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RESEARCH REVIEWS

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- ON THE NAVAL RESEARCH RESERVE

OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

NAVEXOS P-510

COVER PHOTO: Col. E. B. Miller (left), Director of Civil Defense for the State of Minnesota, and LCDR Joseph A. Wise, USNR, Commanding Officer of VNRRU 9-6, discuss a model of downtown Minneapolis which was constructed to demonstrate civil defense techniques during a course held at the University of Minnesota recently. The course is described on pp. 21-22 of this issue in the first of a series of articles dealing with work being done by many Volunteer Naval Research Reserve Units to assist the country's civilian population to prepare for a war emergency. As to what became of the model city during the demonstrations, see the picture facing p. 22.

Approved by Bureau of the Budget, 13 April 1948.

RESEARCH REVIEWS

Informs the Fleet of ONR-sponsored Research

Contents

November 1950

Editorial Notes

Under Secretary of the Navy Dan A. Kimball recently made some interesting comments on the role which research--both basic and applied--will play in maintaining the security of the United States during and after the present emergency. Mr. Kimball, speaking before the West Coast Procurement Planning Conference in Almeda, Texas, had this to say on the steps that must be taken now to safeguard our Nation:

"We have less time than we thought to complete our stockpiles. I believe we should get on with this job as quickly as possible. I like to consider our stockpiles in at least three categories.

"First, in the ordinary sense, as a reserve of critical raw materials . . .

"There is a second stockpile . . . our reserve of industrial strength and productive capacity . . .

"There is a third stockpile item we must not lose sight of. I refer to the stockpile of scientific research. Even though there is added emphasis today on the necessity for practical development of the research we have already proven, there is still time to pursue further our most important basic research projects.

"We are giving attention now to the conversion of certain of our research projects into production items . . .

"The limited demands which we are now making on industry will not preclude a continuation of research and development. If our present program of military expansion is successful in averting War, there is no reason why research and development cannot continue without any interruption."

The fact that Mr. Kimball places scientific research among the three basic resources of our country shows the predominance which it has assumed today in the eyes of those best qualified to judge the Nation's needs. This, of course, is not news. But what may be surprising to many is his insistence that we must maintain our basic research projects even in a time of emergency, when the temptation is to abandon those investigations which do not offer promise of immediate usefulness. The wisdom of the course advocated by Mr. Kimball is obvious, however. While it is clear that full advantage must be taken of any practical applications available from research, it is equally clear that the pressure of circumstances must not be permitted to cloud the issue of what is of greatest benefit to the Nation over a long period of time. When the Office of Naval Research was founded, it had been recognized that the basic research for many of our important weapons (the atom bomb, for example) had been done mainly in Europe. The United States, in spite of its wealth and the diversity of its talent, had been amazingly parsimonious in its support of the theoretical knowledge that ultimately proved to be of such tremendous practical importance. ONR, then, undertook the support of many programs of basic research all over the Nation in an effort to remedy our previous neglect. Many of these programs have already resulted in practical developments of importance to the Navy and others offer promising possibilities for concrete results in the near future. Now more emphasis will be placed upon exploring such possibilities thoroughly, but this will not be done to such an extent that the success of broader and more far-reaching programs is imperilled. In the Office of Naval Research and in other agencies devoted to increasing our basic knowledge, the United States has a vital investment for the future. Mr. Kimball's words indicate that even under the stress of the present emergency this investment will be carefully guarded.

Hydrogen Embrittles Steel

by
Carl A. Zapffe
Baltimore, Md.

Hydrogen has been a costly fellow-traveler in this country's steel industry, both in peace and in war. Its damaging effects are seen in alloys, where its absorption during casting is responsible for inferior strength, and in steam boilers, where it has caused brittleness severe enough to bring about dangerous explosions. For these reasons, a study of the effects of hydrogen on steel has formed an important part of this Laboratory's ONR-sponsored research on gases in metals.

The source of hydrogen in steel is, of course, water vapor, present either as humidity in the air or as steam (in the case of boilers). For this reason the chemical equation that is of interest in this work is the one expressing the reaction of water vapor with various metals.

At the beginning of this program, a Technical Report was issued in which the thermodynamic theory for such reactions was developed(1). This study was principally theoretical, but it was based in part upon data already at hand; and it led to a concept referred to as the "hydrogen potential" of metal-steam reactions.

By the "hydrogen potential" is meant that equilibrium pressure of hydrogen gas which would develop if the reaction were to be conducted in a closed system until a balance was reached between the oxidation of the metal by steam to produce hydrogen:

$$xMe + yH_2O \longrightarrow Me_xO_y + yH_2, \qquad (1)$$

and the reverse reaction between the metal oxide and the hydrogen to produce free metal and water vapor:

$$Me_xO_y + yH_2 \longrightarrow xMe + yH_2O \qquad (2)$$

Since Equation (1) refers to a commercial process for producing hydrogen, and Equation (2) to a number of well-known processes for the reduction of metallic ores, data are available which allow broad calculations to be made for hypothetical equilibrium systems conducted in a closed vessel--where the gas species could develop their respective pressures. It will come as a surprise to many that pressures of an explosive order are indicated for a number of such reactions of metal with steam.

Carl A. Zapffe, now a metallurgical consultant, received his B. S. degree from the University of Minnesota, an M. S. from Lehigh, and his doctorate from Harvard. Dr. Zapffe has been associated with the DuPont Experimental Station, the Battelle Memorial Institute, and the Rustless Iron and Steel Corporation. He was the author of an article on metal testing which appeared in the first issue of Research Reviews.

In Figure 1, for example, a graph shows calculations for a steam reaction with pure iron over a temperature range of 0° to 500°C.

Since these are temperatures which include the operating range for most steam boilers, it is interesting to observe that steam at only one atm. pressure would generate nearly 1000 atm. pressure of hydrogen gas at the boiling point of water. If the steam pressure is raised to 50 atm., the theoretical "hydrogen potential" exceeds the yield strength of the iron in the neighborhood of 250°C, and the ultimate tensile strength near 200°C. At even lower temperatures, it continues to rise into a pressure range far exceeding the strength of iron. Furthermore, steels produce considerably greater "potentials" than pure iron.

In other words, if these calculations were strictly correct, a steam boiler would be blown to pieces from hydrogen pressure alone if the boiler were sealed and the gas-metal reactions allowed to proceed.

In Figure 2, similar reactions are calculated for a number of metals in the high-temperature range of steelmaking, where the "hydrogen potentials" are, as a rule, at a minimum. This diagram shows that

