Under given conditions these values are quite constant. In the monkey the latencies, in milliseconds, average 15 to 20 for toes, 8 to 11 for fingers and 5 to 9 for face; in the cat the values are, approximately, 11 msec. for hindfoot, 8 for forepaw. The values may fluctuate as much as 20 per cent., but are usually constant within 5 per cent. We usually employ a stimulation frequency of one a second. The response progressively decreases in magnitude as the frequency is increased and it disappears at rates of from 12 to 15 a second. This effect is probably due to the same factors which produce the masking phenomenon described below.

A given cortical spot may yield potentials of approximately equal sizes when a discrete tactile stimulus is applied successively to different points on a restricted peripheral area. Thus brush stimulation of a few hairs within an area on the leg one inch wide and two inches long evokes potentials from a specific spot. Of great interest is the fact that these responses are attenuated or obliterated (masked) if another camel's hair brush is applied with a continuous motion anywhere else within that particular skin area. If the secondary stimulation is applied beyond the boundaries of an area represented at the cortical spot it has no masking effect.

Application of Dusser de Barenne's method of thermocoagulation[3] indicates that at least the outer layers of the cortex are not essentially concerned in the elaboration of these potentials. It is possible that only the terminations of thalamo-cortical neurons are involved, but the magnitude of the potentials, the characteristics of the spreading (*cf.* Adrian[4]) and other aspects of the responses speak against such a conclusion.

A general mapping of the entire Rolandic region and the corresponding area on the medial surface of the hemisphere can be achieved in a single experiment on a monkey by exploring with the stimulator the entire body surface each time the "different" electrode is placed on one of a series of arbitrarily selected cortical spots. Such a procedure consumes many hours, but it gives a good outline of a stable arrangement, the total representation which is revealed by these potentials. It uncovers a more detailed picture than any heretofore presented. Under the conditions of our experiments the representation appears to be confined to areas 3, 1 and 2. Up the postcentral gyrus to the hemispheral rim and then down the medial surface to sulcus cinguli the parts of the contralateral body surface are represented in an orderly sequence which roughly corresponds to that of the motor points on the precentral gyrus. Evidence has been found that in the case of the leg this sequence reflects the metameric origin of the dermatomes. No maximal potentials in response to tactile stimuli are found precentrally. Only the face has shown a definite bilateral representation.

This study, based on receptor stimulation and correlated electrical response, has disclosed a cortical representation of tactile sensibility which is definitely stable. We conclude that whatever functional variations may characterize the total cortical response to a tactile stimulus they are based on a highly stable anatomical substratum which is functionally demonstrable.

WADE H. MARSHALL,
Fellow, National Research Council
CLINTON N. WOOLSEY
PHILIP BARD

[3] J. G. Dusser de Barenne and H. M. Zimmerman, *Arch. Neurol. and Psychiat.*, 33: 122, 1935.

[4] E. D. Adrian, *Jour. Physiol.*, 88: 127, 1936.

QUANTITY ULTRACENTRIFUGATION WITH INTENSE FIELDS

THE air-turbine drive[1] makes it possible to ultracentrifuge[2] large volumes of liquid as well as to carry out the analytical procedures developed by Svedberg[3] and his coworkers. This quantity ultracentrifugation has already been used for several purposes—to concentrate the activity of yellow fever virus[4] and the pneumococcic antibodies[5] in immune horse serum and to crystallize[6] tobacco mosaic virus protein[7] directly from the juice of infected plants. Taken in conjunction with ultracentrifugal analyses it has been employed to isolate the unstable virus proteins responsible for several plant diseases[8] and to obtain in a pure state a similar substance,[9] which carries the virus activity causing infectious papillomatosis in rabbits. It is now being used routinely for the preparation of virus proteins in quantities sufficient for a detailed study of their biological, chemical and physical properties. Such ultracentrifugal preparation of proteins too unstable or present in too small amounts to be ex-

[1] E. Henriot and E. Huguenard, *Compt. rend.*, 180: 1389, 1925; *Jour. phys. radium*, 8: 443, 1927; J. W. Beams, *Rev. Sci. Instr.*, 1: 667, 1930; J. W. Beams and E. G. Pickels, *ibid.*, 6: 299, 1935.

[2] J. Biscoe, E. G. Pickels and R. W. G. Wyckoff, *Jour. Exp. Med.*, 64: 39, 1936; J. H. Bauer and E. G. Pickels, *ibid.*, 64: 503, 1936; R. W. G. Wyckoff and J. B. Lagsdin, *Rev. Sci. Instr.*, 8: 74, 1937.

[3] See T. Svedberg, *Naturwiss.*, 22: 225, 1934, for bibliography.

[4] J. H. Bauer and E. G. Pickels, *op. cit.*

[5] R. W. G. Wyckoff, SCIENCE, 84: 291, 1936.

[6] R. W. G. Wyckoff and R. B. Corey, SCIENCE, 84: 513, 1936.

[7] See W. M. Stanley, *Am. Jour. Botany*, 24: 59, 1937, for bibliography.

[8] W. M. Stanley and R. W. G. Wyckoff, SCIENCE, 85: 181, 1937.

