The animals were killed by a blow on the head either immediately after the anesthesia or 2 to 4 hours later. The ascorbic acid content of the various tissues was determined by titration with 2,6 dichlorophenol indophenol according to the procedure outlined by Birch, Harris and Ray.[2]

Table I presents the results obtained. In the case of rats which were killed immediately following the anesthesia, the average ascorbic acid content of kidney and liver is definitely higher than that found in the controls. On the other hand, the average ascorbic acid content of the adrenals is reduced. When the rats were killed 4 hours following the anesthesia, the ascorbic acid content of kidneys and liver, though less than that observed in the animals killed immediately following the anesthesia, is still definitely above the control level. At the same time the ascorbic acid content of the adrenals shows a continued decrease. Somewhat different changes were observed in the case of guinea pigs. There appears in this case to be a definite tendency to a reduced ascorbic acid content of kidneys, liver, adrenal and spleen tissue. That is, the ascorbic acid content of these 4 tissues in animals killed 2 hours following ether anesthesia is definitely below the control level.

Experiments are being continued with the object of finding an explanation for these results.

9053

Relationship Between Brain Potentials and Some Other Physiological Variables.

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Most prominent in the records of the electrical activity from the brain in intact human subjects are large and fairly rhythmic oscillations of potential called alpha waves. In a recent study of brain potentials in children and adults by Lindsley[1] the average frequency of the alpha rhythm in 54 adults was found to be 10.4 per second with a range of variation from 8 to 12 per second. Under normal

2 Birch, T. W., Harris, L. J., and Ray, S. N., *Biochem. J.*, 1933, **27**, 590.

* General Education Board Fellow.

1 Lindsley, D. B., *Science*, 1936, **84**, 354.

conditions the frequency for any one individual was remarkably constant, often varying by less than 1 cycle per second over a period of months and only occasionally by as much as 2 cycles per second. In children the rhythmic alpha waves first appeared at about 3 months of age and at a frequency of 3 to 4 per second. The frequency increased with age until the adult average was reached at 8 to 10 years of age. A slight rise in frequency above the adult level occurred between 10 to 12 years of age.

The present study is concerned mainly with the frequency variations observed in adults, since the various processes of growth and development make difficult certain comparisons in children. An attempt has been made to determine the relationship between the frequency of the alpha waves and some other physiological variables such as metabolic rate, heart rate, blood pressure, rectal temperature and respiration.

Thirteen adults, 12 women and 1 man, were used as subjects. Of these, 4 women medical students ranging in age from 21 to 31 years were studied every morning for 32 or 34 consecutive days. All records were obtained early in the morning under basal conditions. Rectal temperatures were taken by the women on awakening and before getting out of bed. On arrival at the laboratory one-half hour rest was required before records were obtained.

Brain potentials were recorded from the surface of the scalp by means of electrodes attached just posterior to the parieto-occipital fossa, about 2 inches to the right of the mid-line. The records were obtained with the subject lying on a cot in a dark room. Appropriate amplifier-oscillograph systems were employed in the recording of the brain potentials and electro-cardiograms. Repeated readings of systolic and diastolic blood pressure were made by the auscultatory method. Two 8-minute records of basal metabolism (expressed in total calories per hour) were obtained with the Benedict-Roth apparatus.

Figure 1 shows typical records of brain potentials, heart rate (electrocardiogram Lead II) and respiration taken simultaneously. Such records were obtained from the 4 subjects during a control period prior to the first basal, just before the end of the first basal after breathing oxygen for 8 minutes, during a second control period following the second basal, and finally at the end of a period during which the oxygen in a mixture (90% nitrogen, 10% oxygen) was exhausted and a condition of anoxia approached. Records were taken only during a control period for 9 other subjects who were studied but once.

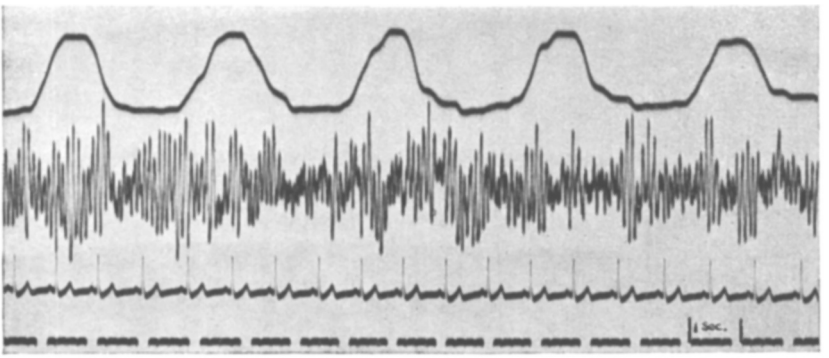

FIG. 1.

