the mean, as the red component of the double is the stronger of the two. In other words a nebular line of slightly greater wave-length than 4649.2A would meet the requirements. There is actually such a line at 4649.5A. Both this and the one at 4267A probably exist as bright bands in the spectra of the Wolf-Rayet stars.[4]

The following is a summary of the wave-length comparisons which have been made:

	Star.	
Nebula	*Nitrogen*	*Carbon*
4097.6	4097.5	
4267.28±		4267.30
4649.5		4649.2 +

In considering the significance of these comparisons it should be borne in mind that the observations of the nebulae were made with a single prism spectrograph and that the lines are faint and difficult to measure. I think, however, that the evidence renders probable the presence in the nebulae of carbon and nitrogen, and fortifies the assumption of a close relationship between the nebulae and the early type stars.

There are other possible points of correspondence between nebular and stellar spectra which will be referred to in a more complete presentation of the subject.

[1] *Pub. Ast. Obs. Univ. Mich.*, 1, 120 (1915).

[2] *London, Proc. R. Soc.*, A, 82, 534 (1909).

[3] *Ibid.*

[4] A paper is just at hand by Mr. T. R. Merton, entitled: On a spectrum associated with carbon, in relation to the Wolf-Rayet stars, *Lond., Proc. R. Soc.*, A, 91, 498 (1915). In this the author makes the suggestion that the two Wolf-Rayet bands in question, with others, are due to carbon.

ENERGY TRANSFORMATIONS DURING HORIZONTAL WALKING

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No form of muscular exercise enters so universally into the lives of all individuals as does horizontal walking, but most of the earlier researches on the energy transformations consider walking on a horizontal plane as incidental to or as a base-line for the work of ascent, particularly in connection with mountain climbing. From the fundamental contributions of Zuntz and Durig and their associates, it has been concluded that for an individual walking on a horizontal plane the energy required to move one kilogram, either of body-weight or of

superimposed load, one meter in a horizontal direction is equivalent to 0.55 gram-calorie. These workers likewise noted the distinct influence of increased velocity upon the energy requirement for the same amount of work.

Prior to a direct calorimetric study of the influence of walking in a horizontal direction, as well as the work of ascent and descent, the present study was made to elaborate the earlier researches on horizontal walking. A modified form of the universal respiration apparatus was employed and a specially designed treadmill. The factors measured were the oxygen consumption, the carbon-dioxide production, the respiration-rate, the distance walked, the number of steps taken by the subject, and the height to which the body of the subject was raised in the up and down motion of walking. The values for the resting metabo-

TABLE I

SUBJECT NO.	AGE	NUDE WEIGHT	HEIGHT	CARBON DIOXIDE PER MINUTE	OXYGEN PER MINUTE	HEAT-PRODUCTION PER MINUTE
	yrs.	*kilos.*	*cm.*	*cc.*	*cc.*	*cals.*
I.....	29	69.7	180	223	280	1.34
II.....	31	68.3	177	214	258	1.25

TABLE II

SUBJECT NO.	NO. OF PERIODS	WEIGHT WITH CLOTHING	AVERAGE RATE OF WALKING PER MINUTE	INCREASE IN HEAT OUTPUT OVER STANDING	HEAT OUTPUT PER HORIZONTAL KILOGRAMMETER
		kilos.	*meters*	*cals.*	*gm.-cals.*
I.....	53	73.10	75.9	2.81	0.507
II.....	57	71.45	71.5	2.52	0.493

lism as determined for both the lying and the standing relaxed positions were taken as base lines for comparison with the values obtained with the subject while walking. A few experiments were made when the subject was walking at a high rate of speed and likewise when running.

The preliminary observations were made on one subject by Dr. Carl Tigerstedt of Helsingfors during his short sojourn at the Nutrition Laboratory. A more extended investigation was carried out on a second subject with special emphasis upon change in velocity and the influence of food, including experiments with uncontrolled diet and diets containing a preponderance of protein, fat, or carbohydrate. A few experiments were prolonged for the purpose of studying the possible influence of fatigue.

