SCIENCE

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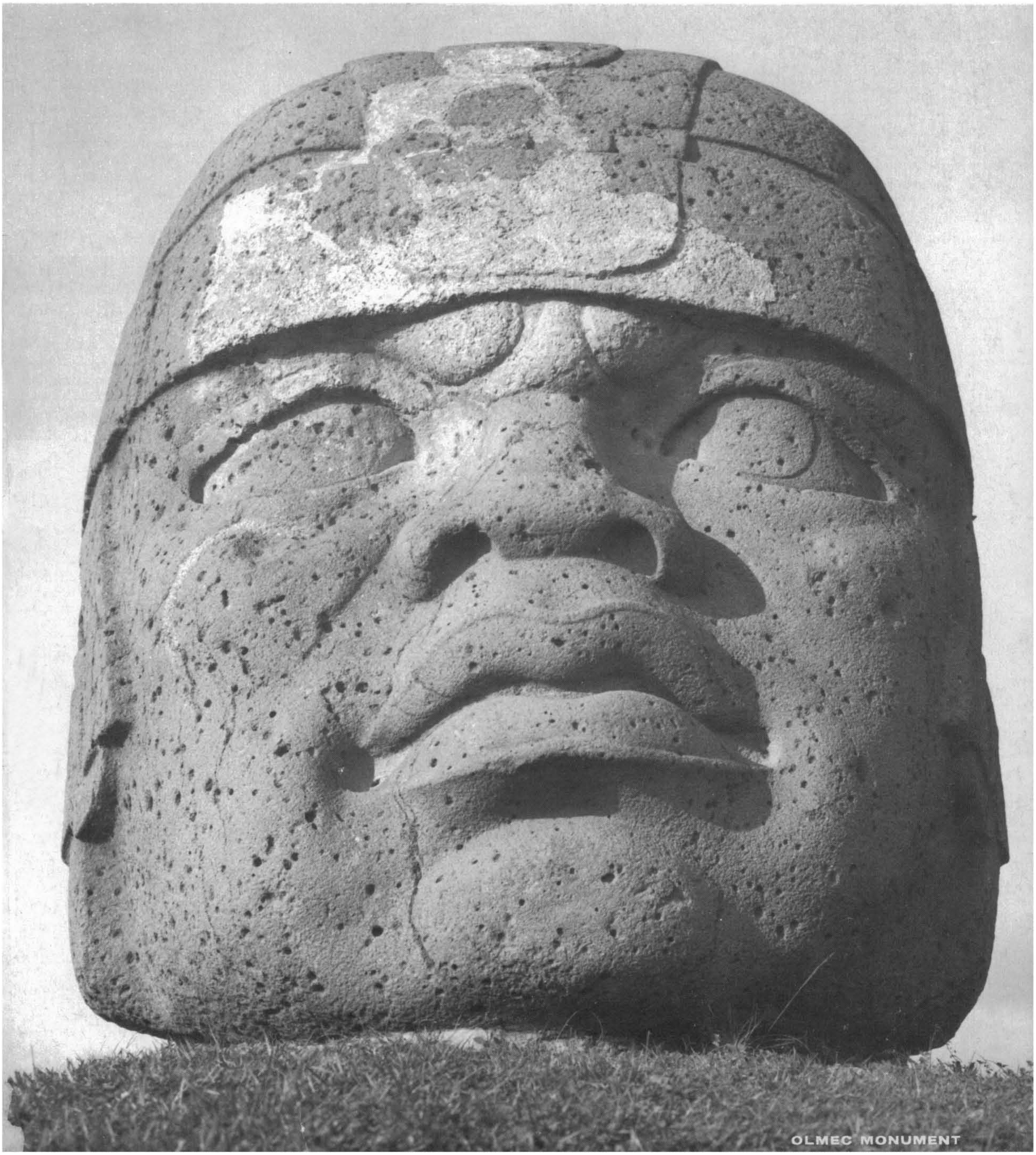
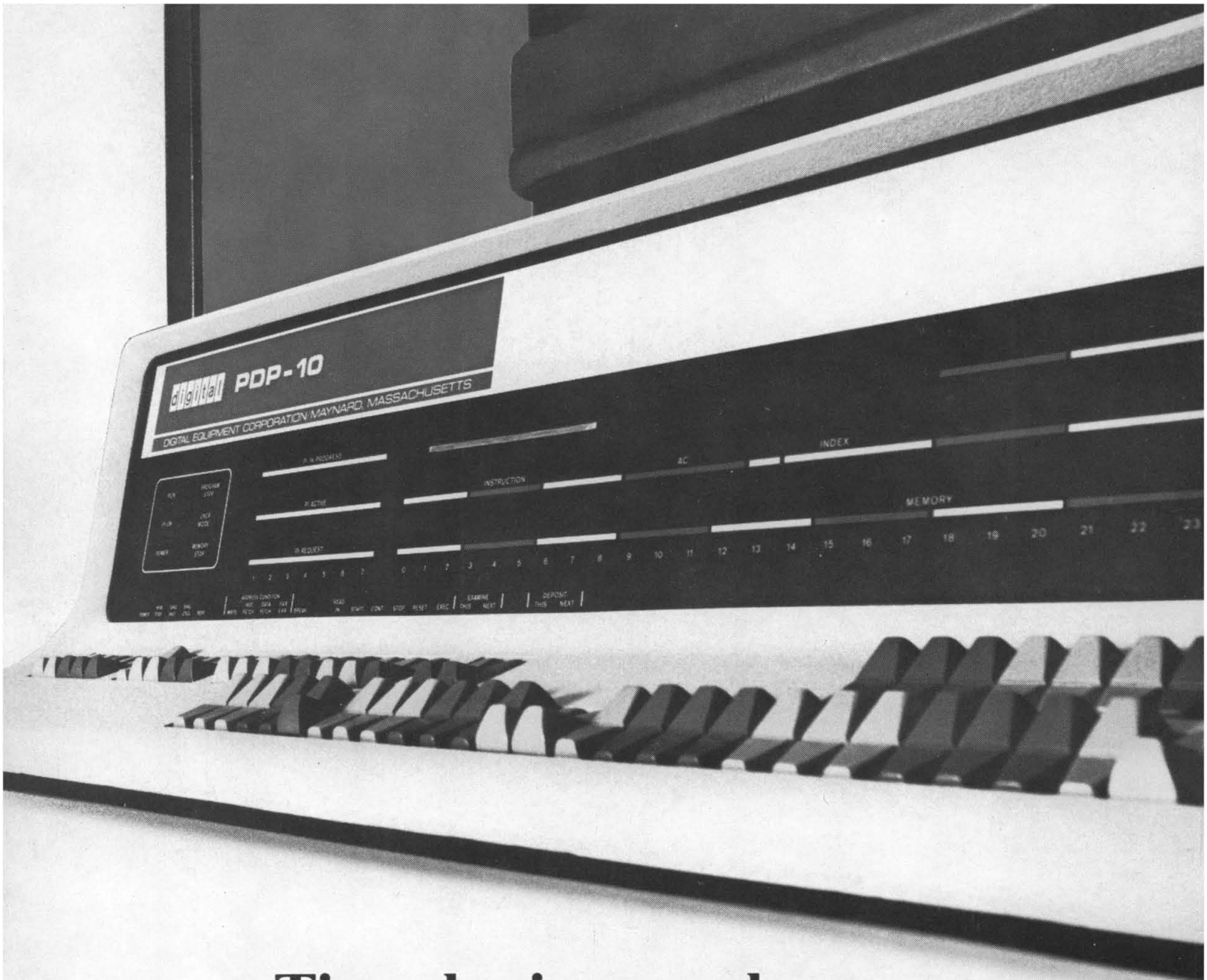
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE





