of the American Association for the Advancement of Science on "Individuality and Science." This session will be held in the Auditorium of the First Baptist Church.

On Tuesday, December 30, at 8:15 P.M., Dr. Edwin P. Hubble, astronomer of the Mount Wilson Observatory of the Carnegie Institution, will deliver the twentieth annual lecture under the joint auspices of Sigma Xi and the association. The title of Dr. Hubble's address is "The Expanding Universe Theory." This session will be held in McFarlin Auditorium on the campus of Southern Methodist University.

On Wednesday, December 31, at 5 P.M., Dr. Rufus B. von KleinSmid, president of the University of Southern California, will deliver the third annual Phi Kappa Phi lecture.

On Wednesday, December 31, at 8:15 P.M., Dean Christian Gauss, of Princeton University, will deliver the seventh annual Phi Beta Kappa lecture in McFarlin Auditorium, Southern Methodist University, on "Can We Educate for Democracy?"

Entertainment, Luncheons and Dinners

The Local Committee will hold a reception for the officers and members of the association and their guests in the Ball Room of the Hotel Adolphus immediately following the address of Dr. Albert F. Blakeslee on Monday evening, December 29.

The American Society of Naturalists, in cooperation with other biological societies and with the association, will hold the Annual Biologists' Smoker at 9:30 P.M. on Tuesday, December 30.

The American Association of Physics Teachers will hold a luncheon on Tuesday, December 30.

Section on Chemistry will hold a dinner on Monday, December 29.

The American Society of Zoologists will hold a dinner on Tuesday, December 30.

The American Society of Parasitologists will hold a luncheon on Tuesday, December 30.

The Botanical Society of America will hold a dinner on Tuesday, December 30.

The American Phytopathological Society will hold a dinner on Tuesday, December 30.

The American Society of Plant Physiologists will hold a dinner on Monday, December 29.

The American Society of Plant Taxonomists will hold a dinner on Monday, December 29.

The Department of Botany of the University of Chicago will hold a luncheon on Wednesday, December 31.

The Genetics Society of America will hold a luncheon on Tuesday, December 30.

The Executive Committee of the American Microscopical Society will hold a luncheon on Monday, December 29.

Beta Beta Beta will hold a luncheon on Wednesday, December 31.

Pi Gamma Mu will hold a luncheon on Wednesday, December 31.

The Metric Association will hold a dinner on Tuesday, December 30.

The American Society for Horticultural Science will hold a dinner on Tuesday, December 30.

The American Science Teachers Association will hold a luncheon on Tuesday, December 30.

The American Nature Study Society will hold a breakfast on Wednesday, December 31.

Phi Kappa Phi will hold a breakfast on Tuesday, December 30.

Gamma Alpha will hold a luncheon on Tuesday, December 30.

Sigma Delta Epsilon will hold a luncheon on Tuesday, December 30, and a breakfast on Wednesday, December 31.

(To be concluded)

SOCIAL IMPLICATIONS OF VITAMINS[1]
II

By Dr. ROBERT R. WILLIAMS

CHEMICAL DIRECTOR, THE BELL TELEPHONE LABORATORIES

But what useful lessons can humanity *en masse* draw from contemplation of this perspective of the ages? What guidance does it give him for the conduct of his racial affairs? May I suggest two points: first, that knowledge brings his significant individual physical environment immeasurably more within his command than a generation ago; second, that his inner nature remains a heritage of a very hoary antiquity which still changes only as the hills change by the slow processes of weathering. With the first, he can adventure with a hopeful intelligence; but the second he must conserve at the peril of extinction.

That man is bringing his external environment increasingly under his control can well be observed throughout the course of history. Cultivated herds and crops, houses, tools, stores of metals, coal and oil, mechanical and electrical power have made his life increasingly secure and leisureful. Almost within our

[1] Lecture given on the occasion of the fiftieth anniversary celebration of the University of Chicago, September 22, 1941.

own memories he has learned of his microbe enemies and has added measurably to his span of life by controlling them. Latest of his discoveries is that his food, which he has continued to choose as the ancients chose it, by its reaction on his palate, contains scores of factors which contribute in unseen but profound and specific ways to his interior environment.