[9] J. W. Beard and R. W. G. Wyckoff, SCIENCE, 85: 201, 1937.

tracted by the usual chemical procedures has suggested that very probably it could isolate other biologically active substances in an unaltered condition.

Virus proteins have proved to be of exceptionally high molecular weight, and the centrifugal fields most advantageous for sedimenting and purifying them do not exceed about 50,000 times gravity. Antibodies, enzymes, protein-linked hormones and the like are smaller and therefore need higher fields for their concentration.

Using suitably shaped heads of light metal alloys we have centrifuged volumes in excess of 100 cc for as long a period as desired in fields several times those employed in the virus work. If the quantity head is made of one of the commercially available magnesium-rich alloys, the maximum field that can safely be used has been between 200,000 g and 250,000 g. Duralumin heads of the same size will run well between 250,000 g and 300,000 g; one has been operated for several hours somewhat above 350,000 g, though this is so near the bursting field that routine operation probably is impractical. In the present design of head a field of 300,000 g is attained at 60,000 r.p.m.

These fields will concentrate most proteins from aqueous or dilute salt solutions. The efficiency of concentration depends on many factors, notably the duration of the run and the viscosity, and hence the concentration and temperature, of the solution. Whether a protein sediments as a solid mass or accumulates in a liquid layer in the centrifuge tube will depend on its solubility.

In order to obtain a measure of the degree of concentration afforded by these higher fields, solutions of proteins with small sedimentation constants have been spun under otherwise comparable conditions at maximum fields of 50,000 g, 200,000 g and 250,000 g. The amount of protein in different layers was determined at the conclusion of the runs. Some results comparing the 50,000 g and the 200,000 g fields are recorded in Table I. It is apparent from these and similar data that molecules with $s > 15$ can be concentrated and those with $s > 40$ can be sedimented within a reasonable time by fields not greater than 50,000 g. Egg albumin is concentrated in the 200,000 g field and hemoglobin can be thrown down completely, though the time needed for such sedimentation is of the order of six hours.

TABLE I

CONTENTS OF LAYERS OF PROTEIN SOLUTIONS ULTRACENTRIFUGED FOR THREE HOURS

	Egg Albumin[10] $s = 3.4 \times 10^{-13}$ $M = 32{,}000$		Hemoglobin[11] $s = 4.4 \times 10^{-13}$ $M = 68{,}000$		Felton Pneumococcic Antibody[12] $s = 16 \times 10^{-13}$ cm sec^{-1} dynes^{-1} $M =$ ca 500,000	
	5×10^4g	2×10^5g	5×10^4g	2×10^5g	5×10^4g	2×10^5g
	Per cent.		Per cent.		Per cent.	
Top	0.8	0.6	0.9	< 0.1	0.1	< 0.1
Middle ..	0.9	1.4	1.1	< 0.1	1.0	< 0.1
Bottom .	1.2	4.8	1.9	6.0	3.8	6.0*
Original solution	0.85		1.0		1.9	

* Most of the antibody was present in the bottom of the tube as a solid precipitate.

[10] B. Sjogren and T. Svedberg, *Jour. Am. Chem. Soc.*, 52: 5187, 1930.

[11] T. Svedberg and J. B. Nichols, *Jour. Am. Chem. Soc.*, 49: 2920, 1927; T. Svedberg and A. Hedenius, *Biol. Bull.*, 66: 191, 1934.

[12] J. Biscoe, F. Hercik and R. W. G. Wyckoff, SCIENCE, 83: 602, 1936; M. Heidelberger, K. O. Pedersen and A. Tiselius, *Nature*, 138: 165, 1936; M. Heidelberger and K. O. Pedersen, *Jour. Exp. Med.*, 65: 393, 1937.

No serious new mechanical difficulties are met in working at 200,000 g. The transparent containers heretofore employed have not withstood still higher fields, but as long as a liquid is not corrosive it can be placed directly in the head and successive layers pipetted off after a run.

Details of the construction of quantity heads suitable for these higher fields as well as examples of their use in protein isolation and purification will be published later.

RALPH W. G. WYCKOFF
ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, PRINCETON, N. J.

BREAKING THE REST PERIOD OF THE STRAWBERRY BY LONG DAYS AT HIGH TEMPERATURES

EXPERIMENTS reported herewith indicate that long days at high temperatures may be fully effective in breaking the rest period of strawberries. The leading southern strawberry varieties when raised in the South require little or no low-temperature rest period in winter to enable them to start into vigorous growth. In contrast, northern varieties under natural field conditions require a low-temperature rest period in winter before they start vigorous growth.

During the winter of 1935–36, 10 varieties—Missionary, Southland, Blakemore, Bellmar, Dorsett, Fairfax, Narcissa, Catskill, Howard 17 (*Premier*) and Burrill—were selected to represent the most widely different growth types. Missionary, Southland and Blakemore were included to represent the southern varieties, which grow the most vigorously in short days, and Howard 17 and Burrill represented the northern varieties, which grow slowly, if at all, under short-day conditions. The other varieties are intermediate in their growth response. The plants were exposed in the greenhouse to three photoperiods (16-hour, 14-hour and normal winter days of the latitude of Beltsville, Md., ranging from 13 to 10 hours long) at each of three temperatures (70° F., 60° F., and 55° F.). The increased daily-light periods were obtained by supplemental exposure for suitable periods