The metabolism found for the standing relaxed position, with the subject in the post-absorptive condition, is given in table I, and for

walking at moderate speed, without food, in table II. It will be seen from the latter table that the average value found in 110 periods with these two subjects was, in round numbers, 0.5 gram-calorie.

The results obtained in experiments after a meal showed that the ingestion of food raised somewhat the resting metabolism but was without material effect upon the forward progression constant of 0.5 gram-calorie per horizontal kilogrammeter.

In the prolonged experiments without food, in one of which the subject walked 22 kilometers, successive periods showed very little, if any, change in the constant, thus suggesting the absence of a fatigue effect. Singularly enough the 22-kilometer experiment with food showed a distinctly lower constant than the comparable experiment without food on the preceding day.

TABLE III

METHOD OF PROGRESSION	NO. OF PERIODS	(a) AVERAGE DISTANCE PER MINUTE	(b) AVERAGE RAISING OF BODY PER MINUTE	(c) AVERAGE NUMBER OF STEPS PER MINUTE	(d) LENGTH OF STEP $\frac{100\ a}{c}$	(e) HEAT (COMPUTED) PER HORIZONTAL KILOGRAM-METER
Without food		*meters*	*meters*		*cms.*	*gm.-cals.*
Walking:						
Slow.....	57	71.5	2.94	111	64.4	0.493
Medium.....	6	106.3	5.87	131	81.1	0.585
Fast.....	7	144.1	7.75	152	94.8	0.932
Running.....	15	147.5	13.75	182	81.0	0.806

The influence on the constant of an increase in the rapidity of walking and particularly of the change in type of locomotion from walking to running is shown in table III. In calculating these values, the metabolism in the standing relaxed position was used for the basal metabolism. It will be seen that with increased velocity the height to which the body was raised, the number of steps, and the length of each step were all increased. The constant for the motion of forward progression was also increased in value, especially at the highest speed.

A more profound effect on all the factors of locomotion is noted when the change was made from walking to running. With essentially the same speed for each method of progression, the height to which the body was raised in running was nearly double that in walking; the number of steps was increased 20% but the length was correspondingly decreased. Of most significance is the decided fall of 15% in the value of the constant, i.e., from 0.932 gram-calorie for rapid walking to 0.806 gram-calorie for running. Since in running the body is lifted

much higher than in walking, this is surprising. On the other hand, in the walking experiments there was, as is customary with trained walkers, considerable arm motion which was absent in the running experiments. Basal experiments made while the subject was standing still but swinging the arms in essentially the same amplitude and rhythm as when walking showed a great increase in the resting metabolism. The use of this base line reduces the progression constant for walking to 0.780 gram-calorie with an average speed of 144 meters per minute. This debatable procedure seems to emphasize the fact that for the most economical transport of the body, with or without superimposed load, some type of gait which reduces to a minimum the elevation of the body and the extraneous arm motion is most desirable.

The details of this research are reported in Publication No. 231 of the Carnegie Institution of Washington.

THE PHYSIOLOGY OF THE NEW-BORN INFANT

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The physiology of the first week of life is of especial importance owing to the unique position of civilized woman who, alone of all mammals, is usually for several days so completely exhausted by labor as to make her existence and even that of her child absolutely dependent upon the ministrations of others. The insufficiency of the breast secretion, the loss in weight of the infant, which almost invariably occurs, and the too frequent but rarely needed complete substitution of bottle feeding for breast feeding make a study of the actual needs of the new-born infant of unusual interest.

In a research carried out by the Nutrition Laboratory, in which a respiration chamber was used, measurements were made of the carbon-dioxide output and the oxygen intake, and records were secured of the pulse-rate, respiration-rate, and body-temperature of 105 new-born infants. The observations often began before the infant was 1 hour old, the child being placed in the respiration chamber as soon as it had been bathed and dressed. The metabolism was then studied, frequently in 1-hour periods, for several consecutive hours. The primary object of the research was to determine the basal minimum metabolism of the infant with special reference to sex, weight, age, and length.

From the data obtained in these observations, the respiratory quotients were computed which indicated the nature of the principal sub-