Until about the beginning of this century, there were no generally accepted standards of food requirements. Each judged for himself by his sense of fullness under his belt. When he judged for others, he did so with envy of the luxurious rich or with complacent contempt for the unenterprising poor, according to his own station in society. Women were long recognized by male physicians as being prevailingly anemic. This was thought an appropriate attribute of the weaker vessel till McCance found as late as 1936 that men and women attain the same level of hemoglobin if both receive an abundance of iron. Till recently, food needs were largely a matter of personal prejudice, a characteristic that even nutritionists perhaps have not yet wholly outgrown.

Only within the past decade has the conviction become general that we must do something systematic about our food supply. There were prophets a generation ago who pointed out that the incomes of the poorer half of society were insufficient to provide adequate diets, but their voices carried little weight as their standards of adequacy were unsupported by direct evidence. When long-term nutritional experiments with animals began to be carried out, all manner of unsuspected anomalies appeared very rapidly. No scientist except perhaps Casimir Funk was capable of the necessary credulity to guess how many vitamins there might be. The conservatives began by denying there were any, then gradually and grudgingly admitted the possibility as the long years passed, first of one, then two and so on one by one as a miser parts with his coins. All now concede the existence of a dozen while half as many more are still in the controversial stage.

Most of the earlier animal studies were performed with very much simpler diets than the bulk of humanity consumes. The object of doing so was to keep each article free from significant impurities and thus to ascertain what are the minimum essentials. The method has been amply justified by the discovery of a succession of essential nutrients. The known nutrients in proper proportions now, for the first time, permit a degree of nutrition in the rat which approximates, though it does not equal, the best that can be done with natural food mixtures. We appear to be nearing our goal of a full knowledge of what is essential at least for this one species.

As our knowledge has progressed, several attempts have been made to test the adequacy of customary human diets for the nutrition of the rat. In many instances relatively poor quality human diets have proven poor for the nutrition of the rat by comparison with very simple mixtures of natural foods, even though the latter are given with unvarying monotony for months or years. As an example, rats fed on a poor-class English diet comprising white bread, margarine, tea with milk, boiled cabbage, boiled potato, canned meat and jam, failed miserably. Growth was stunted, the young were badly proportioned, the coats of all were staring and glossless and by the sixtieth day of the experiment they began to kill and eat the weaker members of the colony. At the end of 190 days, corresponding to about sixteen years of the normal life of man, they were sacrificed. Both pulmonary and gastrointestinal disease was found abundantly present on autopsy. By contrast, rats fed a simple mixture of whole wheat and whole milk grew and reproduced through many generations without evidence of abnormality.

McCarrison, who has done more than any one else to evaluate human diets by experiments with rats, has laid special emphasis on the diets of India, where he did his work. As is well known, the peoples of North India are larger in stature and much more muscular and vigorous than those of the southern end of the Deccan peninsula. Rated according to mean stature and weight, seven important racial elements fall in the following order—Sikh, Pathan, Maharatta, Goorkha, Kanarese, Bengali and Madrassi. Their diets range downward by gradations from that of the Sikh, who subsists chiefly on a coarse wheat flour called "atta," a sprouted bean known as "dhal" and milk, including melted butter or ghee. In the South rice with a little fish or meat makes up the food. Rats fed for two years on these diets showed gradations of vigor comparable with those of the Indian peoples. To take a single example of the incidence of disease, peptic ulcer was found in 29 per cent. of the rats fed on the South Indian diet and not a case in those fed the North Indian ration. Similar contrasts were found by the use of other experimental animals.

Modern studies by Orr in England itself indicate that the diets there present almost as wide a range of nutritional excellence, but one can not as readily reduce them to numerical terms, for the diets have not been submitted as systematically to animal experimentation. By all the evidence adduced by Drummond and Wilbraham in the book "500 Years of the Englishman's Food," this contrast in nutritional quality of food is a product of the industrial age. It did not exist to a like degree one hundred years ago, though inadequacy in quantity was then even more prevalent among the poor.

