at level of nipples in the male, and just above breasts in the female.
Thighs, $O(P + Q)$, 0.508.
O, superior border of the great trochanter to the lower border of the patella.
P, circumference of thigh just below the level of the perineum.
Q, circumference of hips and buttocks at level of trochanters.
Legs, RS, 1.40.
R, from sole of foot to lower border of patella.
S, circumference at level of lower border of patella.
Feet, $T(U + V)$, 1.04.
T, length of foot.
U, circumference of foot at base of little toe.
V, smallest circumference of ankle.

II (943)

On the law relating milk flow to age in dairy cattle.

By RAYMOND PEARL.

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Before the production records of different cows may be critically compared, as in the study of the inheritance of milk flow, for example, it is necessary to make proper corrections for the differing ages of the individuals compared. It has long been a matter of common knowledge that there is a change in amount of milk produced as a cow grows older. Before any proper corrections for this factor can be applied it is essential to determine with precision, and, so far as may be, generality, the quantitative law connecting these two characters milk flow and age. By the associations and individuals who have in charge the Advanced Registry records in all of the dairy breeds of cattle it is generally, and quite erroneously, assumed that the relation between these two variables is a strictly linear one.

[1] Paper No. 74.