Research in High School

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Last year 36 superior students gave 1410 student hours of work on a research problem. They gave this time freely, without diminution, without credit, without pay. They worked as hard for science as the varsity squad did for football.

This receptive attitude toward work in science was motivated by a grant, one of eleven such grants offered in the nation, from the U. S. Department of Health, Education and Welfare. The grant approved a research problem on the hypothesis that high school students might derive measurable value from work with basic research. If successful, it is their hope that some national society or agency would then establish a national program of such efforts.

Although the two teachers who were presented the grant embarked on this experience with optimism and enthusiasm, they, nevertheless, had not anticipated the extent and depth of impact that this problem has had upon the students involved.

But it takes more than student hours and enthusiasm to be of lasting value, and this story will attempt to impart to the reader why this program deserves such merit.

The teachers involved, in an attempt to establish an hypothesis, asked themselves questions such as:

> Will the growth inhibition factor of vitamin A deficiency be overcome or altered in the presence of an excess of a growth stimulating factor?
>
> Will a rat under pituitary growth stimulation be so conditioned as to show pathological signs from a deficiency diet that would not otherwise appear?

Discussion of such questions led to the formation of a tentative hypothesis which might be stated as:

> "Rats, stimulated by anterior pituitary growth hormone, overcome the growth inhibition factor of vitamin A deficiency, and show more clearly the pathological symptoms of the vitamin deficiency."

And so to work. All experiments were begun with 24 day old white female rats of the Sprague, Dawley strain. All rats in each experiment were fed the standard USP Vitamin A deficient diet. Groups of rats were subjected to concomitant variables of Vitamin A per 1,000 grams of body weight, such as:

Group A	0 units
Group B	50 units
Group C	100 units
Group D	400 units
Group E	1,600 units

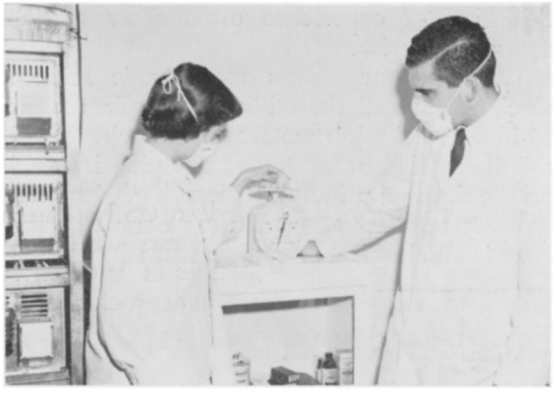
Each group of rats were then subdivided into groups, half of these receiving no growth hormone, and the other half receiving two rat units of anterior pituitary growth hormone subcutaneously, daily.

Four work groups, each comprised of 3 or 4 students, were formulated. Work Group I began its duties at 7:30 a.m. when they donned their lab coats and face masks and proceeded with the seemingly unpleasant task of cleaning the "catch-all pans." This was immediately followed by the animals being fed vitamin A with the aid of 1cc tuberculin syringes equipped with ball tipped needles. The hormone was also administered in the morning. Each rat received 2 rat units of pituitary growth hormone; one unit in the morning and one after school. These tasks completed, the counter tops and floor were mopped, and it was time for the first class.

Work Group II devoted their lunch period to research. Their duties involved a complete external observation of each animal. At the onset of the problem, the students developed a daily report sheet on which they incorporated a check system to facilitate recordings. Three associates worked cooperatively as a team checking each other's observations of weight, eyes, teeth, coat, feces, nostrils. This group also recorded the data on permanent record cards and charted the weights on permanent graphs.

The third work group took over immediately after school. Again one unit of growth hormone was administered.

These students were now deeply imbued with the principle that science is not romantic glamor and tinsel as were their thoughts when



Each time an animal is weighed, the results are checked by a person other than the one doing the weighing. Here Mr. Scheel checks, as Carol weighs a rat. (Photo by Del Cryer.)

they came to us. They had developed a scientific attitude. Perhaps even as important was the development of an appreciation for, and skill in, problem solving. In this regard evening sessions proved most rewarding. Questions such as: can we test whether or not a rat is hearing well; are rats right or left pawed; how can the heart beat be accurately counted; and others were presented and solved with ingenuity and intelligent application of logical reasoning to a problem in science.

Some conclusions from the work of last year follow:

The anterior pituitary growth hormone works independently of Vitamin A.

The minimal amount of Vitamin A necessary for a normal development is somewhere between 400 and 1,600 units per 1,000 grams of body weight per day.