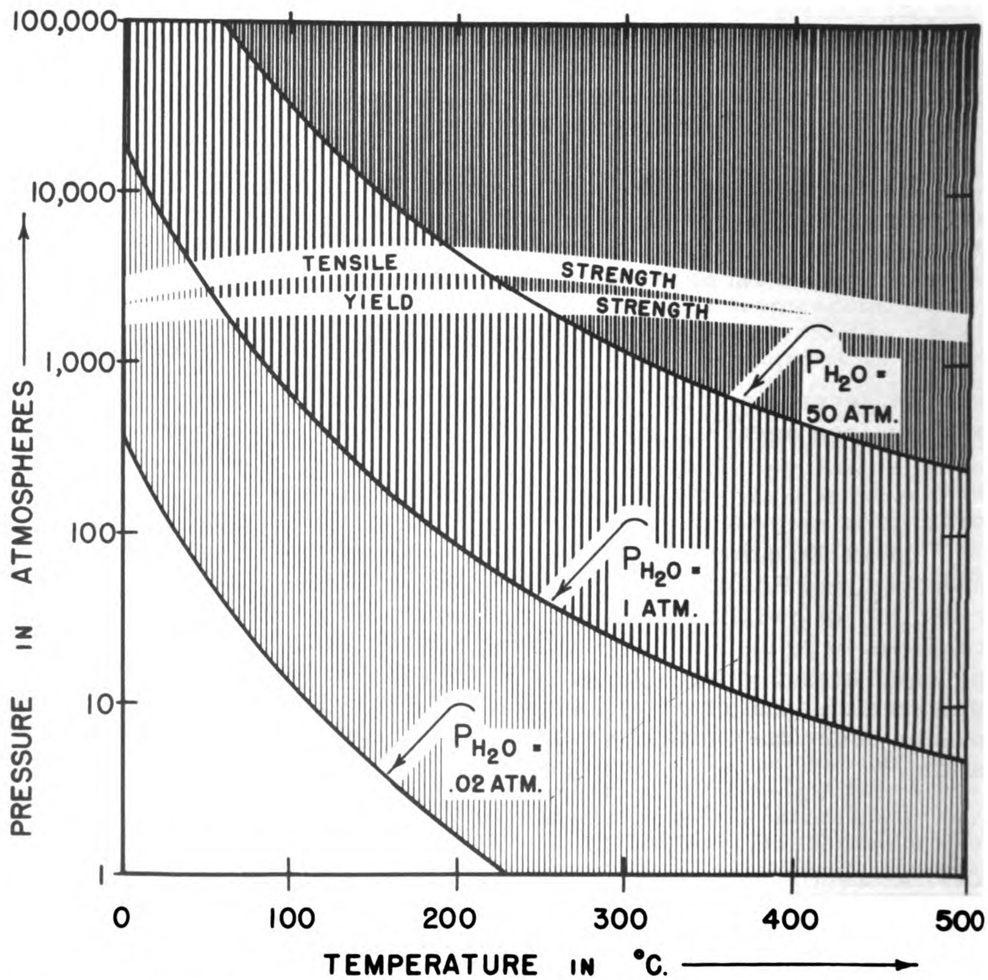

Figure 1. Calculations of "hydrogen potentials" are shown for steam reacting with iron in the steam-boiler range.

the calculations for iron are the lowest of the group, and that the potentials for aluminum and magnesium exceed many millions of pounds per square inch.

While the calculations are not claimed, by any means, to be true to fact, due to a number of important modifying factors, they are nevertheless highly significant from a qualitative standpoint, and they conform directly to metallurgical experience. For example, magnesium and aluminum, whose "hydrogen potentials" are of a vast order, cannot be melted and cast to provide nonporous metal without first removing the hydrogen which the metal absorbs from even slight amounts of moisture present as atmospheric humidity. As for chromium, it lies high above iron on the graph; consequently, in the making of stainless steel, it is important that the ferritic chromium grades be protected from hydrogen pickup on contacting moisture(2). Indeed, it is now becoming common knowledge in iron- and steel-making that the metal must be protected from moisture during melting in order to avoid a number of hydrogen-caused difficulties.

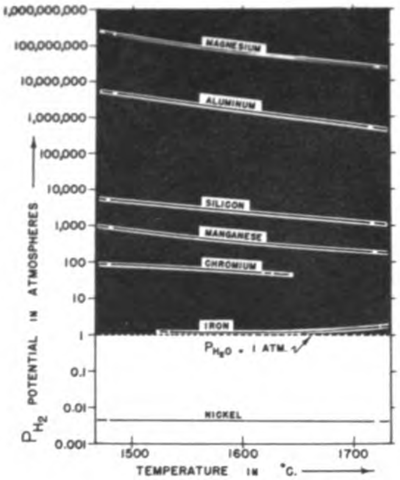

Figure 2. Here are the "hydrogen potentials" for several metals contacting steam at one atm. pressure in the steelmaking temperature range.

For the lower temperature ranges, the information in Figure 1 has been used to explain the serious phenomenon of "boiler embrittlement", which has taken a substantial toll of lives as well as material since the steam boiler was first developed(3). The theory in the current investigation is also extended now to the intermediate temperature ranges where steels are heat-treated to develop their special properties. The surprising results of this research not only sustain the validity of the hydrogen-potential theory but also point to a matter of broad importance in the general handling of iron and steel (4,5).

In this work it was, of course, desirable to have a measure of the extent of hydrogen absorption in steel. Instead of actually analyzing for hydrogen content, however, a special machine(6) was designed which measures the angle of bend that a 1/4" bar will endure before breaking--before and after exposure to hydrogen. In Figure 3, bend data from this machine are plotted for a steel which not only has broad engineering importance, but is specifically designed for service in steam turbines. This

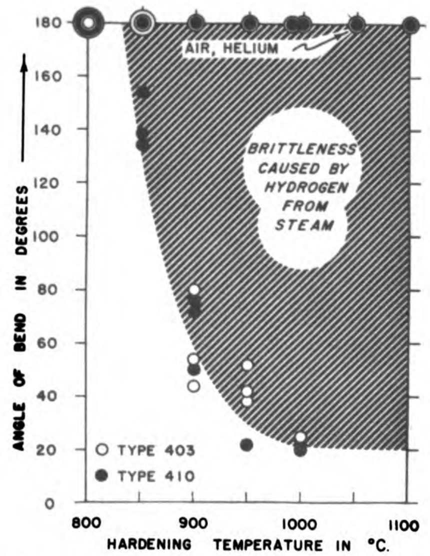

Figure 3. The effect of steam on the bendability of steel.

is the A.I.S.I. Type 403--a slight modification of Type 410, containing 12 percent chromium and approximately 0.10 percent carbon. The graph in Figure 3 shows that both of these grades heated in the temperature range of 800° and 1100°C. and subsequently quenched in oil will sustain a full bend of 180 degrees around a 1/4" pin when the atmosphere in the furnace has been either normal air or carefully dried helium.

In marked contrast, however, when steam is admitted into the furnace atmosphere, both of the steels fracture over the entire hardening range and break at angles as low as 20 degrees.

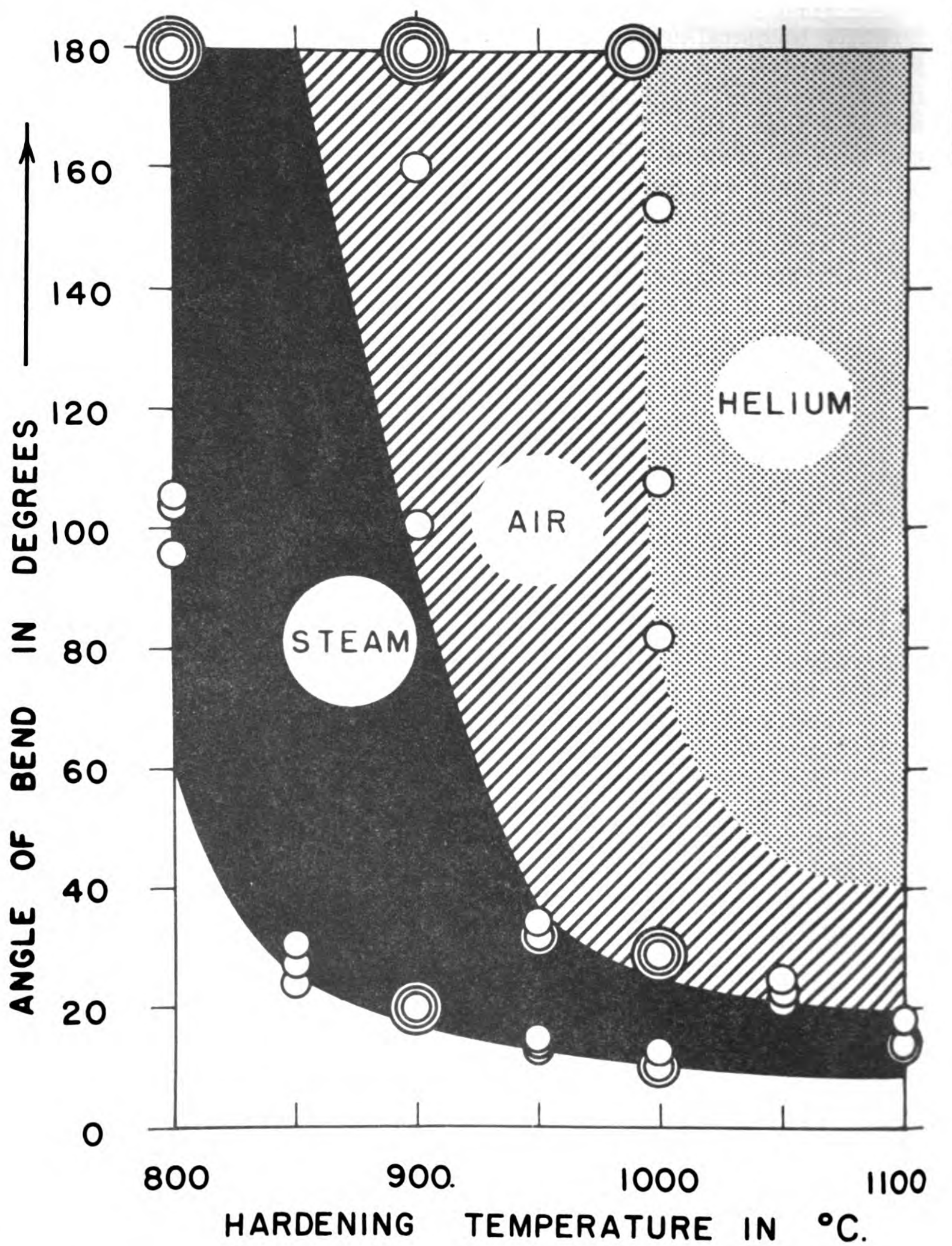

Figure 4. The damaging effect of steam and also of the moisture in normal air is shown on Type 414 stainless steel hardened from different temperatures and different atmospheres.