Increasingly it becomes reasonable to suppose that the falling birth rate which characterizes peoples of long-established cultures may be traceable to dietary causes. Food supply has always been a major motive of human striving. When the supply becomes secure as to quantity, there has always appeared historically a marked tendency to adorn it with elegances of selection or of preparation. Just as simplicity of food characterizes primitive cultures, so epicurean delights of the table have characterized declining civilizations.

Experimentally, we know that food may in some degree determine mentality and disposition. In great measure it determines vigor and efficiency. To some degree it influences resistance to infection and therefore death rates. It may demonstrably determine fertility and influence maternal instinct. The chemical bases of sex urges are already in part known, but the relationship, if any, of their genesis to components of the diet is not yet evident.

Will not continuing examination surely reveal whether, or to what extent, food supply has governed the tides of conquest not only by furnishing a prize of war but also by crowding the populations of the aggressors, intensifying their pugnacity and at the same time reducing the birth rates and undermining the vigor of those destined to be vanquished. This thought has grown in part from the observation that of all the peoples of Western Europe to-day, the Germans have practiced the decortication of grain for human use far the least extensively. They have enjoyed a more generous supply of thiamin and other vitamins which grains provide than Scandinavia, the Low Countries, France, Spain, Italy or the British Isles. Perhaps pacifism is a product of malnutrition. If so, malnutrition has its virtues. I prefer to believe that the pacific spirit is a product of democratic organization and that we can perhaps achieve German efficiency and thoroughness without suffering an attack of belligerency.

To associate efficiency with details of food supply may seem to many a far cry. Yet it seems justified at least in part by a recent experiment at Mayo Clinic under the guidance of Dr. Wilder and his associates involving eleven women of the staff. On a diet low in grain vitamins, they became "depressed, irritable, quarrelsome, uncooperative and fearful. Their ability to work suffered because of inattention, uncertain memory and loss of dexterity." Corresponding physical evidences of impairment were noted. "All of these abnormalities, including the anemia, could be corrected only by raising the level of intake of thiamine." Many other competent observers report an increase of buoyancy of spirits and a greater resistance to fatigue achieved by the regular administration of thiamine to people laboring under what are for them normal nervous strains.

In so far as we can approach any social problem from the view-points of physics, chemistry and physiology, we shall be on far more certain ground, for in these fields observations can be made experimentally and objectively to a degree impossible along the lines of sociological approach. It may well be possible to preserve the vigor of youthful civilization without sacrificing the intellectual and cultural advancement of long stabilized societies. There is no sufficient evidence that the decadence of nations is due directly to a weakening of the germ plasm. Germ plasm is a relatively stable inheritance.

The first attempts at reform of mass nutrition have been inaugurated within recent months. They began with the British decision in July of last year that under the stress of war the staple bread of its people should not continue to be emasculated by refining of the grain till its nutritive quality is demonstrably impaired. Like action in the United States was inaugurated last November, partly under the influence of the British example. In both countries, retention of the natural nutrients of the grain is encouraged, but in order that some prompt mass effect should be achieved the use of synthetic restoration of the nutrients is permitted. This has the effect of preserving the whiteness of the bread, a quality still demanded by popular taste, and so avoids the long postponement of an effective remedy. In America three vitamins, thiamin, nicotinic acid and riboflavin, as well as iron, are required to be added to flour or bread which is artificially "enriched." These are nutrients which naturally occur in grain and are known to be more or less widely lacking in the American dietary. While the precise amounts which are to be added are not yet fixed by official regulation, the contemplated quantities are nearly those present in whole grain bread. The progress of the program has been somewhat more rapid in America than was possible in Britain amid the havoc of war. In our country already we are told that half the family flour and a large fraction of bakery bread are enriched in this manner. Those versed in nutrition will eagerly await the first evidences of its reaction on the public health. Many forecast a major betterment as the practice becomes more universal.

This action has been endorsed after extended study by the Food and Nutrition Committee of the National Research Council under the able chairmanship of Dr. Russell M. Wilder. It is a part of a national program of nutritional benefit including popular education, production and distribution to special groups of superior foods and many other phases. There is no intention to resort to general rectification of the food supply with synthetic nutrients. A very few other staples may be favorably considered for such treatment. A special concern is the amplification of the

vitamin A supply, perhaps through butter and butter substitutes, but no runaway wholesale application of our recently acquired knowledge need be feared.