Rats are not right or left pawed.

Vitamin A deficiency slightly lowers the rate of heart beat.

Vitamin A deficiency results in a marked whitening of the teeth, which are normally yellow.

The growth hormone factor compensates for the retarded growth factor of Vitamin A deficiency. Thus a rat on a normal amount of Vitamin A without growth hormone reaches about the same size as a rat on no Vitamin A, but 2 units of growth hormone. In spite of this correlation, these two factors are independent of each other.

A few of the benefits to the students may be stated now.

A new dimension of the understanding of scientific methods dawns. Terms such as hypothesis, control, concomitant variable, are not something to be memorized and parroted back to the teacher, while deep down some of them think of it as gibberish nonsense. Rather, they are terms used in conversation when setting up a phase of the problem, and in turn actually applied to the problem. They no longer look at the methods of science but look through them.

Ron looks on as Mr. Scheel checks Roger and Carol's recording of data in the permanent records. (Photo by Del Cryer.)

The students coming to us are literal minded. Science, to them, is the discovery of the vacuum tube or to make a radio. Science is the discovery of the Salk vaccine to cure polio. They are forced by an inner compulsion to apply everything. They have no conception of the term pure science. The idea of a search for truth for truth's sake is to them impractical, unrealistic, nonsense. How shall one correct this thinking? Have them work with science. Then, will they experience just a

A comprehensive observation sheet is filled out for each animal daily. Mr. Baker looks on as Joanna observes and Julie records. (Photo by Del Cryer.)

mite of the thrill of discovery. Then they understand.

Superior students have an intellectual dignity too seldom tapped. When working with a research problem they are allowed to let their minds come to grips with tough problems. From this is gained new self esteem, new respect from fellow students, and new humbleness through failure. Students with this kind of experience often show an increased maturity.

With all our efforts to upgrade science teaching, and all the millions of dollars spent to improve the job we are doing, why hasn't this been tried before? And the plan is based on the simplest principle of learning. How can we best teach the superior student what science is all about? Have them learn by doing!

Lucky Strike for Education

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For over two years I have been sending fossil specimens to schools, colleges, universities, clubs, private collectors, and museums all across America and Alaska. In addition to local or national requirements, six countries are also on the mailing list, with one somewhat unusual request coming from a graduate student connected with the Soviet Academy of Sciences in Moscow. He was doing work on a certain species of fossils, and he indicated that he made periodic trips into Siberia. I refer to this because I had hoped to create a system of exchange whereby he would get fossils from North America, and our schools would have the rare experience of getting their hands on fossils from Siberia, an area which has proved a happy hunting ground for scientists for many years. While I failed in my effort to get Russian fossils, and since he was unable to send any money, the barter system found me the recipient of the complete works of Pushkin, and an English-Russian Dictionary. Another unusual order came from the Frei Universiteit, located in the western zone of Berlin. I visited the University several years ago little realizing that I would be sending fossils to that science department.

A fossil is any material evidence of ancient form of plant or animal life, or one might put it this way: that a fossil is the preserved remains or mineral replacements of living things of previous ages; for example, a piece of petrified wood is a fossil, for while it has changed its chemical organic composition, it has nevertheless retained its shape; in fact, petrified means turned to stone.

And the bonanza of fossils now being enjoyed by so many of our science students would perhaps never have come about if it were not for the fact that I had accepted a faculty position in northern New York. I wanted to be near the famed St. Lawrence Seaway project, and I had some personal plans that required my attention across in Canada.

One late afternoon, dusk, some would say, I went for an aimless stroll into a glorious sunset. It was unusually vivid, and as a result I stumbled and fell over a small outcropping that had been deposited and buried there by the giant excavation equipment of the construction company busy with the creation of the Seaway at that particular area. Something caught my eye. It looked like the impression of a shell. I examined it quickly to find that what I had fallen over was a section of a system of rocks deposited during the paleozoic era which flourished about 400 million years ago. I discovered myself among tons of rock embedded fossils. There were brachiopods, exclusively marine animals that covered their soft bodies with shells made of two parts—they look like a small mussel—and there were trilobites, meaning three-lobed, consisting of the head, body and tail. They were among the earliest and most widely known of fossils—and much sought after, and here I sat among a fortune of them which schools and colleges all over America, in fact the world, would be happy to have among their science collections.

Fossils aid the teacher in presenting no fewer than ten courses at the junior and senior high school level as well as at university and college level. Industry uses fossil specimens as a guide and index in their search for oil de-