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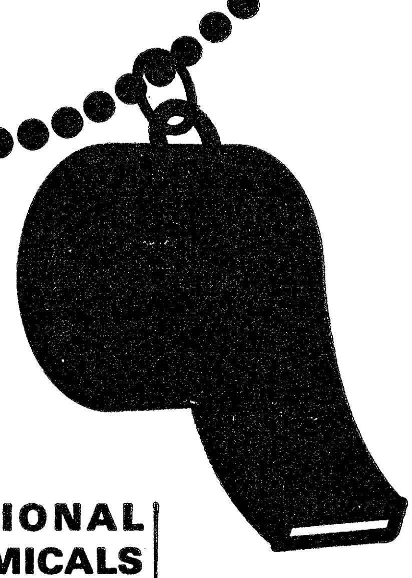

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

Monument 1, San Lorenzo (from the San Lorenzo Tenochtitlan group, Veracruz, Mexico). This Olmec head was carved from basalt between 1200 and 900 B.C. It is believed to be a portrait of an Olmec lord and is one of twelve colossal heads now known from the Olmec area. (Height, 2.85 meters.) See page 1399.

RECENT
FINDINGS

RESEARCH LABORATORIES

Advances in thermionic emission microscopy and the study of high temperature reactions

Transmission electron microscopy is a conventional method for studying materials (both metallic and non-metallic) on a microscopic scale. However, this technique has a number of inherent disadvantages to it, especially in the study of high temperature reactions. These include the need to use extremely thin specimens (in the order of 1000Å), the difficulties involved in heating and measuring the temperature of such a specimen, and the contamination problems caused by the poor operating vacuums (about 10^{-5} torr at best) associated with such instruments.