But if the addition of an artificially-made substance to our food can be justified is there any artificial alteration of man's ways of life that must be condemned as a departure from nature? Can one consistently be a progressive in one field and a conservative in another and if so how can one define the boundaries of either?

The discerning biologist will answer that one should be progressive in matters which are subject to preliminary experiment. Among such are those which make up environment. If a mistake should be made in such a matter, its ill effects will be less permanent and can be corrected when the error is discovered. One must be conservative in what can not be forecast by systematic experiment. The latter includes both physical inheritance of the individual and social organization of a nation or race. Since small-scale experiment is slow, broad social decisions have in general rested only on *a priori* reasoning. This is little more than guessing, in testimony of which please note the diametrically opposite views held with great assurance by different schools in sociology, economics. education, etc.

Our environment has been subject to change throughout the period of evolutionary development and is now grossly different from that of primitive man, but the process of natural selection by survival of the fittest is still, so far as we know, the only means of developing a better race or indeed of preventing retrogression. Our present inheritance is the only base from which we can proceed to select further. We may experiment with our environment, using animals in the early stages, but we can not make a trial alteration of our genes. We can even experiment with our own food after extended and judicious experiment with the foods of animals, but we can not experiment on a wholesale scale with our economic structure or our social organization without affecting a nation's future. Social and economic experiment, so called, is often experiment in name only and bears no practical resemblance to experiment in the physical and biological sciences. The latter deals only with a small sample and does not affect the whole.

As I see the evidences of evolution, especially those derived from genetics and from biochemistry, nature's process is one of timeless patience and inexhaustible ingenuity. What more useful lesson can we learn than that nature does not wantonly discard what it has produced but builds ever by adaptation of its earliest concepts. As best we can discern, nature has preserved many mechanisms ever since the process of evolution first began in the mud eons ago. Among these mechanisms are not only those chemical mechanisms of which we have spoken but also those of individual variation and selection of the better adapted by eradication of the worse. Nature's mode has been that of trial on a small scale, a scheme which man rediscovered only some two hundred years ago and dubbed the experimental method. From the conscious application of that method in the fields of the physical and biological sciences has grown the entire product of man's modern mastery of nature.

Society is also, by all evidences, an evolutionary product. We note insect societies of great complexity. Presumably they, like ours, developed because they possessed survival value. So our society should further develop along lines which offer the greatest survival values. Even the spiritual nature of man is an evolutionary product, for we see man's spiritual and intellectual qualities in more elemental and primitive but still recognizable forms in many higher animals. These qualities as well as the social integration toward which they impel us appear to have arisen from submission, one by one of the traits produced by individual variation, to the test of compatibility with the environment.

Only the experimental method, so it seems, offers tangible promise of improving our social and economic structure. But, as in its other applications, experiments in social fields must be on a small scale, even at the risk that each experiment shall be poorly controlled. If so, each man must still be free to follow his own discretion, subject to restraint only when he interferes with the like freedom of his fellows. Love of liberty is not a mere catch phrase but a cosmic wisdom growing out of man's racial experience. His social cooperation in an ideal society must grow with his sense of advantage of cooperation and not by compulsion. His leaders, if they are to be worthy of a following, must appeal not to the sense of immediate advantage of an individual or of his group or class but to the desire of each for the preservation of his freedoms. I submit that all despots, autocrats and Fuehrers, as well as advocates of reform by compulsions, share a common arrogance of opinion in the face of the record of man's upward climb almost, if not quite, exclusively by trying this and trying that, first on a small scale. We may well ask each of those who would save us with a slogan whether it is reasonable to suppose that his advent on the scene marks a turning point in the hundreds of thousands of years of social evolution.