Typical record of respiration, brain potentials and heart rate (electrocardiogram Lead II).

Analysis of the records in terms of frequency and amplitude of the alpha waves revealed no significant differences between the first control period and the breathing of oxygen, nor between the second control period and the period of exhaustion of oxygen. Gibbs, Davis and Lennox[2] reported an increase in amplitude and a decrease in frequency of the waves on breathing pure nitrogen, and especially marked changes when a state of confusion or unconsciousness were produced. Our failure to obtain similar changes may have been due to the fact that the experiment was never continued beyond an initial state of discomfort so that a prolonged period of complete anoxia was probably never attained.

Using the data from the first control period correlation coefficients were obtained between the frequency of the alpha waves and each of the other daily measures of physiological activity. The correlation coefficients were inconsistent from subject to subject and in general were low and without prediction value. This may have been due to the fact that the range of variation of the frequency of the alpha waves for any one individual was small, and also that the variability of certain of the measures in these 4 subjects was high during a period of from 1 to 2 weeks near the middle of the menstrual cycle,[3] which may have tended to obscure relationships between measures for any one subject. In addition, correlation ratios showed some of the regressions to be non-linear, thus making the correlation coefficients in these particular cases invalid.

The variation in the frequency of the alpha waves from subject

[2] Gibbs, F. A., Davis, H., and Lennox, W. G., *Arch. Neurol. and Psychiat.*, 1935, **34**, 1133.

[3] Rubenstein, B. B., and Lindsley, D. B., Unpublished data.

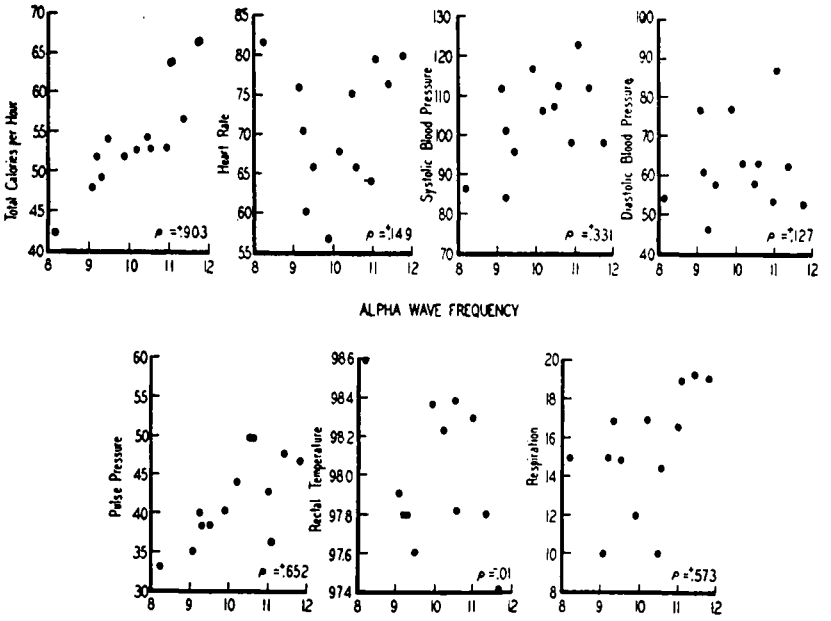

FIG. 2.
Graphical representation of data from Table I and the correlation coefficients between the frequency of alpha waves and the other physiological variables for 13 subjects.

to subject was much greater than that for any one individual and it is only when comparisons of the measures from one subject to another are made that significant relationships are observed. Table I shows the means and standard deviations of all the measures for the 4 subjects studied 32 or 34 days and also the daily values for each of the other 9 subjects. Figure 2 shows these data plotted against the frequency of the alpha waves for each of the 13 subjects. Rank difference correlation coefficients are also given. The relationship between the frequency of the alpha waves and metabolic rate (total calories per hour) is very significant. Pulse pressure and respiration show less significant relationships to the frequency of the alpha waves, but nevertheless values which approach significance. There was not a significant relationship between the frequency of alpha waves and the other measures (systolic and diastolic blood pressure, heart rate, and rectal temperature).

The correlation between alpha wave frequency and basal metabolic rate in *calories per square meter per hour* is of doubtful significance ($\rho = +.396$). The relationship between frequency and surface area or body size is significant ($\rho = +.715$); that between total calories per hour and surface area is $\rho = +.719$.

TABLE I.
Means and Standard Deviations of Measures for 4 Subjects Studied 32 or More Consecutive Days and Single Day Values for 9 Other Subjects.

