Field of Doctorate Specialization as a Function of Size of High-School Graduating Class

In the course of an intensive study of the science doctorates of 1957 and 1958, an interesting relationship was observed between size of graduating class in high school and field of doctorate specialization. The science doctorates were grouped into three broad classifications: physical sciences (including mathematics, physics, chemistry, geology, and engineering); biological sciences (including, along with other biology fields, agriculture, biochemistry, biophysics, and research degrees in the medical sciences); and behavioral sciences (all fields of psychology and anthropology). Those scientists who had graduated from public high schools in the United States were then classified by size of high-school graduating class. The numbers of individuals by class size in public high schools, and by major field, are shown in Table 1.

It is clear that the percentage of physical-science specialists goes up with class size, that the percentage for the biological sciences drops precipitously, and that the percentage for the behavioral sciences climbs slowly but rather consistently. The numbers are large enough to insure that these trends are reliable.

The reasons for this differential in field of doctorate specialization are undoubtedly complex and only partially understood at this time. There is an obvious relationship between size of high school and urban concentration; small public high schools are most characteristic of agricultural regions. For this reason, the regional variations in public-high-school origins were examined. It was found that the biologists tend to come with disproportionate frequency from the agricultural regions, and the behavioral scientists, from areas of greatest urban concentration. (These two regional characterizations are negatively but imperfectly correlated.) The physical scientists, on the other hand, show far less regional variation in high-school origins. Table 2 shows the regional distributions of the public-high-school origins of scientists in these three major fields. (In numbers of individuals Tables 1 and 2 do not agree because of missing data in some cases.)

One may hypothesize that greater contact with life forms in the more rural schools leads to greater interest in the biological sciences (including agriculture) among the graduates of smaller high schools. Greater urban concentrations, on the other hand, expose people to more social problems, conflicts in cultures, and so on, and one may hypothesize that these contacts are a partially determining factor in the higher concentration of people from these areas in the behavioral sciences. The availability of science and mathematics courses prerequisite to careers in the physical sciences may be another powerful influence. Research now under way on the high-school backgrounds of these people may throw considerable light on this third factor. Meanwhile, class size and regional variations for those who received doctorates in 1959 are being checked.

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National Academy of Sciences–National Research Council, Washington, D.C.
27 July 1959

Table 1. Size of public-high-school graduating class for individuals who received doctorates in three major fields.

Major field	No. of individuals in high-school graduating class											
	1–19		20–39		40–59		60–99		100–199		200+	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Physical sciences	170	42	355	48	269	50	376	51	646	51	1727	55
Biological sciences	196	48	316	43	209	39	266	36	422	33	817	26
Behavioral sciences	41	10	68	9	62	11	97	13	196	16	599	19
Total	407	100	739	100	540	100	739	100	1264	100	3143	100

Table 2. Regional distribution of public-high-school origins for individuals who received doctorates in science in 1957 and 1958.

Geographic region	Physical sciences		Biological sciences		Behavioral sciences		Total No.
	No.	%	No.	%	No.	%	
New England	220	48	149	33	89	19	458
Middle Atlantic	931	54	421	25	359	21	1711
East North Central	662	54	387	32	176	14	1225
West North Central	292	47	218	35	114	18	624
South Atlantic	248	47	210	40	72	13	530
East South Central	95	49	71	37	27	14	193
West South Central	210	55	127	33	47	12	384
Mountain	130	50	102	40	26	10	258
Pacific	281	52	185	35	72	13	538
Foreign	666	54	474	38	97	8	1237
Total	3735	52	2344	33	1079	15	7158

Enzymatic Factors in Experimental Galactose Cataract

Abstract. In the rat lens, glucose-6-phosphate dehydrogenase activity is specifically inhibited by galactose-1-phosphate, both in vitro and in vivo. In galactose-fed animals this inhibition occurs prior to the apparent inhibition of soluble protein synthesis in the ocular lens.