Therefore, in order to study reactions which occur at high temperatures another form of electron microscopy, thermionic emission microscopy, must be utilized. This form of electron microscopy differs from the more conventional transmission electron microscopy in that the specimen itself is the source of electrons. These electrons, once emitted from the material being studied, are focussed in a suitable lens system and projected onto a fluorescent screen, yielding a metallographic image, as can be seen in Figure 1.

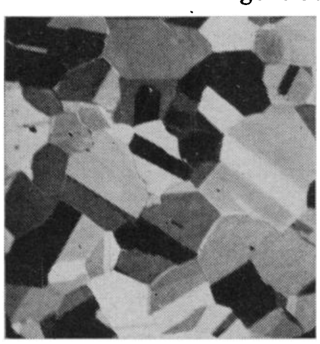


Fig. 1. Thermionic emission micrograph of an iron —0.305% carbon alloy taken at 800°C. Magnification 660X.

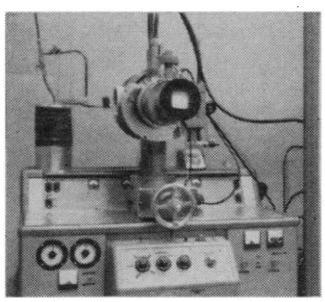


Fig. 2. View of the thermionic emission microscope. Console contains the microscope chamber, vacuum system, lens power supplies and the high voltage power supply.

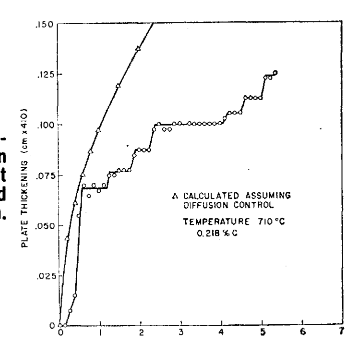
While the thermionic emission microscope is the oldest form of electron microscopy, it was one of the least developed forms and the instruments associated with it had severe deficiencies. In order to eliminate the mechanical problems associated with this instrument, the scientists at Ford Motor Company's Scientific Research Staff designed and built a new thermionic emission microscope. This instrument has electron-optical lenses, a combination electrostatic-electromagnetic objective lens and a magnetic projector lens. It is capable of magnifications of from 78 to 6000 diameters with a resolution in the order of 300Å over the entire magnification range, and can be used to study reactions in the temperature range of from 450°C to 2300°C.

There are a number of important and novel features associated with this microscope. The vacuum system has an ion-getter type of high vacuum pump and is capable of operating at 10^{-8} torr with the specimen at room temperature and at 10^{-7} torr with the specimen at 1600°C. Also available is a temperature measurement and control system capable of measuring specimen temperature to better than ±5°C. The specimen at a potential of 50 KV required designing a system which is floating and isolated at this voltage. Specimen movement is controlled electronically and a measuring system devised so that the exact area of the specimen which is being viewed on the microscope can be determined. Figure 2 is a photograph of this microscope.

With an instrument of this kind, it is possible to study the reaction kinetics of phenomena which occur at temperatures above 450°C. These include such reactions as phase transformations in metallic and non-metallic systems, recrystallization and grain growth, diffusion studies, sintering mechanisms in metal or ceramic compacts, solidification of metals, segregation, and creep. From surfaces, it can also do fundamental studies of electron emission.

One such study being made with the thermionic emission microscope is the thickening kinetics of ferrite sideplates in iron-carbon alloys. Preliminary results indicate that these plates of body centered cubic iron form in a discontinuous manner from the face centered cubic parent phase as is shown in Figure 3. It can also be seen that growth kinetics are much less than assumed diffusion control. These results indicate that ledge mechanisms of plate thickening may be operative in this reaction. Studies such as these should lead to a better understanding of the mechanism of the allotropic transformation in steel and should eventually lead to production of better alloys.

Fig. 3. Plot of ferrite sideplate thickening as a function of time for an iron —0.218% carbon alloy transformed at 710°C. The smooth curve is calculated assuming a diffusion controlled reaction.



PROBING DEEPER FOR BETTER IDEAS

He doesn't seem to grasp its deserved place in the general scheme of things. As an amanuensis-grade technical editor who has jousted with a few outstanding jargoneers during his career, I know that science needs jargon. Without it, everyone—even I—would understand science. This would be calamitous. Consider the consequences if the most elaborate scientific abstractions were perfectly clear to every man, woman, or child. Jargon gives us something to live for, to impress upon our friends and colleagues, and to deploy in undermining our enemies. It enables us to persuade our bosses and peers that we are doing something constructively with our precious time. It gives us a chance to convince our wives and innocent offspring that we have something on the ball even if we can't fix the light switch or mend a broken toy. You gotta have jargon, lots and lots of jargon, because it creates jobs like mine. Edit it out of the scientific paper and you cast serious doubt, to boot, on the author's credibility. Many a scientist's or author's reputation has slipped down the drain because he has stubbornly refused to integrate jargon into his work. . . .