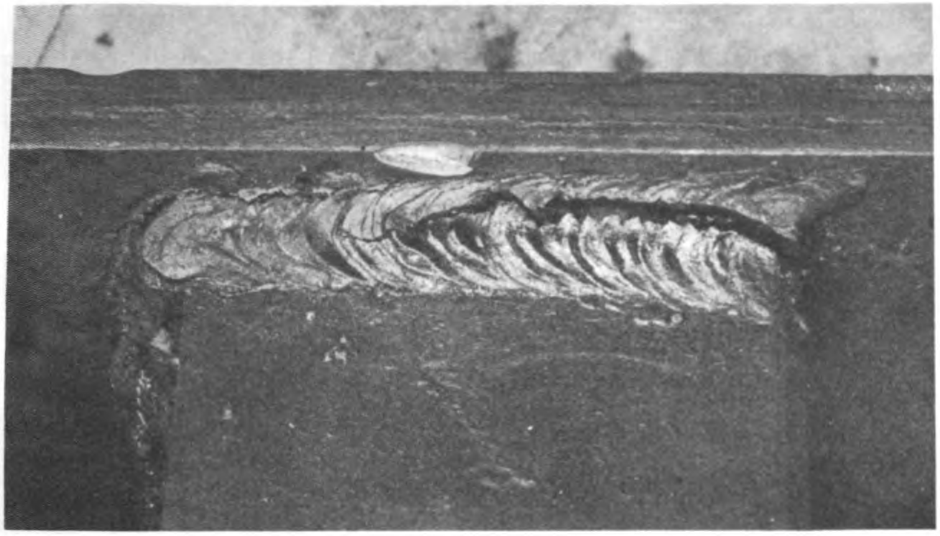

Figure 5. This is a huge steel "H" beam--the type used in battleship construction. The crack shown was initiated at the junction of the weld metal and the basic steel by the hydrogen mechanism which is described in this article.

If we now consider a steel which is more sensitive to the injurious effects of hydrogen, a distinction can be drawn even between normal air and carefully dried helium. Type 414 stainless steel (having approximately the Type 410 composition with 2 percent nickel added) behaves as shown in Figure 4 when hardened over the same temperature range. In carefully dried helium, hardening from 1000°C and above causes some fracture.

However, hardening duplicate specimens by the same method, but from an atmosphere of Baltimore air instead of dried helium, causes fracture to develop at hardening temperatures of only 900°C, and much lower bend angles result. At 1000°C, for example, the bendability has been reduced from a scattered position near 100 degrees down to triplicate fractures at almost exactly 30 degrees. This represents an important injury to the steel, and one that is rarely appreciated.

When steam is added to the furnace atmosphere, this steel fractures after hardening at any temperature, and the bend angles attain extremely low values. The additional damage to bendability caused by the steam is indicated by the blackened area while the damage from moisture in ordinary air is shown by the shaded area. The stippled region for dry helium

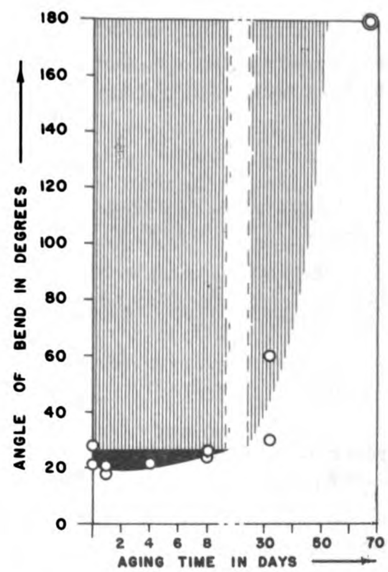

Figure 6. Recovery of Type 410 from embrittlement over an aging period of two months at room temperature indicates an "aging minimum" caused by internal precipitation of the damaging gas.

represents brittleness which is due to inherent features of the steel and for that reason probably cannot be avoided.

Finally, in Figure 6, we turn our attention to the recovery of steel from the embrittlement caused by hydrogen and the metal-steam reaction. The data in Figure 6 show the recovery of a full bend of 180 degrees after a period of two months in which the steel was allowed to age at room temperature. The specimen is the Type 410 stainless steel shown in Figure 3, and it has here been embrittled by hardening in an atmosphere of steam. The shaded area is a measure of the loss in bendability caused by the steam, and the blackened area is an indication that this steel has first become more brittle before recovery set in.

This phenomenon of spontaneous embrittlement, continuing to develop after charging of the metal with hydrogen has ceased, is believed to represent the precipitation of hydrogen atoms, previously dissolved within the atomic lattice of the metal, to form insoluble molecules of H_2 at microscopic imperfections and openings within the structure. The embrittlement itself is the result of the development of pressures of H_2 to values which finally exceed the strength of the steel.

In the specimen of steel shown in Figure 6, then, we have an instance of a certain measure of embrittlement which occurs immediately after hardening of the steel; this is followed by a slight increase in embrittlement as hydrogen atoms continue over an extended period of time to precipitate from the lattice into the voids. When the precipitating action dissipates itself, the brittleness then noticeably decreases as the gas explodes its way from pocket to pocket and diffuses by this means to the surface, where it escapes.

[The author wishes to acknowledge the assistance of M. E. Haslem, F. K. Landgraf, R. L. Phebus, and C. O. Worden, who have contributed to this study during the course of their work in the author's Laboratory.]

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The Protein Problem

by
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St. Luke's Hospital

One of the most complex aspects of human nutrition, and one long under study by ONR investigators, is the problem of protein requirements. Finding out the exact nature of these requirements presents some difficulty in itself and one which will be solved only by further study of the body's complicated mechanism for converting food into tissue. Moreover, once human protein needs are precisely determined, the problem still remains of best utilizing the world's relatively short supply of foods containing these vital substances. The two articles which follow continue the description of ONR studies in this field, first discussed in the September issue in the article "Amino Acids--Body Building Blocks".

In the last decade, despite the blood-letting of World War II, the population of the world has increased by 10 percent. This means that there are now only 1.7 cultivated acres per person--and agronomists estimate that 2.5 acres are needed to sustain a human being properly! Authoritative reports show that only Argentina, Australia, Canada, and the United States have more than the necessary minimum of cultivated land for each inhabitant. The rest of the world, then, must either import food from these reservoirs or go hungry. With their own populations on the increase, however, the four rich areas are not expected to continue to have food surpluses indefinitely.

Many means have been suggested to avoid these impending food shortages. One promising possibility, not yet fully explored, exists in more efficient utilization of available food supplies. This can only be achieved by an adjustment of food consumption to the actual physiological needs of the individual. Furthermore, this sparing of essential nutrients must be based on scientific measurements of the food requirements of man, since an arbitrary reduction in over-all intake is not compatible with the maintenance of the national health. In the light of accepted nutritional concepts, this goal can be achieved only be recognizing the fact that satisfactory nutrition of man and other mammals requires above all, that the right kinds and amount of protein be supplied in the diet.

Proteins, the most complex of Nature's primary body building materials, are composed of chains of 23 small units known as amino acids. They regulate the chemistry of all living cells to such an extent

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Anthony A. Albanese, Chief of Nutritional Research at St. Luke's Hospital in New York City, received his doctorate from Columbia University, where he served from 1933 to 1940 as a research assistant in the Department of Pathology. After a year of research work at the National Institute of Health, Dr. Albanese became Associate in Pediatrics and Research at The Johns Hopkins University. Following this, he served on the teaching staff of New York University as an Assistant (and later an Associate) Professor of Pediatric Biochemistry until he came to St. Luke's in 1949. Dr. Albanese has been the author of many publications on human nutrition.

