Without any correction for weight, the difference in the means, $M_R - M_B$, is 9.2, which is less than 4 times the probable error of M_R and as such would be just barely significant statistically when one considered the heterogeneity of the data and the great changes from sample to sample. An allowance for the difference of 35 grams in the average weights might easily reduce M_R to around 25 or 26 days and unless the probable error shrunk to less than 1.2 would eliminate whatever there was of statistical significance. If the probable error of M_B were used the result would be more hopeful, but in strict fairness we should use the formula for the probable error of the difference 9.2 of the two means as a function of their indiivdual probable errors; this would give a substantial indication of a significant statistical difference between the means provided, only no allowance for the weight correction be made.

We may raise the question of the comparison of the raw milk on the one hand and of the totality of treated milks on the other. I have not had time to compute the probable errors. The results for the means are:

			Reduced
Raw	M = 30.65 days	Avg. Wt. = 299	Raw
Bot. Past.	M = 21.4 "	" " = 264	26
Boiled	M = 18.7 "	" " = 238	22
Vat Past.	M = 18.2 "	" " = 252	23
Autoclaved	M = 17.4 "	" " = 232	22
Air Free	M = 15.5 "	" " = 237	22

The last column contains a rough estimate of the value of the mean for guinea pigs of the given average weights if fed raw milk. It is my judgment, though I can give no numerical estimate of the probability of that judgment, that the following conclusions are reasonably safe:

(1) On treated milk the pigs do develop scurvy sooner than on raw milk even when allowance for weight is made.

(2) The difference in the time required is smaller than I should have expected.

(3) There is no indication that the different ways of treating the milk produce statistically different results.

(4) An experiment simultaneously performed with sets of 25 pigs of like age, weight and sex and as homogeneous genetically as possible would probably give a good deal of significant statistical data. (The size of the litters from which the pigs were taken might have to be kept constant.)

In bringing this paper to a close I must plead the brevity of my time for preparation as an excuse for so inadequate a treatment of the large amount of data submitted to me and of similar data found in the literature on feeding experiments. Statistical work carefully done takes time—not merely time for routine calculations but far more time for thought. I am glad to know that statistical studies are arresting the attention of biochemists. The physicists and engineers of the Western Electric Company have found that they must resort to such methods when dealing with measurements of such inherently variable phenomena as the microphonic properties of carbon as used in telephone transmitters where the utmost care does not suffice to control the properties to the extent ordinarily attainable in physics. And as the use of the statistical method spreads, we must and shall appreciate the fact that it, like other methods, is not a substitute for but a humble aid to the formation of a scientific judgment. Only with this philosophy in mind may we truly hope, with care, to avoid, in the main, being classed in the superlative category of that oft-cited sequence of liars, damned liars and statisticians!

EDWIN BIDWELL WILSON
HARVARD SCHOOL OF PUBLIC HEALTH

THE SELECTION OF SUBJECTS FOR RESEARCH

THE question whether students should select subjects for research entirely of their own choice, or from a list of subjects proposed by their chosen professor, has been raised in many places and by numerous student generations, but I do not recall seeing any discussion of the subject. Wherever any considerable amount of research work is being done, it is important that the general policy be thoroughly understood in order that the *esprit de corps* may be maintained at the highest possible level.

Let us admit at the outset that almost any subject that one can suggest is worthy of investigation and that, *other things being equal,* the more lines that are being followed in a given laboratory the better. Diversity of interest has a broadening influence.

The trouble is that other things are never equal. No institution, no matter how large or how richly endowed, can possibly be equipped to do research work of an intensive character in more than a very few fields in which students may profess an interest. It is not too much to say that any institution which attempted to offer research facilities to meet the supposed needs of every student would descend to superficiality. It would receive for its pains the contempt of its graduates and the neglect of the public.