SHELDON J. KARLAN
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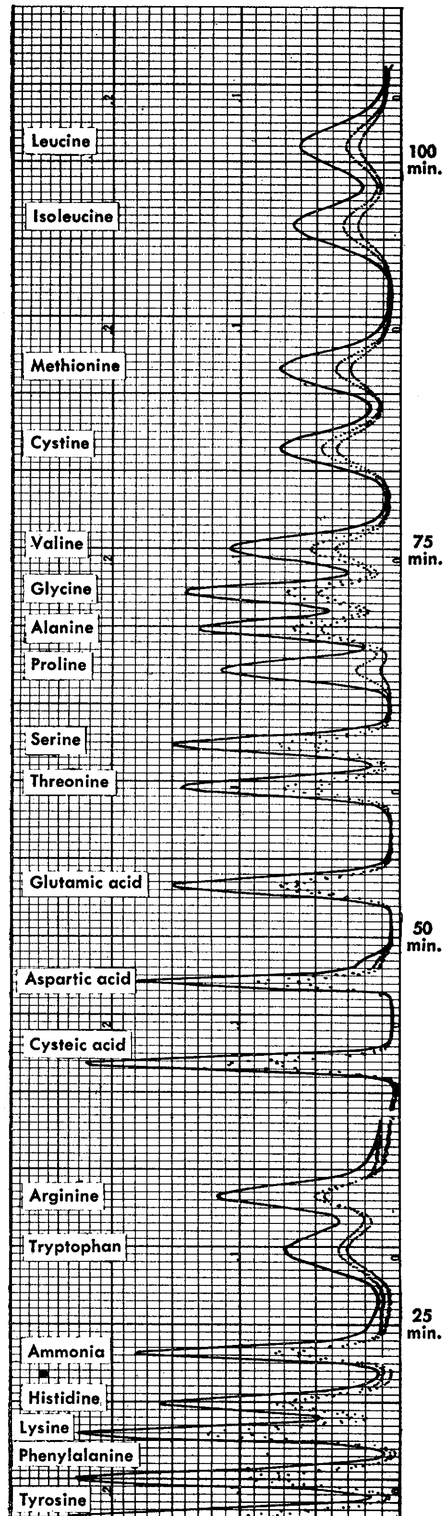
The editorial of 27 January incorrectly stated that Barbara Tuchman had "quoted the opening passage of a paper presented at the AAAS annual meeting as an example of bad writing." It was not Mrs. Tuchman but Fred Hechinger, the education editor of the New York Times, *who quoted that example. He used it in reporting Mrs. Tuchman's address at the meeting of the American Historical Association.*—ED.

Again, Classical versus Molecular Biology Studies

I should like to support Branson (Letters, 28 Oct.) in her concern at the prevailing attitude toward the teaching of high school biology as typified by the Biological Sciences Curriculum Study Blue Version. This attitude is expressed by Bonner (Letters, 23 Dec.) who implies that he regards so-called "classical" biology as neither "scientific" nor exciting.

I protest that classical biology has



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both these attributes and that it conveys them to the high school student more easily and directly than does cellular and molecular biology. The reason is this: any educational process should proceed from familiar matter and concepts into related ones which contain new features. In this way new experiences can be integrated and related with the individual's existing knowledge and understanding. This may seem a truism, yet a biology course which begins with amoeba or with the cell or with DNA comes very near to presenting the student with concepts and objects totally foreign to his experience and understanding. Too many modern biology texts do just this. It may be the logical sequence to the graduate biologist but it should be remembered that the student (who is only beginning the rigorous study of chemistry and physics) has limited experience and understanding and so is frequently compelled to accept many findings and concepts as articles of faith. "In the beginning was the Molecule. And the Molecule was DNA." Producing a rabbit from DNA can be as magical as producing one from a hat. However, if one starts with the rabbit, the nature and significance of DNA for the reproduction of rabbits can be shown in due course, when the student's experience and understanding of chemistry and physics are adequate for the task. It is perhaps significant that the BSCS Biology Teachers' Handbook has a section devoted to the physics, chemistry, and statistics necessary as a background to "the teaching and learning of modern biology."

