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

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.

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.

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.

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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 at the end of each day to 500-watt Mazda lights suspended about 24 inches above the plants. In each light and temperature test there were three plant groups, one group placed under the differential light treatments on September 1; a second group brought into the greenhouse and placed under the light treatments on November 15, after having been exposed to the normal temperatures and short days of fall (about 11 hours); and a third group brought into the greenhouse and placed under the light treatment on January 1, after having had a low-temperature rest period in an unheated house. Records were taken on March 2, after the September 1 lots had been in the greenhouse 6 months, the November 15 lots 3½ months, and the January 1 lots 2 months. Leaf areas for one plant each of Blakemore and Fairfax were averaged to indicate amount of growth attained under each treatment, as an examination of all plants of all varieties showed that these two varieties were representative except in the case of Missionary under short days. Table 1 gives the average leaf area for the plants of the two typical varieties under the different light and temperature conditions on March 2.

TABLE 1

EFFECT OF VARIOUS PHOTOPERIODS AND TEMPERATURES ON LEAF AREA OF STRAWBERRY PLANTS, BELTSVILLE, MD.

Date of starting experiment	Condition of plant at start of experiment	Average leaf area on March 2, 1936					
		Day length at 70° F.			Day length at 60° F.		
		16-hr. day	14-hr. day	Normal day	16-hr. day	14-hr. day	Normal day
		Sq. cm	Sq. cm	Sq. cm	Sq. cm	Sq. cm	Sq. cm
Sept. 1	Not resting ..	934	667	426	913	460	407
Nov. 15	Resting	1,023	991	508	531	200	274
Jan. 1	Rest broken	1,023	947	668	825	581	422

At 70° F. all varieties in all three groups developed approximately the same leaf area, both in the 16-hour and the 14-hour-day tests (the September 1 14-hour-day plants being smaller but not significantly so). In the normal-day lot, however, the September 1 and November 15 groups were similar and were still in their rest period, while the January 1 group had developed a considerably larger leaf area, indicating that its rest period had been broken. Thus, a 70° F. exposure to photoperiods of 16 and 14 hours (1) prevented a rest period in the September 1 group and (2) broke the rest period in the November 15 group. Previous exposure to low temperatures had already broken the rest period of the January 1 group.

At 60° F. the 14-hour- and normal-day lots of the September 1 group were still in their rest period, while the 16-hour lot was growing vigorously. None of the November 15 group grew vigorously at 60° F., although the 16-hour lot made some growth. Plants in the 14-hour- and normal-day lots of the November 15 group even decreased in size from loss of leaves. Each lot of the January 1 group made good growth (the normal-day plants after two months actually being as large as the September 1 normal-day lot) after six months in the greenhouse. Thus, at 60° F. under 16-hour days, (1) plants that were not in the resting condition at the start of the experiment (*i.e.*, the September 1 lot) did not undergo a rest period; and (2) plants that were in the resting condition at the start (*i.e.*, the November 15 lot) had their rest period partially broken at 60° F. under 14-hour days; (3) plants not in the resting condition (*i.e.*, September 1 lot) went into a rest period; and (4) plants in the resting condition (*i.e.*, November 15 lot) did not have their rest period broken.

The strawberry differs from many plants in that it retains its green leaves while in the resting condition. Most fruit plants lose their leaves when entering the rest period, and as a result light has no effect on the rest period. In southern states, when there is not sufficient low temperature in winter to break the rest period of fruits such as the peach, the leaves appear slowly, and after many weeks the rest period is broken and active growth is resumed. In contrast, in this experiment the strawberry plant had green leaves through which light could have an effect, and long days at high temperatures were fully effective in breaking the rest period.

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BOOKS RECEIVED

Actualités Scientifiques et Industrielles. 328, Exposés d'Histoire et Philosophie des Sciences, 1936, III: Histoire des Origines de la Théorie Cellulaire, by MARC KLEIN. Pp. 71. *376, Biologie du Travail et Biotypologie. I: La Sélection du Personnel dans les Entreprises de Transport*, by PIERRE LÉVY. Pp. 37. 4 figures. *397, Exposés de Biologie; VI, La Coacervation les Coacervats et Leur Importance en Biologie*, by H. G. BUNGENBERG DE JONG. *Tome I, Généralités et Coacervats Complexes.* Pp. 52. 13 figures, 3 plates. *398, Tome II, Coacervats Auto-Complexes.* Pp. 64. 11 figures. *401, Biophysique Moléculaire, I, La Temperature Critique du Sérum:* P. LECOMTE DU NOÜY. *I, Viscosité et Phénomènes Optiques.* Pp. 83. 36 figures. *402, II, Phénomènes Optiques et Phénomènes Ioniques.* Pp. 187. 79 figures. *403, III, Fixation d'Ether-Tension Interfaciale et Spectre d'Absorption Ultra-Violet.* Pp. 228, 93 figures. *404, IV, Action des Lipoïdes sur les Phénomènes de la Lyse*, by BARUCH S. LEVIN. Pp. 83. Illustrated. Hermann & Cie, Éditeurs, Paris.

FISCHER, MARTIN. *Christian R. Holmes, Man and Physician.* Pp. 233. Illustrated. Thomas.

HOLMES, ERIC. *The Metabolism of Living Tissues.* Pp. x + 235. Macmillan, Cambridge University Press. $2.25.

RUSK, ROGERS D. *Atoms, Men and Stars; A Survey of the Latest Developments of Physical Science and Their Relation to Life.* Pp. xxviii + 289 + ix. Knopf. $3.00.

STEMEN, THOMAS R., and W. STANLEY MYERS. *Oklahoma Flora.* Pp. xxix + 706. Harlow Publishing Corporation, Oklahoma City. $6.00.