Kalckar *et al.* (*1*) have recently demonstrated a relative or absolute lack of the enzyme galactose-1-phosphate (gal-1-P) uridyl transferase in the red blood cell and liver of individuals suffering from congenital galactosemia. Similar findings were observed in the cataractous lenses removed from a galactosemic infant (*2*). Schwarz and Golberg (*3*) found that this ester accumulates in the lens capsule and epithelium of rats maintained on a 30-percent galactose diet. They noted that the concentration of gal-1-P in these lenses was approximately 10 times the amount present in the normal lenses, and that the amount of ester present in these cataractous lenses was of the same order as that found in galactosemic red cells. Since the lens is dependent on glucose as its main source of energy, an accumulation of gal-1-P in the lens may be a precipitating factor in the development of human and experimental galactose cataract.

Kinoshita (*4*) has shown that the hexose monophosphate shunt is of considerable importance in lens metabolism. In order to investigate the possibility that galactose phosphate might directly inhibit this pathway of glucose metabolism, the enzymes glucose-6-phosphate (G-6-P) and 6-phosphogluconate (6-PG) dehydrogenase were assayed in the lenses of normal and galactosemic rats.

Twelve Rochester colony white male rats, 26 days of age and weighing approximately 60 gm each, were employed. Six animals were put on a cataractogenic galactose diet (5), while six others were fed a control dextrose diet (5). As soon as the rats on the galactose diet began to show the first ophthalmoscopic evidence of cataract formation (peripheral subcapsular vac-

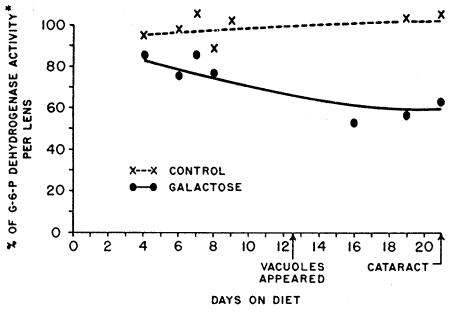

Fig. 1. Percentage of G-6-P dehydrogenase activity per lens (ordinate) as a function of days on diet (abscissa). The enzyme activity (assayed at *p*H 7.4) is expressed as μgr of TPN$^+$ reduced per hour per milligram of soluble lens protein (100 percent G-6-P dehydrogenase activity equals 21.93 units).

uolization), which occurred at the 12th to 14th day after the commencement of the galactose diet, both the control and experimental groups of animals were sacrificed. Their lenses were immediately assayed for G-6-P dehydrogenase and 6-PG dehydrogenase activities according to the method of Glock and McLean (*6*).

In the lenses derived from the experimental (galactose) animals, there was a marked inhibition of G-6-P dehydrogenase activity. The average level of activity in these animals was 13.8 units (*7*) (range 7.9 to 18.8) which was approximately 45 percent lower than the value obtained for G-6-P dehydrogenase in the control group, 25.2 units (range 23.7 to 26.9). However, the 6-PG dehydrogenase activity was essentially the same for both groups of animals. The average value in the experimental (galactose) group was 6.25 units (*7*) (range 4.71 to 9.15), while the control group showed an average of

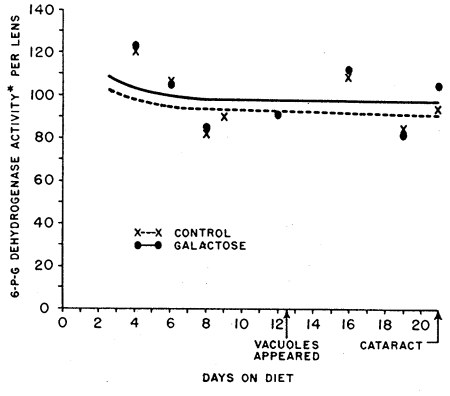

Fig. 2. 6-Phosphogluconate dehydrogenase activity per lens (ordinate) as a function of days on diet (abscissa). The enzyme activity (assayed at *p*H 7.4) is expressed as μgr of TPN$^+$ reduced per hour per milligram of soluble lens protein (100 percent 6-P-G dehydrogenase activity equals 6.9 units).

6.16 units (range 5.10 to 7.41) of 6-PG dehydrogenase activity.