If we avoid the schism between Biology B.C. (Before Crick) and Biology since A.D. (Anno Watsoni), and if we have an equal regard for the scientific achievements of the molecular biologists, Watson and Crick, and the biologists, Darwin and Wallace, then the question at issue is—what is the most effective and balanced way of presenting biology to high school students? I believe that it is to proceed from the human organism to the concept of the cell and sub-cellular components via functional anatomy, histology, and embryology; from man as a primate, through related animals, to the less familiar animal and plant groups and so to the concepts of evolution, the mechanisms of heredity, and the history of life on earth; from man in his environment to ecology, behavior, and social biology. Incidentally, a course of this kind will fascinate and educate those children (the majority) who are going to be ordinary citizens as well as those who will also become professional biologists. Such a scheme is not new, and the interested teacher can find a complete course in *The Science of Life* [H. G. Wells, J. Huxley, G. P. Wells (Garden City Publishing, New York, 1939)], although it clearly needs revision and the addition of the proper amount of molecular biology. This book is the product of three exceptional individuals whereas the BSCS courses are the result of a cooperative venture. The danger with such enterprises is that they reflect the attitudes of the majority to the exclusion of the insights of talented individuals. . . . Perhaps I should also add that I am a zoologist, for I should not like psychologists to be blamed for these reactionary views.

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My two children are currently enrolled in completely different biology courses. My daughter studies the BSCS Blue Version with an enthusiastic teacher who helped develop this version and the well-equipped laboratory in which it is taught. She enjoys and is stimulated by this study even though science does not figure in her future plans. It is an excellent course and does all that Bonner claims. On the other hand, my son studies biology in a different school, and this course, taught by an experienced and competent teacher, is traditional in that many kinds of animals and their habitats are studied. Field trips to the beach and valley are frequent. Numerous creatures are kept around the laboratory for the students to observe. My boy loves it and is being stimulated to continue in science.

My point is that it is the teacher, his ability and enthusiasm, and to some extent, the facilities provided, which are important rather than a particular version. It would be as unfortunate for the student to study the natural history approach with a teacher who had little experience outside the laboratory as to take molecular biology with one who had not himself mastered biochemistry and cell physiology.

The Yellow, Green, and Blue BSCS versions were originated with the idea that a particular teacher might choose the one or combination best suited to his training and facilities. Let us continue to encourage more good teachers rather than worry about the precise subject content.

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My son is a nonscience major, a boy born and reared in a large metropolitan area, far removed from personal experience with nature. His first science course was a course in molecular biology, offered to college-bound beginners, with no previous instruction in physics, chemistry, or biology, and it was a devastating experience, time-consuming, anxiety-producing, with rewards incommensurate to the time and effort expended. After a year of hard work, he is well versed in DNA and in the theory of evolution, but he is grossly ignorant of classical biology. I feel strongly that my son was shortchanged by the BSCS Blue Version course. Had the same amount of time been spent on *Modern Biology* [T. J. Moon, J. H. Otto, A. Towle (Henry Holt & Co., New York, 1960)], he would at least have had some understanding of the world around him.

Why couldn't classical biology be offered as an alternative course to these students unprepared or uninterested in molecular biology? What possible use is there for details of DNA or the Krebs cycle in the lives of nonscientists?

If a course in molecular biology is to be the biology course for beginners in high school, then I suggest the two cultures be separated. Let the science majors have this "intellectually interesting and stimulating course." Let the humanities majors have their own stimulating program. The college entrance requirements are, at present, the dilemma.

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. . . Last September our department gave an examination to our entering freshman medical students, prior to the formal course, in order to assess their background for microscopic anatomy. For the sake of convenience, we arbitrarily divided the test into three major categories of structural and functional information: namely, cytology, histology, and organology. Over 80 percent of our entering students were knowledgeable about the structure of DNA, the triplet coding system, as well as many other aspects of cellular biology. On the other hand, less than 15 percent had any appreciation of tissues and less than 2 percent were aware of organ structure or function! While I recognize that 164 students represent an extremely small and select sample, it is indeed curious that the vast majority of our "pre-med" students were thoroughly familiar with the esoterics of molecular biology while all had little or no appreciation for tissues and organs and the essential processes involved in their function. Why, for example, were they familiar with the theoretical role of messenger RNA but could not relate this information to higher levels of biological organization?