Subject	Age	Alpha wave freq.	Total cal./hour	Heart rate	Syst. blood press.	Diast. blood press.	Pulse press.	Rectal Temp.	Respiration
A	30	10.58	52.75	66.16	113.38	63.31	49.72	97.82	14.44
		.45	3.89	3.87	3.21	4.71	4.09	.36	2.49
B	32	10.23	52.80	68.06	107.09	63.09	44.00	98.23	16.97
		.40	2.71	4.55	3.09	3.54	3.73	.38	1.78
C	23	11.39	56.73	77.47	111.59	63.16	48.44	97.81	19.19
		.47	4.51	4.76	4.63	5.67	4.53	.28	2.08
D	22	11.00	53.41	64.18	97.74	54.24	43.21	98.13	16.71
		.40	3.25	5.26	3.17	3.22	2.74	.33	2.55
E	27	8.2	43.1	82.	87.	54.	33.	98.6	15.
F	39	9.9	51.9	56.	118.	78.	40.	98.4	12.
G	30	10.5	54.3	76.	108.	58.	50.	98.4	12.
H	30	9.2	51.7	72.	102.	62.	40.	97.8	15.
I	22	9.5	53.6	66.	96.	58.	38.	97.6	15.
J	23	11.77	66.8	81.	99.	52.	47.	97.4	19.
K	36	9.1	47.8	77.	113.	78.	35.	97.9	10.
L	24	9.3	49.1	60.	84.	46.	38.	97.8	17.
M*	36	11.05	64.0	80.	124.	88.	36.	.....	19.

*Male subject.

Further suggestion of the relationship between the frequency of the alpha waves and metabolic rate was found in an individual subject whose metabolic rate was increased by taking thyroxin. Control records showed the frequency of the alpha waves to be 10.5 per second and the total calories per hour to be 53.7. Three days after 1.6 mg. of thyroxin had been administered, when the metabolic rate had reached its highest value (59.0 calories per hour), the frequency of the alpha waves had increased to 11.4 per second. On the fourth day the total calories per hour had dropped to 56.7 and the frequency to 10.6 per second.

Although the basic rhythm of the alpha waves is undoubtedly established in adults by other factors, it appears from our results that metabolic rate largely determines the differences in frequency (8 to 12 per second) observed in adults. It is possible also that metabolic rate has much to do with variations in the frequency observed in children.

Summary. A very significant positive relationship ($\rho = +.903$) between the frequency of brain potentials (alpha waves) and metabolic rate (total calories per hour) has been demonstrated in 13 adult subjects. A similar relationship was demonstrated in a subject whose metabolic rate was elevated by 1.6 mg. of thyroxin. The relationships between the frequency of alpha waves and pulse pressure and respiration barely approached significance, whereas those between the frequency of the alpha rhythm and systolic and

diastolic blood pressure, heart rate and rectal temperature were not significant. No variation in the frequency or amplitude of the alpha waves was observed in 4 subjects during the breathing of oxygen or during the breathing of a mixture (90% nitrogen, 10% oxygen) until the oxygen had been exhausted.

9054

Unrecorded Form of *Bacterium aurescens*, Sole Colon-Group Representative in a Fecal Specimen.

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Chromogenic members of the colon-group are not unknown. MacConkey[1] listed yellow colon-group liquefiers from horse feces, pond water, rain water, roof washings, oats, beans, malt and ears of corn, and he reported a yellow *B. coli communis* from rain water. Rogers, Clark, and Lubs[2] reported that but few grain cultures are without pigment, many being decidedly chromogenic. They stated that this property is correlated with other characters and consequently is of value in classification. In a collection of colon-bacteria from human feces they found chromogenesis almost entirely absent. All their fecal cultures gave a faint yellow color but this was so slight and showed so little variation that it was of no value in differentiation. They did state, however, that there were a few exceptions to this rule. Wood[3] reported that 7 of 20 colon-group strains isolated from grains, hay and dried eggs and milk produced yellow pigment. In his Pocomoke river series Perry[4] encountered 5 cultures of aërobic, non-sporulating bacteria producing gas from lactose which produced a distinct yellow pigment. He excluded these chromogenic strains from consideration as fecal *coli*.

On January 14, 1936, a fecal specimen was received for study. Although the patient complained of certain general symptoms none referred to the gastro-intestinal tract and the analysis was under-

1 MacConkey, *J. Hygiene*, 1909, **9**, 86.

2 Rogers, Clark, and Lubs, *J. Bact.*, 1918, **3**, 231.

3 Wood, *J. Hygiene*, 1919, **18**, 46.

4 Perry, *Am. J. Hygiene*, 1929, **10**, 580.