This experiment was repeated with 28 rats of the same strain and weight. Half of these animals were fed the galactose diet, while the remaining half were fed the dextrose diet. Two animals in each group were sacrificed at the 4th, 6th, 7th, and 8th days, respectively, after commencing on their respective diets. The remaining animals were sacrificed at varying periods of time, as shown in Figs. 1 and 2.

The activity of G-6-P dehydrogenase showed a significant decline at the 4th day of galactose feeding and continued to fall till the 14th day, where it leveled off at approximately 60 percent of normal, as shown in Fig. 1.

The level of 6-PG dehydrogenase showed no change in the lenses of the galactose-fed rats as compared to those of the control animals (Fig. 2).

The soluble protein fractions of all these lenses were measured by the micro-Kjeldahl method. The results are generally in agreement with Dische's findings (*8*), although the apparent inhibition of soluble protein synthesis did not occur until the 8th day of galactose feeding.

In an effort to reproduce this enzymatic inhibition in vitro, paired lenses from five normal rats were employed. Each pair of lenses was homogenized (in an ice-water bath) in 2 ml of distilled water, and the insoluble protein was removed by centrifugation. Half of each soluble protein fraction was incubated with an excess of gal-1-P to G-6-P in the media (*9*), while the remaining half was incubated with G-6-P as the sole substrate. After 3 hours of incubation at 37°C, an aliquot (0.6 ml) was removed and assayed for combined G-6-P and 6-PG dehydrogenase activities. The results of this experiment showed an average inhibition of 21 percent (range 16 to 35 percent).

Since all the aliquots contained some G-6-P, it was not possible to derive the activity of each dehydrogenase separately. This experiment was therefore repeated with four sets of paired normal lenses in which half of the incubates contained 15 μmole of gal-1-P while a similar amount of sucrose was added to the other incubates.

The results of these in vitro experiments showed that an average of 20-percent inhibition (15.6 to 34 percent) of G-6-P dehydrogenase occurred, while the 6-PG dehydrogenase activity remained unimpaired.

The foregoing experiments have demonstrated that gal-1-P is capable of specifically inhibiting G-6-P dehydrogenase in vitro and that it may act in a similar manner in vitro. This inhibition apparently occurs prior to any observed inhibition of soluble protein synthesis. An inhibition of the hexose monophosphate shunt may therefore be implicated in the pathogenesis of experimental galactose cataract. (*10*).

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7. The enzyme activity is expressed as micrograms of TPN$^+$ reduced per hour per milligram of soluble lens protein. Both G-6-P and 6-PG dehydrogenase activities were assayed at *p*H 7.4.
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9. The incubation media consisted of Krebs-Ringer phosphate buffer, 0.1*M* at *p*H 7.4. The control group contained 1.5 μmole of G-6-P Na$^+$ salt, while the experimental group contained 1.5 μmole of G-6-P Na$^+$ salt and 15 μmole of gal-1-P K$^+$ salt.
10. This investigation was supported by research funds granted by the Rochester Eye Bank and Research Society.

30 June 1959

Requirement of Bound Calcium for the Action of Surface Chemoreceptors

Abstract. The ability of *Hydra* to carry out the feeding reflex in response to reduced glutathione was inhibited by either (i) standing in distilled water, (ii) the presence of ethylenediamine tetraacetic acid, or (iii) the presence of magnesium ions. These three types of inhibition were reversed instantaneously by the addition of calcium ions.

Chemoreceptors are known to exist on the surface of some cnidarians, as shown by the effects of meat juice in the environment on eliciting a feeding reflex in *Hydra* (*1*) and in other species (*2*). It was not until the quantitative chemical studies of Loomis that the substance which stimulated the *Hydra* chemoreceptor was positively identified as reduced glutathione (GSH). In a lucid study Loomis demonstrated that this tripeptide is among the numerous compounds present in the fluids oozing from the wound of the prey punctured by the harpoon action of the *Hydra's* deadly nematocysts, and that GSH induces the *Hydra* to open its mouth in an attempt to swallow that prey. Loomis colorfully describes GSH as an "environmental hormone," released from a specific source—the damaged prey; passing through a fluid environment—the water between the prey and the