On the other hand, no institution is so small or poor that it can not do something to increase the sum of human knowledge, provided that it adheres unswervingly to a sufficiently narrow program, mapped out perhaps many years in advance of its possible realization. Such a program furnishes its own justification. Only one criterion must be met. Does the proposed program deal with fundamental problems or are the problems of only ephemeral interest? If the results will not be worth publication, the work is not worth attempting. If, on the other hand, the work is so very important to some particular industry that its results can not be published, the work should be done outside of the university laboratory.

As a matter of fact, training in research in our colleges and universities is really training in the methods of research and practically never in the particular research work which the student may care to follow later. The student takes up a problem suggested by his professor and according to the ethics of the matter which have gradually evolved, the student does not feel at liberty to continue the investigation of the same subject without the approval of the professor who first suggested the problem. The reason for this is obvious. Of the large number of students who have toiled so unceasingly in the Harvard laboratory in measuring the atomic weights with an accuracy heretofore unknown, how many have continued to measure atomic weights as part of their life's work? Bear in mind that I am not suggesting that the work going on in the Harvard laboratory is unimportant. It is most important and it had given that laboratory an international reputation, even before its unexpected fruition in the discovery of the *isotopes.* I do not even suggest that atomic weight work is not excellent training for chemists of the proper caliber.

The point which I wish to make is that the particular problem is of little moment to the student. He is learning research methods and they are not so very different, whether in chemistry, physics, biology or history. The work is monotonous and often discouraging. There is much chaff for every kernel of grain. To the student I would say, "Here is the test of tests for your absolute integrity, your tenacity of purpose, your ability to stand in the No-Man's Land of knowledge and profess a love for truth where there seems to be no truth. Here is

> Machinery just meant
> To give thy soul its bent,
> Try thee and turn thee forth, sufficiently impressed."

Students are going to the Cavendish Laboratory in Cambridge, England, because Rutherford is working on radioactivity there; others are going to Cambridge, Massachusets, because Richards and Baxter are measuring atomic weights and volumes. Narrow fields for great laboratories, you say? Careful, you may not know how vast those little atoms are or how great their powers as shown by radioactivity. Today is narrow only because it is here and now. Lift your eyes and to-day becomes a part of all time as broad as your mind can conceive. The narrow problem is like the

> Flower in the crannied wall,
> I pluck you out of the crannies,
> I hold you here, root and all, in my hand,
> Little flower—but if I could understand
> What you are, root and all, and all in all,
> I should know what God and man is.

Our tiny problem quickly branches out into more fields than any one mind can compass, and there must then come the process of delimitation.

If I may be pardoned a personal reference, I have tried to limit my own researches to the field of a certain kind of flow of matter. I say a "certain kind," because the subject is so large that I have had to exclude the ordinary flow which we have in rivers and pipes, yet the problems lead one through chemistry, physics, engineering, mathematics, biology, geology, not to mention excursions into the modern and ancient languages and the fascinating subject of philology. How is a student to be expected to have any interest in, let us say, plasticity, about which one knows scarcely anything as yet. But, if "everything flows," as Heraclitus maintained, who can say that it may not prove to be worth while to measure the plasticity of the rocks and metals as well as of rubber and paint? If it should turn out that the new knowledge was worth while, there would be a demand for men who possessed it, and students would be drawn towards this particular branch of knowledge. As a corollary, it is supposed that industries will seek elsewhere men with other types of specialized knowledge, and students desiring those types of knowledge will seek them elsewhere. There is thus a very desirable specialization going on in the universities of the world.

After all, the important thing is to be engaged on some problem. As Carlyle has said:

> Produce! Produce! Were it but the pitifullest infinitesimal fraction of a product, produce it in God's name! 'Tis the utmost thou hast in thee: out with it, then.

And whether we ourselves can produce or not, it little behooves us to harshly criticize the meager results of those who struggle on in the quest. Arthur Gordon Webster was a world authority on sound, the inspiration of his colleagues in physics for a generation, the life of the meetings of the American Physical Society, of which he was a founder. He imagined that his colleagues were no longer giving him their praise and encouragement, and he stopped his researches forever with a revolver shot. For lack of encouragement, others have stopped their researches at all periods of life or before really beginning them —not so dramatically as poor Webster, but quite as effectively. America needs to turn out a far greater volume of scientific research, and the only thing that is lacking is adequate popular support. In the selection of subjects for research we may safely follow the successful European practice, since only in this way may the morale be maintained.