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that without them life cannot exist. Hair, nails, skin, and muscle tissue consist almost entirely of proteins. They enter into the formation of enzymes, vitamins and the mysterious hormones. Proteins can also serve as a source of fuel for maintaining body temperature--that is, they can replace fats and carbohydrates. But this is a wasteful use because proteins are the most expensive and scarce of the human foodstuffs and should be used in the diet primarily to furnish those constituents which no other food can supply.

How much protein, then, is needed for normal growth of children and maintenance of good health in adults? Strange as it may seem, an exact answer to this most important question can be given for rats, chickens, swine and cows but not for the human, because all of the necessary measurements have not yet been made. The question of protein requirements is essentially a question of amino acid requirements. Not all proteins have the same value in meeting the specific requirements of the human body. In order to understand why this is so, it is only necessary to call attention to the fact (established by many investigators) that Nature has imposed a peculiar limitation on the ability of the animal body to produce 10 of the 23 amino acids which are known to occur in proteins. Each of the many varieties of protein which constitute tissue cells requires for its construction a different but very definite assortment of amino acids. Hence, if a single one of the 10 essential amino acids which the body cannot produce is lacking from the diet, then certain of the tissue proteins, and in turn tissues themselves, cannot be formed, no matter how great the surplus of other amino acids. Consequently, when proteins lacking in one or more of the 10 essential amino acids constitute the sole source of dietary protein, young animals will not grow and adults will lose weight, regardless of the amount eaten. In addition to these general symptoms, certain characteristic tissue changes have been noted in rats fed diets deficient in protein or essential amino acids. Such changes are shown in Table I.

Obviously, then, human protein needs depend primarily on the body's requirement of essential amino acids. And conversely, the nutritional value of any protein food depends on the extent to which it can meet the essential amino acid requirements of man. Thus, it is apparent that rational recommendations for the most effective use of protein supplies cannot be made until accurate and complete information is obtained on human need of the ten nutritionally indispensable amino acids, and their availability in food.

Although pertinent data of the desired exactness is lacking, some useful approximations are already on hand. First among these is the list of Recommended Dietary Allowances issued by the Food and Nutrition Board of the National Research Council which is based on the data available prior to 1948. The daily protein intake recommended by this Board is as follows: Adult male, 70 grams; adult female, 60 grams (an additional 15 grams should be allowed during pregnancy and 40 during nursing); children, 1-3 years, 40 grams; 4-6 years, 50 grams; adolescent girls, 75-80 grams; adolescent boys, 85-100 grams. On a body-weight basis, the requirement of an infant is 1.6 grams of protein per pound of body weight--3.5 times the requirement of the adult.

Recent investigations in several laboratories have yielded information on the specific amino acid needs of man. The results of these

Table I

Pathological Changes in Rats, Caused by

Lack of Protein or Specific Amino Acids

Dietary deficiency	Symptoms*	
	Young animals**	Mature animals
Protein	Anemia Hypoproteinemia Edema	Anemia Hypoproteinemia Edema
Tryptophane	Cataracts Poor dentition Alopecia Gastric hyperplasia	Corneal vascularization Alopecia Testicular atrophy Fetal resorption
Lysine	Anemia Sudden death	Anemia Suppressed estrous cycle
Methionine	Anemia Hypoproteinemia Alopecia Fatty liver and cirrhosis	Anemia Hypoproteinemia Fatty liver and cirrhosis
Phenylalanine	Cataracts	
Histidine	Cataracts	
Arginine		Hypospermia
Isoleucine	Anemia Hypoproteinemia	
Threonine	Edema	
Valine	Locomotor dysfunction	
"Unessential amino acids", e.g., glutamic acid cystine tyrosine, etc.	Poor growth	

*All changes are reversed when diet is supplemented with missing component.

**All deficiencies or any amino acid imbalance causes corneal vascularization (blood-shot eyes) in immature rats.

Table II

Amino Acid Requirements of Young Adults and Infants

Amino Acid	Young Adults				Male Infants	
	Harte and Travers*		Rose		Albanese	
	Amount (Mg/kilo)	Maintenance** pattern	Amount (Mg/kilo)	Maintenance pattern	Amount (Mg/kilo)	Growth pattern
Arginine	17	2.8	0	0	126	4.2
Histidine	7	1.1	0	0	63	2.1
Tryptophane	6	1.0	7	1.0	30	1.0
Phenylalanine	20	3.3	31	4.3	169	5.6
Lysine	11	2.0	23	3.2	170	5.6
Threonine	14	2.3	14	1.9	87	2.9
Valine	16	2.7	23	3.2	161	5.4
Methionine	7	1.1	31	4.3	85	2.8
Leucine	24	4.0	31	4.3	425	14.0
Isoleucine	17	2.8	20	2.8	20	3.0

*Values derived from the investigations of Mitchell et al.

**Growth and maintenance pattern figures obtained by assigning value of unity to tryptophane; in other words, twice as much lysine as tryptophane is required and four times as much leucine.

studies are listed in Table II. It will be noted that the amino acid needs of young adults, as derived from the studies of Dr. Mitchell (and others)[1] employing diets containing all the "essential" and "unessential" amino acids, are less than those reported by Dr. Rose[2] employing highly purified diets providing only eight essential amino acids and a disproportionate number of calories. These studies, both made at the University of Illinois, indicate that the presence in a diet of all 23 amino acids in their naturally occurring form not only decreases the amounts of the "essential" amino acids needed for normal protein balance of the body, but also changes the maintenance pattern. It is obvious from these results that, in order to obtain data of value in finding the best ways to use protein supplies, means must be sought to measure amino acid requirements under the nutritional conditions which prevail in life.

The amino acid requirement values of male infants given in Table II have been derived from ONR-supported studies by the author and his associates. The diets employed contained milk, beef, and wheat proteins which provided all the essential and unessential amino acids and a normal amount and distribution of calories in the form of protein, carbohydrate and fats. Because these diets included nearly all the amino acid patterns which infants are likely to obtain from infant foods in current usage, it is believed that these values have practical as well as fundamental significance.

These results indicate that unsupplemented breast feeding of infants is inadequate beyond the third month of life because of the lack first of methionine and lysine and subsequently of these two amino acids as well as phenylalanine, leucine, valine and threonine. Examination of the amino acid composition of various foods indicates that the nutritional shortcomings of breast feeding can be best corrected by supplements of milk and meat products. When these are scarce, soybean milk may be employed to advantage.

A consideration of the fundamental aspects of these results relates our studies to the physiology of growth. It will be noted that the pattern and quantities of amino acids required by the child for growth are markedly different from the maintenance values of the adult. When adult tissues have been damaged by infection, surgical procedure, or battle trauma, however, their repair depends on the regrowth of particular tissues in the adult organism, and consequently it is apparent the nutritional needs of the convalescent adult will take on the character of those of the infant. Thus, it seems plausible to suggest that the period of convalescence from various diseases will be appreciably shortened when the amino acid requirements for human growth are better understood, and the knowledge applied to the planning of diets for the invalid.

A more remote, yet ever-intriguing aspect of these measurements of nutrient requirements for growth, lies in the fact that they provide an increasing understanding of the factors involved in the formation of tumors. These masses of tissue represent, in their various forms, anarchial growth processes, which seldom proceed as fast as an infant

[1] Harte, R. A. and Travers, J. J., Science 105, 15 (1947)
Bricker, M., Mitchell, H. H., and Kinsman, G. M., Journal of Nutrition 30, 269 (1945)

[2] Rose, W. C., Federation Proceedings 8, 546 (1949)

grows. The study of the effect of amino acids on normal growth may possibly throw some light on such abnormal growth.

To return to our original theme--the development of a program for the best use of protein foods--we find that, as a result of these recent investigations, the amounts of various foods needed to supply the known amino acid requirements can now be calculated. The figures derived from these calculations are useful because they enable us to make judicious recommendations not only on the consumption of scarce animal foods but also, and more important, on the proper supplementations of the incomplete protein foodstuffs. In general, animal proteins, with their content of the dietary essential amino acids, are very effective in supplementing the more plentiful but incomplete vegetable proteins. Wheat proteins for example, are known to be poor in the much-needed lysine, and this deficiency is usually corrected by the addition of small amounts of milk, as in bread. Zein, the chief protein of corn, is lacking in the essential lysine and tryptophane; for this reason corn-derived products require reinforcement with generous amounts of animal foods. The proteins of the navy bean, lima bean, field pea, and lentil are poor sources of the sulfur amino acids, which are required for the formation of hair and nails. This nutritional defect is corrected by processing or mixing these vegetables with animal foods, as in the familiar pork and beans.