The foregoing is of course an over-simplification. Modern societies are so complex that it is extremely difficult to determine just when one man's freedom begins to infringe another's. What has been said is only the expression of a broad principle which nature

appears to have used consistently throughout the drama of expanding life. The principle is, however, worth enunciating, for the main trends of human thought and action about racial affairs during recent times and especially during the past decade seem definitely in a contrary direction. We are indulging in credulity if we accept panaceas for social ills, if we think to remake human society overnight and most of all if we submit to sweeping changes at the behest of captivating leaders.

Such a view will not be accepted without controversy. Few people are evolutionists in social matters. Prejudices are easily aroused in such affairs especially in the discussion of current questions. To escape these prejudices, we shall do well to look at human history by centuries or by eras and not focus our attention wholly on to-day's headlines. Our American economic history has long been one of booms and depressions and, especially since the Civil War, has involved a series of class subsidies; first, land grants to railroads, then tariffs as protection for manufacturing and, latterly, benefits to agriculture and special privilege for labor. To correct our past over-corrections, we have instituted a score of government regulatory bodies to curb whichever of our past sinful creations happens at the moment to be gaining an ascendancy. Many of the evils can be traced to ancient fictions; for example, that a corporation is a person and its members free from individual responsibility or the idea that a labor union if unincorporated can not be sued. Shall we ever reach the end of regulation short of complete tyranny or inaction unless we return to nature's pattern of individual experiment? To escape anarchy we shall have to have laws, but we should strive to limit these to principles which are nearly universally accepted. Respect for even small minorities is part of the essence of democracy. Such is the view of human society best justified by the perspective of evolution.

Ancient civilizations died apparently of ennui. Depopulation, born perhaps of the substitution of artificial luxury for natural simplicity and heterogeneity of population resulting from the import of elements of subjugated peoples, preceded conquest by more virile neighbors. Whatever the complex causes, a high degree of humanism was not one of them. Our civilization does face this added cause of decay. So long as humane feeling concerns itself only with cultivation of a kindlier sympathy between man and man or class and class, it sweetens the whole of life and enriches culture without doing a direct biological injury. We should not be willing to forego our spiritual aspirations even to assure the physical integrity of posterity. Harshness and cruelty, however, never had a highly selective effect anyhow. Child labor, for example, destroyed good blood as much or more than bad, for it was the industrious and skillful child whose labor was most valued. War and pestilence were also not very discriminating. When, however, humane feeling implements itself with the tools of modern medicine, it does a major biological injury by saving the congenitally unfit. The fit less need its ministrations.

Looking forward then to the decades that shall follow the present cruel and destructive war, biologically intelligent humanity faces first the task of restoring freedom of thought and enterprise, freedom to resume practice of the ancient experimental method. Any other course, no matter how appealing to sentiment or *a priori* reasoning, must only delay the progress of mankind. Artificial restrictions to free interplay must be dispensed with. Trade barriers must be removed between nation and nation. Class legislation which rates men otherwise than according to intrinsic individual worth must be abolished. Artificial subsidies must likewise be set aside. Virtue which can not stand on its own feet in a fair field is dubious virtue; weakness which must forever be protected is ruinous.

Once these principles are popularly accepted perhaps we shall be prepared to begin our second and even more difficult task, to invent means, both scientifically sound *and* humane, to restore or reenforce the process of natural selection for the protection of the future of the race. We can not dismiss this as wholly utopian and impossible. Artificial selection in the breeding of plants and animals is more efficacious and much faster than natural selection ever was because it leaves much less to chance. But the basic tasks of measuring biological excellence, of devising humane measures of restraint of reproduction of the unfit and of promoting the declining reproduction of the desirable will be as challenging to future genetics, biochemistry and medicine as will the equally necessary job of persuading the masses to accept the measures, to future sociology and law. The latter will be possible only if we of the scientific fraternity supply tangible objective facts for guidance and for proof. This should not appal us. Are we not the sole conscious practitioners of nature's ancient method of small-scale experiment? Science in its own fields now commands a popular respect almost beyond its deserts. Is it not our duty to urge the use of its uniquely useful tool and method in other fields of human endeavor? Shall we grow impatient if an understanding of its method and an extension of its thought to other fields requires repetition? No, for our responsibilities are race-wide and extend beyond the realm of things into the realm of the spirit of man himself.