Bonner suggests that classic biology should be taught in elementary school and molecular biology in high school. I am not convinced that the elementary school student is competent to understand or correlate out of context the "anatomies, ecologies, and taxonomies" proposed by Bonner with subsequent emphasis on molecular biology in high school. Since only a very small proportion of high school students will continue on into graduate work in biology, it seems to me that the profundity of knowledge being imparted to the *majority* of students is unjustified as well as unwarranted. I would assume that the average high school, and for that matter, college graduate would be a better informed citizen if the curriculum included not only concepts of taxonomy, morphology, and cellular biology but an appreciation of our bios in general. Such a curriculum would put a proper perspective on *all* biology. Would not a mature insight into the methods of conservation, the problems of animal behavior and population explosion, as well as an understanding of ecological relationships be important in providing for an enlightened citizenry? Is it rational to include simply for the sake of novelty recently acquired information whose significance is lost to the student? I believe that the role of high school biology is to provide a *fundamental* background so that a student who decides to continue in biology can do so and the overwhelming majority can appreciate the important role of biology.

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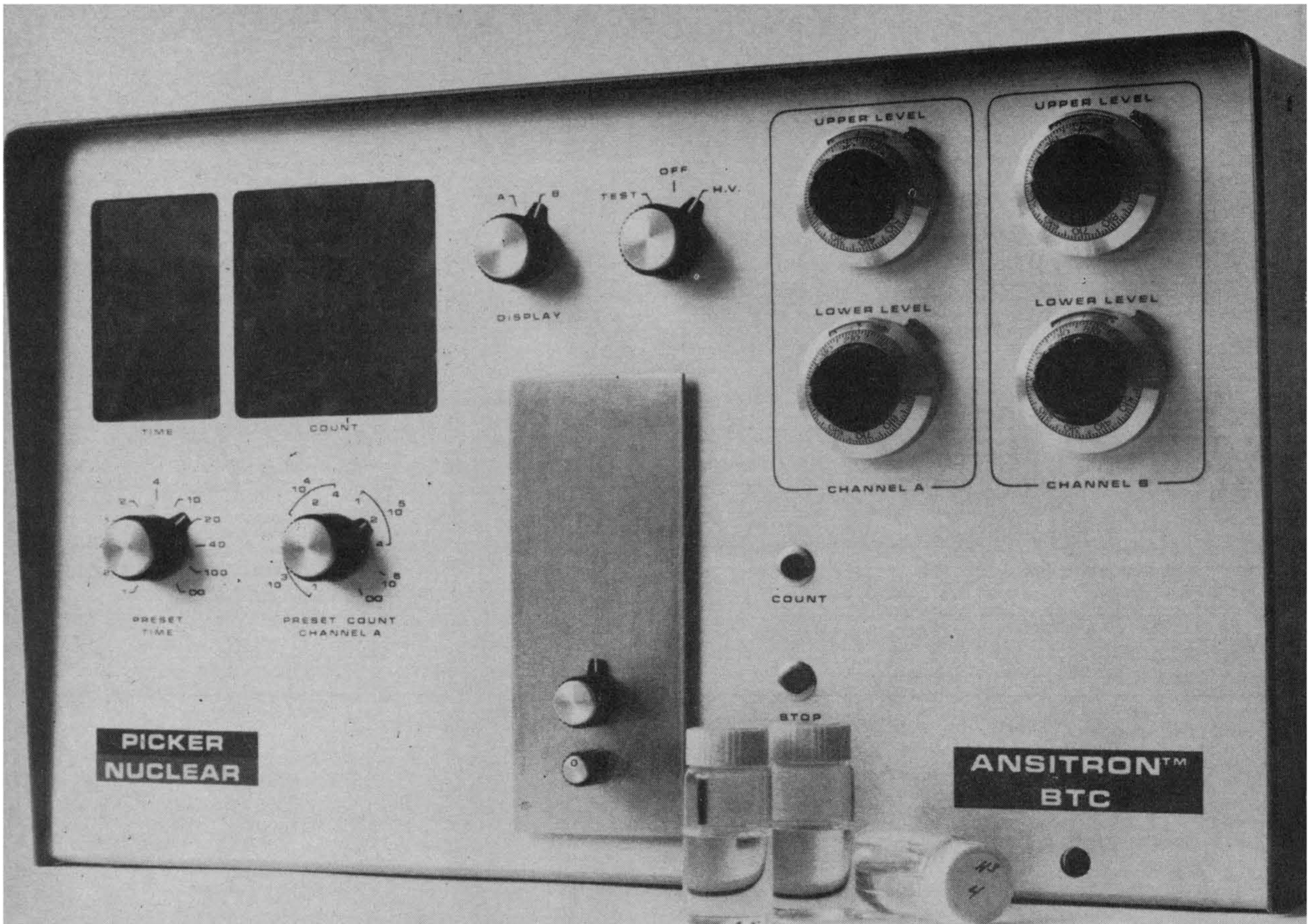
Medical School, Ann Arbor 48104



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SCIENCE

The Future Space Program

In support of the Administration's recommendations on the future of the space effort, panels of the President's Science Advisory Committee have prepared a report, entitled "The Space Program in the Post-Apollo Period."* This document seems designed to provide an intellectual justification for a continuing program likely to cost more than $50 billion. In view of the issues involved, one might hope for a comprehensive report delineating and weighing alternatives; the actual product is thin, and it advocates oftener than it weighs.