In each of these instances (and there are many others) a poor protein food has been nutritionally salvaged by the addition of animal protein. But today, chemists are wondering if the precious animal protein cannot also be spared and the deficient foods reinforced with synthetic amino acids. Experience with methionine-supplemented soybean, cottonseed, and peanut meal for animal feeds indicates that this practice is nutritionally and economically sound. Experiments with lysine-reinforced grain feeds for farm animals have yielded encouraging results and the practice may soon be adopted on a commercial scale. Can these procedures be applied to human foods? The answer is yes, once a working knowledge has been secured of the amino acid requirements of the human at all ages from infancy to senescence.

Moreover, once the cost of the synthetic amino acids is reduced, they can also be employed in the extension of the value of animal proteins. Analytical data have shown that the food value of our most complete foods could be doubled or even trebled by the addition of small amounts of one or two amino acids. Such a program would greatly extend the world's food resources and improve the health of its population.

Dr. Tuve Receives Franklin Institute Medal

Dr. Merle A. Tuve is the most recent name to be added to the long list of ONR contractors who have received awards for outstanding work. In recognition of his leadership in developing a workable proximity fuse, Dr. Tuve was awarded the Franklin Institute Howard A. Potts medal for 1950 at a presentation made in Philadelphia on October 15. Dr. Tuve is Director of the Department of Terrestrial Magnetism at the Carnegie Institution of Washington, where he is presently conducting ONR-sponsored research on the earth's crust.

Protein Hydrolysates - Food for the Sick

by

P. R. Cannon, L. E. Frazier and R. H. Hughes
University of Chicago

One of the significant nutritional advances of the past decade has been the development of protein hydrolysates for intravenous administration. These substances are protein which have been hydrolyzed in the laboratory into amino acids--a process which usually takes place in the body. The amino acids can be directly injected into the blood stream, and the patient can consequently receive the food value of protein foods without having to digest them. Because of the availability and relatively low cost of these hydrolysates it is no longer necessary for patients who are unable to take food by mouth to continue to lose tissue protein because of a lack of dietary nitrogen. It is now possible, by means of parenteral feeding with protein hydrolysates, glucose, and vitamins, to minimize tissue wastage with its attendant loss of muscle strength and physiologic impairment.

The therapeutic use of the hydrolysates, however, has brought with it a need for better bioassay methods for their nutritive evaluation. Otherwise, some of them (particularly those which have been hydrolysed with acid) may be used in the treatment of sick patients without assurance that they are providing a complete assortment, and in proper amounts, of all the essential amino acids. Moreover, because these hydrolysates are now usually dispensed in glucose solution, the possibility arises that, during sterilization, the so-called amino-acid-sugar reaction of Maillard may lead to the formation of certain compounds that resist the body's enzyme activity and that, in consequence, certain essential amino acids may not be readily available.

In previous reports we and others (1, 2, 3, 4) have emphasized the usefulness of the protein-depleted rat for the bioassay of dietary protein. We have called this procedure the Rat-Repletion Method and have employed it extensively. In this method adult male albino rats weighing

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Paul R. Cannon (A.B. James Millikin, Ph.D. Chicago, M. D. Rush) is Chairman of the Pathology Department at the University of Chicago. A member of the Food and Nutrition Board of the National Research Council, Dr. Cannon has been especially interested in studies of protein metabolism. In addition to his research and teaching duties he serves as Associate Editor of the Journal of Immunology and the American Journal of Pathology. He is a recipient of the Ward Burdick Award of the American Society of Clinical Pathology and the William Gerhard medal from the Philadelphia Pathological Society.

Lawrence E. Frazier (B. A. University of Oregon, M. S. University of Chicago) is an Assistant to Dr. Cannon in the Department of Pathology. He has taught in high schools and at the University of Oregon.

Randolph H. Hughes is a laboratory technician assisting in this work.

approximately 200 grams are fed a "depletion" diet (adequate in all dietary essentials except protein) until they have lost approximately 25 percent of their initial weights. This loss mainly represents a diminution in muscle mass; however, there is also a decrease in plasma proteins, hemoglobin, enzyme systems, and other tissue proteins. When animals depleted in such a way are fed a "repletion" ration containing a high-quality protein, they quickly rebuild their depleted tissues and recover weight and strength. The daily repletion ration, in a fixed amount of 15 grams per day, supplies an ample intake of calories (48 per day), 1.35 grams of protein, and the necessary vitamins, salts and roughage. If the protein being evaluated contains all the essential amino acids in proper proportions and amounts, a depleted rat will make a weight gain of 50-55 grams in 10 days. If, on the contrary, one or more essential amino acids are present in the test protein in low amounts, weight recovery will be reduced. It was found in these studies that when a mixture of synthetic crystalline and purified amino acids is substituted for the protein in the repletion ration the depleted rat utilizes the amino acids for tissue protein synthesis almost as effectively as he utilizes native protein.

More recently we have been concerned with the problem of the nutritive evaluation of amino acid solutions and protein hydrolysates which are (or may be) used for intravenous feeding. In this work we have used the Rat-Repletion Method, by supplying in drinking fountains all dietary nitrogen in a five percent solution of amino acids or protein hydrolysate. All the non-protein constituents of the diet are taken in a specially compounded solid ration. Under such conditions the depleted rat will drink the equivalent of 1.35 grams of protein (35 ml per day), eat the synthetic ration completely, and make a weight gain of from 40-50 grams in ten days. However, if any one of nine essential amino acids is omitted from the solution, the animal will quickly stop drinking, reduce his daily food intake, and fail to gain weight. Moreover, if any one essential amino acid is present in the test solution in a reduced amount, the weight gain will be correspondingly restricted. Conversely, if a good protein hydrolysate is supplied, its total consumption is accompanied by the total ingestion of the basal ration and an excellent weight recovery.

The experiments to be described will illustrate the problem of evaluating protein hydrolysates marketed for intravenous use. Three of them (Amigen, Aminosol, and Hydrolysate, Baxter's)[1] were bought as five percent solutions in five percent glucose solution; the fourth, Parenamine, was bought as a six percent solution without glucose. Glucose was added to the latter, therefore, to five percent concentration, and 29 ml of the hydrolysate were given per day instead of the usual 35 ml. All solutions were adjusted to a pH of 7.0.

Because the rats were in a poor nutritive state at the end of the depletion period, they were supplied for three days with the synthetic basal ration supplemented by an amino acid solution (Solution A) containing 14 crystalline and purified amino acids. This was done both to accustom the animals to drinking from the fountains and to give them a "boost" in tissue regeneration before they were shifted to the test

[1]Names of products are mentioned here only because the materials were purchased on the open market and were intended for medical use.

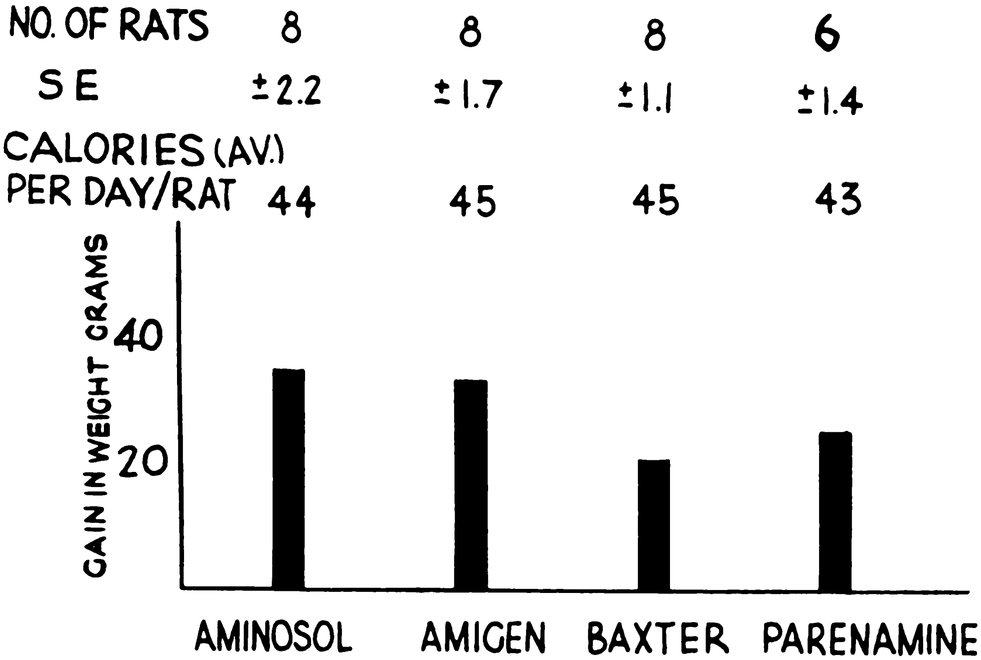

Chart 1. Average weight recovery made in ten days by four groups of protein-depleted rats each of which was fed one of the four protein hydrolysates described

solutions. This procedure was followed in case the animals should be so repelled by the bad taste or odor of a protein hydrolysate that they would at first refuse to drink it. Practically every rat accepted the amino acid solution promptly. It was thus possible to compare the nutritive potentialities of the hydrolysates in the animals during the ensuing seven or more days. The summarized findings are shown in the following four charts.