EUGENE C. BINGHAM

LAFAYETTE COLLEGE

SCIENTIFIC EVENTS

THE BRITISH JOURNAL OF EXPERIMENTAL BIOLOGY

HITHERTO there has existed in Great Britain no journal which served specifically for the publication of researches in experimental biology lying outside the confines of genetics on the one hand, and traditional human physiology on the other. American workers who have created a powerful impetus to experimental inquiry in biological science will, it is hoped, welcome the announcement that a *British Journal of Experimental Biology* will appear in September, 1923, issued by Messrs. Oliver and Boyd, from the Animal Breeding Research Department at Edinburgh. While a primary object of the journal will be to promote in Great Britain the extension of inquiry along experimental lines, it is the earnest hope of the editorial board that American and continental scientists will give their support not only by subscribing but also by offering contributions for publication. All communications should be addressed to the Managing Editor, the Animal Breeding Research Department, the University, Edinburgh, Scotland.

F. A. E. CREW,
W. J. DAKIN,
J. HESLOP HARRISON,
LANCELOT T. HOGBEN,
JULIAN S. HUXLEY,
J. JOHNSTON,
F. H. A. MARSHALL,
GUY C. ROBSON,
A. M. CARR SAUNDERS,
J. MACLEAN THOMPSON.

FELLOWSHIPS IN MEDICINE[1]

"THE Rockefeller Foundation, New York, has entrusted the Medical Research Council with a fund to be used in providing fellowships in medicine in the United States. Fellowships will be awarded by the council, in accordance with the desire of the foundation, to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery and are likely to profit by a period of work at a university or other chosen center in the United States before taking up positions for higher teaching or research in the United Kingdom. A fellowship will be of the value of not less than £315 a year for a single fellow, or £470 for a married fellow, payable monthly in advance. Traveling expenses and some other allowances will be made in addition. A fellowship will be tenable for one year, which will as a rule begin in September. Applications for fellowships tenable for the academic years 1923–24 should be made not later than July 20th next. Full particulars and forms of application are obtainable from the Secretary, Medical Research Council, 15, York Buildings, Adelphi, London, W.C.2. It is understood that similar medical fellowships provided by the Rockefeller Foundation will be awarded by the National Research Council at Washington to American graduates desiring to work for a time at selected centers of research work in this country. Both announcements are of great interest. It is of course a commonplace to say that science is international and knows no boundaries; but the practical application of the principle frequently encounters difficulties, to the detriment of progress. Some of these difficulties are removed when scientific workers know those of other countries and their methods of work. The United States now possesses many first-rate laboratories and research institutes, and it will be a great advantage to the British fellows to work in them."

[1] From the *British Medical Journal.*

THE INFLUENCE OF MODERN SCIENCE ON HISTORY AND CIVILIZATION

DR. EDWIN E. SLOSSON, director of "Science Service," Washington, D. C., delivered a series of five lectures before teachers attending the summer session in the University of Pittsburgh. Schedule of these lectures follows:

July 16, "Gasoline";
July 17, "Refrigeration";
July 18, "Photography";
July 19, "Sugar";
July 20, "Coal-tar Products."

These lectures clearly illustrated the possibility of bringing to the layman a realization of his debt to science. Not only did Dr. Slosson show how we were indebted for conveniences, but he intimated how gasoline and other modern fuels had a tendency to spread civilization toward the poles, while the application of the principles of refrigeration made it possible to advance into tropical climates. In his talk on coal-tar products, he referred to Bayer 205, which Germany offered for her lost African colonies. He told how the discovery of a single chemical product might render it a medium of exchange in international relations.

In the talk on photography, applications of the four dimensions and Einstein's principle of relativity in our every-day motion picture were cited.

Dr. Slosson is to be commended for the compelling evidence which he has gathered to show that science is