Major matters that need to be discussed are: What are the major scientific challenges? What is the importance of these questions as compared with those which can be studied on earth? What are the chances of discovering extraterrestrial life? What are the arguments for manned versus unmanned exploration of space?

In outlining objectives for the post-Apollo period, the report slights near-earth activities that are likely to pay off well both scientifically and practically. The principal questions set forth are these:

1. Does life abide in places other than the earth, and if so what is its nature, how did it evolve and what are its probable forms elsewhere?
2. What is the origin and evolution of the universe, and what is its ultimate destiny? What is the place of our sun and solar system in it? Do natural laws as we know them on earth indeed govern the behavior of every observable part of the vastness of space?
3. What are the physical conditions on the moon and on the other planets in our system, and how did our solar system evolve? What dynamic relationships between the sun and the planets shape their environments?

These are grand questions, but it was not made evident that the post-Apollo program has much chance of answering more than a few of them. The best prospect for fundamental, scientific findings is a program employing astronomical observatories in orbit.

The report is less than complete in its discussion of the comparative value of space and nonspace activities: "space programs can be thought of as competitive with other quite different programs, for example, in oceanography, improved transportation, or in urban renewal." However, the difficult problem of priorities was quickly ducked: "Comparisons among the different programs go well beyond the competence of the Panels."

A substantial fraction of the expensive post-Apollo program is to be devoted to a search for extraterrestrial life. However, only a few sentences in the report mention the search. Nowhere is there an evaluation of the chances of finding life on Mars or Venus.

Another deficiency is the lack of a full discussion of the role of man in deep space exploration. To date, manned missions have contributed little scientifically. The unmanned missions have had a cost effectiveness for scientific achievement perhaps 100 times that of the manned flights. Nevertheless, the report implicitly calls for a major role for man in the post-Apollo program.

The advocates of a large continuing space program have made their report. A committee of nonspace scientists would recommend differently. However, they are not likely to be asked to do so.—PHILIP H. ABELSON

* "The Space Program in the Post-Apollo Period," may be obtained for 50 cents from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Crop Production, Univ. of West Indies, Trinidad)

2–8. Latin Federation of **Medical Electro-Radiological** Soc., Barcelona, Spain. (F. Manchon, Aragon 290, Barcelona 9)

2–8. Seventh World **Petroleum** Congr., Mexico City, Mexico. (Amer. Petroleum Inst., 1271 Avenue of the Americas, New York 10020)

3–4. **Rubber** and **Plastics Industry**, 18th technical conf., Akron, Ohio. (Office of Technical Activities Board, 345 E. 47 St., New York 10017)

3–5. American Acad. of **Pediatrics**, spring session, San Francisco, Calif. (E. H. Christopherson, Executive Secretary, 1801 Hinman Ave., Evanston, Ill. 60204)

3–5. American **Hospital** Assoc., Boston, Mass. (E. J. Lanigan, 840 N. Lake Shore Dr., Chicago, Ill. 60611)

3–5. American Soc. of **Mechanical Engineers**, Washington, D.C. (Meetings Manager, The Society, 345 E. 47 St., New York 10017)

3–5. **Metals Engineering**, conf., Amer. Soc. of Mechanical Engineers, Houston, Tex. (Meetings Manager, The Society, 345 E. 47 St., New York 10017)

3–5. **Biometric** Soc., Eastern North American regional, Atlanta, Ga. (E. L. LeClerg, 6804 40th Ave., University Park, Hyattsville, Md. 20782)

3–5. British **Hydromechanics Research** Assoc., 3rd intern. conf., Cambridge, England. (H. Stephens, Information Officer, Cranfield, Bedford, England)

3–5. European Soc. of **Ballistocardiography** and **Cardiovascular Dynamics**, 6th congr., London, England. (D. C. Deuchar, Guys Hospital, London)

3–5. European Soc. of **Experimental Surgery**, Louvain, Belgium. (J. J. Haxhe, c/o Laboratoire de Chirurgie Experimentale, Univ. de Louvain, 69, rue de Bruxelles, Louvain)

3–5. Resistive and Dielectric **Properties of Thin Films**, Inst. of Physics and Physical Soc., Nottingham, England. (Meetings Officer, Inst. of Physics and Physical Soc., 47 Belgrave Sq., London, S.W.1, England)

3–5. Society for **General Microbiology**, 49th general mtg., London, England. (The Society, 19 Albermarle St., London, W. 1)