Chart 1 demonstrates the results obtained in groups of protein-depleted rats fed the four protein hydrolysates for a repletion period of ten days. Prior to this all of the animals drank the amino acid solution completely for three days, ate their basal rations well and made an average weight recovery of approximately 20 grams per rat. Having demonstrated their willingness to drink the amino acid solution, they were shifted to the test solutions. All continued to drink the solutions and to eat their rations almost completely. They also made substantial weight recoveries, as shown by the bar graphs representing the averaged results of weight recovery for the ten days.

Not all the animals gained the same amount of weight, however. The eight rats who took the Aminosol solution in ten days made average weight recoveries of 35 grams each, while those drinking the Amigen solution averaged a gain of 33 grams. Since the daily caloric intakes were essentially identical, it is obvious that these two solutions exhibited excellent nutritive properties and that there was no serious amino acid shortage in either of them.

The performance of the other two hydrolysates, however, was less effective. The eight rats given the Baxter's Hydrolysate consumed all of the solution each day and ate the basal ration well; nevertheless, the

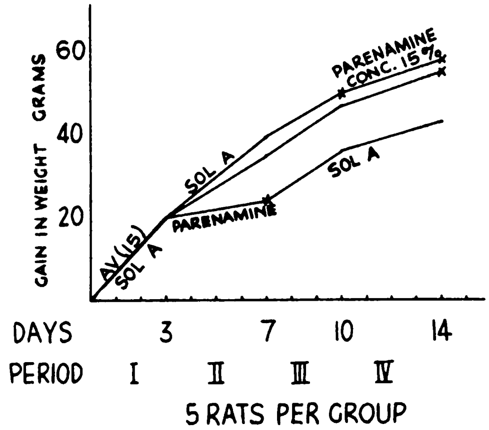

Chart 2. Comparative average weight gains made in 14 days by protein-depleted rats fed Parenamine or Solution A

average weight recovery was only 21 grams each. In the case of the six rats drinking the Parenamine solution, weight recovery for the ten days was 24 grams per rat, although more than 90 percent of the solution was accepted and consumption of the basal ration was good. These results are to be compared with those obtained with five rats who drank only Solution A. Although they consumed all of it each day, and ate their basal rations completely, they averaged a weight recovery of 26 grams per rat. It is obvious from these findings that Baxter's Hydrolysate, Parenamine and Solution A were all inferior nutritively in their capacity to regenerate tissue protein. The problem was to ascertain the reasons for this inferiority. As a matter of fact, it is not surprising that Solution A should have been imperfect, made up as it is of synthetic amino acids, and lacking in some constituents present in native protein. But why should an acid hydrolysate of casein (Parenamine) or an enzymatic hydrolysate of beef plasma

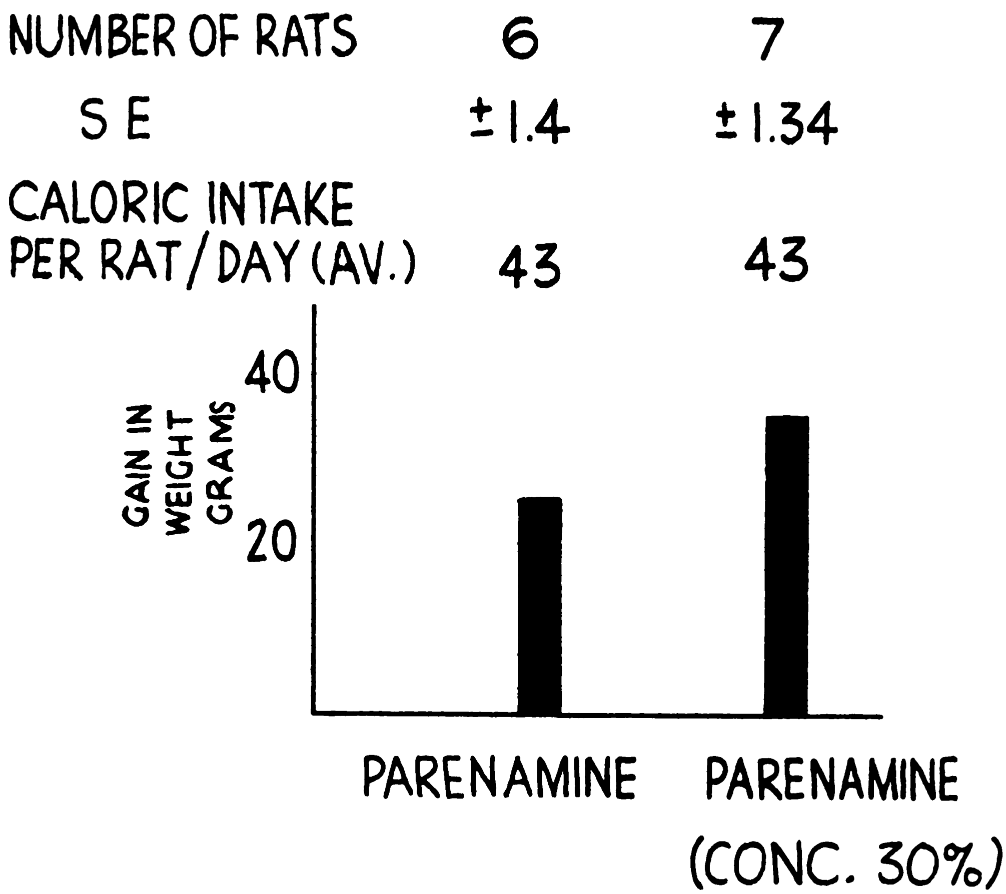

Chart 3. Comparison of average weight gains made in ten days by protein-depleted rats fed Parenamine before and after concentration

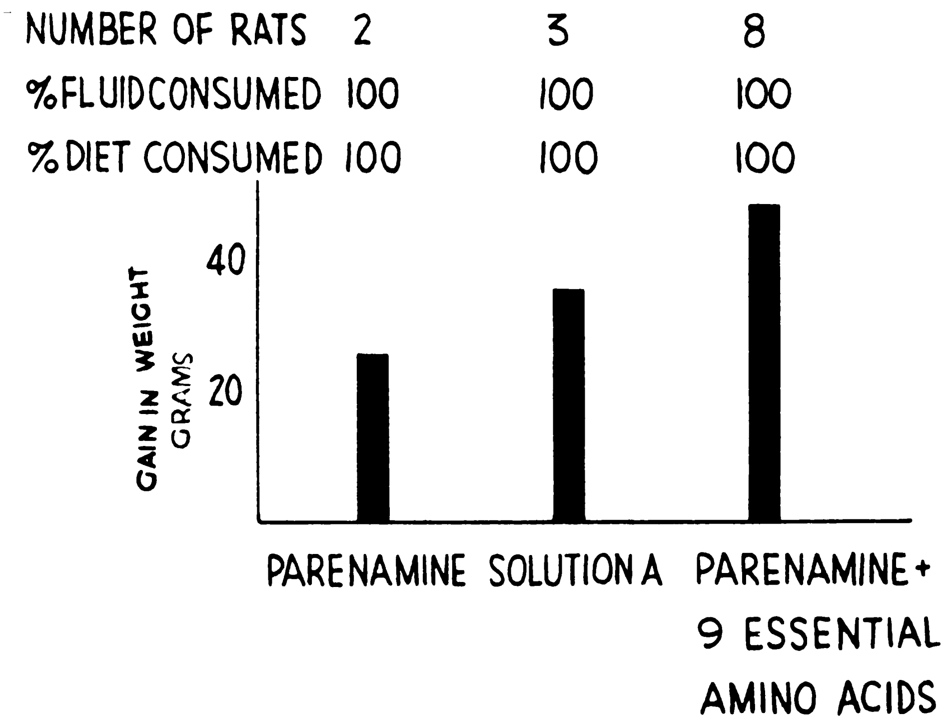

Chart 4. Average weight gains of protein-depleted rats fed for ten days on diets of ordinary Parenamine, Solution A, or enriched Parenamine

(Baxter's) have reacted less effectively than the hydrolysates of casein (Amigen) and fibrin (Aminosol)?

In the case of Parenamine it would not have been surprising if its bad taste and odor had prevented its uniform acceptance. But in these experiments this was not the case, and it was therefore necessary to consider the possibility that a deficiency of one or more essential amino acids restricted its nutritive value. This possibility was explored in 14-day experiments recorded in Chart 2, in which 15 protein-depleted rats, in groups of five, were given Solution A for three days. During this time all the animals responded well and gained approximately 20 grams each. The rats in two of the groups were continued on Solution A and continued steadily to recover lost weight. Those in the third group, however, when shifted to Parenamine solution for four days, evidenced a definite retardation of weight gain. When they were again given Solution A, the tempo of weight recovery accelerated. On the other hand, the animals in one of the groups supplied with Solution A for ten days, were then given a solution of Parenamine which had been concentrated in vacuo to 85 percent of the original volume; these rats did as well as those in the group receiving Solution A for the entire fourteen days. Evidently, concentration of Parenamine, although increasing its bad odor and taste, had also concentrated certain nutrients, thereby improving its nutritive potentiality.

In order to test this effect more precisely, Parenamine was concentrated to 70 percent of its original volume and was compared with Parenamine of original strength (Chart 3); both concentrations were given in equal volumes of 29 ml per rat per day. The depleted rats drank the concentrated Parenamine avidly and made weight gains equal to those of the rats drinking Amigen and Aminosol (Chart 1)--an average of 35 grams each in ten days. It is obvious, therefore, that the original Parenamine solution did not have a complete quota of essential amino acids but that concentration gave it a considerably improved nutritive potentiality. These results suggest, therefore, that after acid hydrolysis, with its attendant loss of tryptophane and perhaps other essential amino acids, reconstitution with essential amino acids was not complete. To illustrate this point further (Chart 4), depleted rats were given Parenamine solution to which had been added nine essential amino acids. These animals accepted both the hydrolysate and the basal ration completely and made weight recoveries superior to those induced by any of the hydrolysate solutions (48 grams per rat in ten days). This is obviously due to the fact that each rat received more amino acids per unit volume of fluid. The important fact is, however, that the addition of only essential amino acids made a fair hydrolysate into one of high nutritive potentiality.

The problem with respect to the enzymatic hydrolysate of beef plasma (Baxter's Hydrolysate) is different. This solution was yellowish brown, suggesting the possibility that in its preparation or sterilization the amino-acid-sugar reaction might have impaired its nutritive potentiality. Evidence supporting this supposition was later given when we tested another sample of this product which contained no glucose. Protein-depleted rats thrived on this solution and made an average weight gain in ten days of 35 grams, which equalled the performance of those drinking Amigen or Aminosol.

It is clear from these experiments that protein hydrolysates may vary considerably in their nutritive value. It also seems clear that a principal cause of the impairment of these substances is the method of their preparation; apparently injury to certain amino acids, either as a result of acid hydrolysis or because of a combination of amino acids with reducing sugar, considerably lessens their value. It should be emphasized, however, that these findings pertain only to particular samples tested, and that processing improvements may soon be forthcoming which will eliminate the cause of nutritive impairment. Fortunately the experiments showed that damage to the hydrolysates can definitely be prevented, now that its causes are more clearly understood. Consequently we can hope for valuable improvements in these substances which are so important in providing for the dietary requirements of patients who are unable to get proper food by ordinary means.

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On the Naval Research Reserve

Dr. Sawyer Selected for USNR Captaincy

Dr. Ralph A. Sawyer, Dean of the Horace H. Rackham School of Graduate Studies at the University of Michigan, has been selected for the rank of Captain in the United States Naval Reserve. Dr. Sawyer, a member of VNRRU 9-3, was Technical Director of the A-Bomb tests carried out at Bikini and is now an advisor of the Naval Ordnance Test Station at Inyokern. During World War II he served as a Commander at the Naval Proving Ground.

Keysort System to be Used by VNRR for Selection of Personnel

Very soon, the Volunteer Research Reserve will be "in there punching" but perhaps you should read the rest of this article before looking for your sea chest.

The punching will be done literally in an effort to put the bewildering array of qualifications of Research Reserve personnel to the best use of the Naval Establishment, by means of modern personnel record systems. With the approval of CDR Albert B. Cook, Director, Naval Research Reserve, and Cdr. E. L. Edmondson, Training Officer of the ONR Washington Office, Unit 8-2 of Baton Rouge, Louisiana, undertook the preparation of a punched card filing system for the Research Reserve. After the preliminary reports were ready, LTJG H. B. Williams and LTJG O. A. Nance, CO and member of VNRR Unit 8-2, took training duty in the headquarters office in order to plan for the installation of the system. While they were there, LCDR G. H. Ayres of Unit 8-5 joined the "Task Force" with material benefits to the final scheme.

The "Keysort" system makes use of a file card around whose margin holes may be punched to code the required information. An operator equipped with a sorting machine (or merely a handful of knitting needles!) may then rapidly select the card of any desired officer in a minimum amount of time. Selections may be made on the basis of civilian experience, biographical data, geographical location, and a number of other pertinent items. The card also is coded to indicate the member's mobilization assignment and the time after mobilization day at which he may be expected to report for duty.

According to the present plans, cards and instructions will be distributed to members of VNRR Units through their CO's. After the required information has been entered on the face of the cards, they will be returned to the Program Officers. Volunteering units will then slot the cards according to the coding system and Units will maintain files for the officers under their command. Code 230 will enter the mobilization data and use the filing system to keep abreast of the changing needs of the Naval Service.

Radiological Defense Seminar to be Held at Oak Ridge for Research Reserve Members

A fourteen-day seminar, consisting of lectures, field trips and problems on radiological defense, is scheduled to be held at Oak Ridge, Tennessee from 29 November to 12 December. Only officers who are members of Research Reserve Units are eligible for this active duty training. Prior to issuance of orders approval should be obtained from the Office of Naval Research. The quotas for the various Naval Districts are as follows:

District	Quota
1	5
3	5
4	5
5	3
6	20
8	5
9	17
PRNC	5

Officers selected must report prior to 0900, 29 November 1950 to the Representative of the Inspector-Instructor, Knoxville, who will be located at Claremont Hall, Oak Ridge. No government quarters are available.

Courses in Malariology and Mosquito Control Offered as Training Duty

A varied program of courses in malariology and mosquito control is offered at the Naval Air Station, Jacksonville, Fla. for Naval Reserve entomologists and malariology technicians. These courses, which occupy a period of two weeks, are opened on the first and third Wednesdays of each month, and may be taken by research reservists as their annual training duty.

Since those who report for this duty represent a variety of experience and educational backgrounds, it has been necessary to plan a diversified program of activities. The following studies are included:

1) Relation of insect vectors to diseases of military importance
2) Methods of insect control
3) Participation in routine and special tests (i.e., evaluation of dispersal equipment and/or insecticides)
4) Administration and operation of Navy insect and pest control unit
5) Toxicity, chemical characteristics and uses of most common insecticides
6) Review of pertinent literature in the field of prevention of insect and rodent problems

CIVIL DEFENSE I

Minnesota's Short Course on Civil Defense Covers Many Aspects of Problems Involved

Many vital problems involved in the wartime defense of this country's civilian population were discussed during the one-day course recently conducted by VNRRU 9-6 at the University of Minnesota. for about 150 members of the State's civil defense organization. The course was arranged for Col. E. B. Miller, Head of the latter group, by LCDR Joseph A. Wise, Commanding Officer of 9-6.

The meeting was opened by Col. Miller who briefly reviewed the history of the present civil defense program. He emphasized that the Hopley report, which forms the present basis for the civil defense organization, was published in 1948 but that there had been a delay in executing its recommendations. Col. Miller then went on to describe the defense organization in Minnesota, which has already established air-spotter services. Further development of civil defense and disaster relief now becomes a matter of local responsibility according to Colonel Miller, who urged those in attendance to return to their communities and begin work toward that end.