3–6. **Chemical Society**, anniversary mtg., Exeter, England. (The Society, Burlington House, Piccadilly, London, W.1, England)

3–7. **Education** for **Scientific Information Work**, intern. conf., London, England. (Aslib, 3 Belgrave Sq., London, S.W.1)

3–7. **Nonlinear Function Analysis and Computation Methods**, Atlanta, Ga. (Director, Dept. of Continuing Education, Georgia Inst. of Technology, Atlanta)

3–7. Containment and Siting of **Nuclear Power Plants**, symp., intern. **Atomic Energy Agency**, Vienna, Austria. (J. H. Kane, Chief, Conf. Branch, Div. of Technical Information, Atomic Energy Commission, Washington, D.C. 20545)

4–6. Strong Tough Structural Steels, British **Iron** and **Steel Research** Assoc., Scarborough, Yorkshire, England. (The Association, 24 Buckingham Gate, London, S.W.1, England)

4–6. Conference on **Molecular Sieves**, London, England. (Soc. of Chemical Industry, Honorary Sec., 14 Belgrave Sq., London, S.W.1)

4–6. Combustion in Advanced **Gas Turbine** Systems, intern. symp., Cranfield, Bedfordshire, England. (I. E. Smith, Dept. of Aircraft Propulsion, College of Aeronautics, Cranfield)

4–6. **World Meteorological** Organization, 5th congr., Geneva, Switzerland. (WMO, 41 Avenue Giuseppe Motta, Geneva)

4–7. American Assoc. of **Anatomists**, Kansas City, Mo. (R. T. Woodburne, Executive Secretary, East Medical Bldg., Univ. of Michigan, Ann Arbor 48104)

4–7. International Conf. of **Chest** and **Heart** Assoc., Sussex, England. (Miss H. Walsh, Conf. Secretary, Tavistock House North, Tavistock Sq., London, W.C.1, England)

4–8. French Inst. of **Fuels** and **Energy**, 7th intern., Paris. (Institut Français des Combustibles et de l'Energie, 3, rue Henri-heine, Paris 16ᵉ)

5. Institute of **Textile Science**, annual mtg., Montreal, P.Q., Canada. (J. E. Currah, c/o Millhaven Fibres Ltd., P.O. Box 10, Montreal)

5. **Nursing School Librarians of Midwest**, mtg., Chicago, Ill. (Medical Library Assoc., Inc., 919 N. Michigan Ave., Chicago)

5–6. First Rock Island Arsenal **Biomechanics** Symp., Rock Island, Ill. (RIA Biomechanics Symp., 1967, c/o J. E. Ekbald, Augustana College, Rock Island 61201)

5–7. **Ocean from Space**, symp., Amer. Soc. for Oceanography, Houston, Tex. (The Society, P.O. Box 53600, Houston 77052)

5–7. German **Concrete** Conf., Berlin. (Dilp.-Ing. Misch, Geschaftefuhrer, Deutscher, Beton-Verein, Bahnhofstr. 61, Postfash 543, 6200 Wiesbaden, West Germany)

5–7. Institute of **Electrical** and **Electronics Engineers**, 5th intern. conf., Washington, D.C. (Office of Technical Activities Board, 345 E. 47 St., New York 10017)

5–7. Institute of **Management Sciences**, Boston, Mass. (L. White, Sloan School, Massachusetts Inst. of Technology, Cambridge)

5–7. **Spark Discharges**, Inst. of Physics and Physical Soc., conf., Liverpool, England. (Meetings Officer, Inst. of Physics and Physical Soc., 47 Belgrave Sq., London S.W.1, England)

5–7. **Textile Research** Inst., 37th annual mtg., New York, N.Y. (H. J. Jansen, Textile Research Inst., Princeton, N.J.)

6–7. American Soc. for **Metals**, New York, N.Y. (C. R. Cupp, International Nickel Co., Inc., Paul D. Merica Research Laboratory, Sterling Forest, Suffern, N.Y.)

6–7. **Industrial Mineral Development**, Univ. of Kansas, Lawrence. (R. G. Hardy, Mineral Resources Section, State Geological Survey, Lawrence)

6–7. Society for **Biological Rhythm**, 9th intern. conf., Wiesbaden, West Germany. (W. Menzel, Amalie-Sieveking-Krankenhaus, Farmsener Landstrasse 73, Hamburg-Volksdorf, West Germany)

6–9. **Germfree Life Research**, intern. conf., Nagoya, Japan. (M. Miyakawa, Dept. of Pathology, Nagoya Univ. School of Medicine, Showa-ku, Nagoya)

7–8. Pennsylvania **Acad. of Science**, mtg., Selinsgrove, Pa. (B. Fried, Dept. of Biology, Lafayette College, Easton, Pa.)