The next speaker, Professor J. O. Christianson, Superintendent of the School of Agriculture at the University of Minnesota, emphasized the obligations of good citizenship in helping our own communities to prepare, and in assisting neighboring communities in defense against enemy attack. Professor Christianson described the recent floods in Minnesota, in which communities prepared for disaster had been able to help themselves materially and had received aid from others equally foresighted. A film, "Your Army in Disaster Relief", was then shown. This film is a graphic record of the role played by the Army in three emergencies--the Texas City disaster, last winter's snows, and the Spring floods in Minnesota.

Mr. Horace L. Sprague, Coordinator of Civil Defense for the American National Red Cross, discussed the role of the Red Cross in civil defense. He emphasized that the Red Cross would assist in those services for which it was prepared but that each community would have to shoulder a large share of the work in case of disaster.

After lunch LCDR Wise spoke on the effects of shock and blast and fire attacks on structures. In a discussion of the general matter of shock waves, he used a blast tube to illustrate the fact that such a wave has a steep rise in pressure in its front, followed by a constant decrease in pressure. To demonstrate the effects, a sheet of glass near the end wall of the tube was shattered by the suction phase of the shock wave. LCDR Wise then discussed the various types of high explosive bombs which are used in modern warfare. The aerial burst utilizing a proximity fuse damages light structures over a large area. Instantaneous-fusing bombs, on the other hand, are used on collections of vehicles or personnel, or against highways, railroads or airport landing strips, to produce large surface damage. Delayed action fuses are used with bombs intended to penetrate into structures or into the ground and to burst there. These would be employed, for example, against modern steel or reinforced concrete structures or against industrial plants with heavy machinery. The use of incendiary bombs in an air raid was also discussed. The effects of these various types of bombs were illustrated on the model of downtown Minneapolis, shown on this month's cover. Explosions were simulated by the detonation of N. 6 blasting caps. One such cap was placed inside a small metal bomb shown suspended over the model city. Another cap was placed just below the surface of a parking lot. The photograph at the right shows the explosion that resulted when this cap was detonated. Other explosions occurred within buildings and underground. Finally, an incendiary attack was simulated by igniting small wads of cotton saturated with petroleum ether and dropping them upon the target. The resulting fire was then extinguished by a CO_2 tube fire extinguisher.

Professor Paul M. Berry, Professor of Sociology at Macalaster College, discussed mob psychology, mass hysteria, rumors, and misinformation. He cited particularly the studies made after the Orson Welles episode a few years ago to show that the people need to be educated to form sound critical judgments of information.

A panel discussion of atomic bombing was the next item on the program. Professor C. L. Critchfield, Professor of Physics at the University of Minnesota, discussed the general nature of atomic energy, fission and chain reactions. He described the nature of shock blasts and radiation from an atomic explosion and gave some demonstrations of the use of geiger counters, ionization chambers and dosimeters. Dr. Asher A. White, a physician from Minneapolis who was an official observer at the Bikini tests, then discussed the physiological effects of atomic bombing. His talk was illustrated with some slides taken in Japan illustrating the nature of burns, trauma, and radiation effects on human beings. Lt. Paul M. Wilson, U. S. Army Reserve, a member of the Army Reserve Control Group and also the Technical Services Division of Minnesota Mining and Mfg. Co., discussed the civil defense problems of atomic attack and described the measures which could be taken to minimize the effects and to save the injured. These talks were followed by an open forum in which many of the audience asked questions and discussed the topics of the day.

After a dinner at the Nicollet Hotel, two movies were shown to the group. The first was, "Able and Baker Day Tests at Bikini", and the second was "Medical Aspects of Atomic Bombing". The latter is an excellent presentation produced by the Army.

Members of VNRRU 9-6 contributed by assisting in the planning of the meeting, in making models, in registration and guidance of visitors, and in the preparation of a number of mimeographed summaries of some of the topics under discussion. They were assisted by members of the 5007th Research Development Group, US Army Reserve (Lt. Col. W. T. Blake, Commanding) and by Flight F, US Air Force Research Reserve (Lt. A. E. Tillisch, Commanding).

The short course received a great deal of publicity in local newspapers and, in addition, the proceedings were broadcast from transcription over radio station KUOM. Colonel Miller expressed his gratification at the result obtained and indicated a desire for further cooperation in future short courses.

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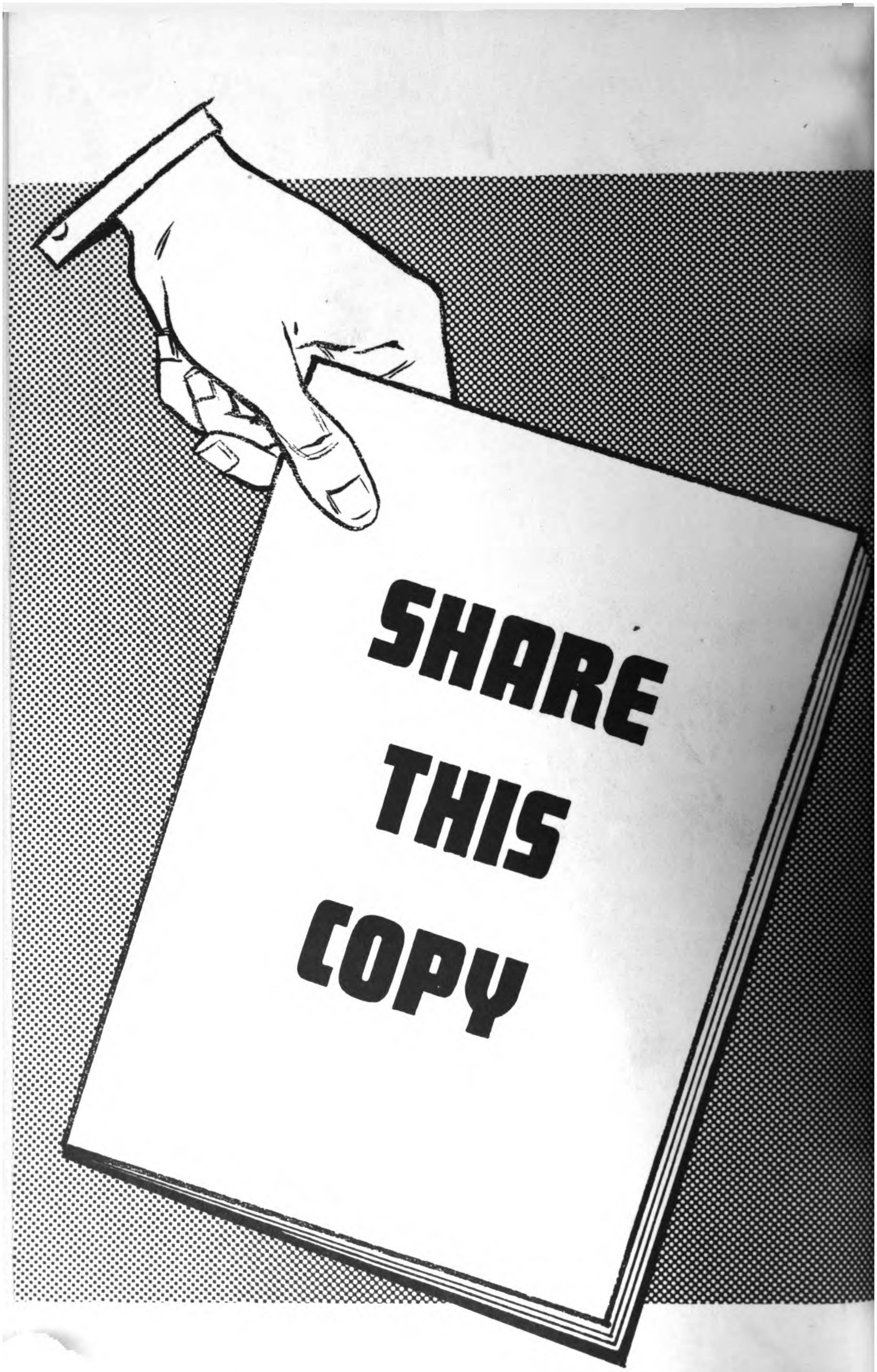
Model City
Blows Up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