energies for point defects. The potential functions used were short-range, central-force potentials. Linear, isotropic elasticity theory was used to describe atomic displacements in the mantle.

Currently of interest are the properties of dislocations, stacking faults, grain boundaries, and free surfaces, the interactions between these extended defects, and their interactions with point defects. In the discussions of dislocations, stacking faults, and grain boundaries, the participants in the colloquium indicated a need for noncentral, medium-range potentials and nonlinear, anisotropic elasticity theory. In addition, they indicated that point-defect calculations should be repeated with noncentral potentials. In this respect, a new generation of point-defect calculations has been started by R. A. Johnson and W. D. Wilson. They have constructed noncentral potentials for the transition metals and have performed computer experiments on properties of point defects with these new potentials. A systematic Green's function approach has been developed by R. Bullough and V. K. Tewary. Seeger's group has begun work on computing boundary conditions in terms of nonlinear elasticity theory.

The quest for a generally valid pairwise interatomic potential is the quest for a succinct and general description of atomic interactions in crystals. No one really expects that this quest will be realized, of course. But, practically speaking, reasonably good approximations can be found for a particular problem. Apparently, this will be done by means of empirical potentials or force constants. Most of the potentials used so far have been empirical potentials in the sense that even though their functional form has been suggested by theory, they have been calibrated by fitting to experimental data. All potentials used are pertinent to a particular qualitative range of defect-property simulations, determined by the nature of the experimental data used to calibrate them. Generally applicable potentials do not exist.

Interatomic potentials specifically constructed to simulate the properties of point defects in bulk crystals have been used fruitfully in the simulation of internal surfaces such as grain boundaries. However, because of the local disruption in the electron density at a free surface, a vast amount of work remains to be done in developing suitable potentials for use in computer experiments on the behavior of free surfaces and the interactions of other defects with free surfaces. Correlations between bulk and surface properties, such as the correlation between compressibility and surface tension outlined by N. H. March, would be valuable in an empirical approach to constructing interatomic potentials for studies of free surfaces.

Three types of computer-experiment techniques are likely to dominate future work. These are the dynamical, Monte Carlo, and lattice statics methods. The dynamical method is the touchstone of computer-experiment methods. It generates the phase space for a classical system of atoms as a function of time. In principle, it can completely describe the implications of any classical physical model of an assembly of atoms. The Monte Carlo method, in essence, develops atomic configuration states in accordance with statistical mechanical laws for thermal equilibrium. The lattice statics method determines the atomic displacements associated with a crystal defect on the basis of the harmonic approximation for the energy density of a crystal.

The general problems mentioned, namely, construction of potential functions, solutions for atomic displacements in the mantle, and the design of correct and efficient computer-experiment techniques, are difficult problems. Immense amounts of hard work lie ahead in the computer-experiment field, but the impression left by the discussions was an impression of optimism.

P. C. GEHLEN
J. R. BEELER, JR.
R. I. JAFFEE
Battelle Columbus Laboratories, Columbus, Ohio 43201

Reference and Note

1. Annually, Battelle has organized a Materials Science Colloquium since 1966. The topic of the 1972 meeting is Deformation and Fracture of High Polymers, and it will be held from 11 to 16 September in Kronberg, Germany. The meetings are by invitation only.
2. P. C. Gehlen, J. R. Beeler, Jr., R. I. Jaffee, Eds., *Interatomic Potentials and Simulation of Lattice Defects* (Plenum, New York, in press).

Disease Transmission by Arthropods

At least 80 percent of all infectious disease is arthropod-borne and yet minimum research effort has been directed toward an understanding of the dynamic roles of the arthropod vector and host in disease transmission. The vector's capacity for disease transmission and the host's response to the vector are determinants which have been studied primarily on a unidisciplinary basis, that is, without collaboration by specialists in different fields. There has been little attempt at a multidisciplinary examination of the factors that determine the outcome of the interaction between host, vector, and parasite. Such an opportunity was made possible through a symposium held in Hamilton, Montana, on 15 September 1971, sponsored by the Tropical Medicine and Parasitology Study Section, Division of Research Grants, National Institutes of Health, and by the Rocky Mountain Laboratory, National Institute of Allergy and Infectious Diseases, NIH. Members of the laboratory and of the study section and other interested specialists met to consider current knowledge on the interactions of arthropod vectors with hosts and infectious agents, and to identify areas requiring further investigation.

Reviews of current knowledge were presented in two main topic areas: (i) intra- and interspecific variations in the capability of vectors to transmit disease agents, and (ii) the host response to arthropod bites. Vector-to-host transmission of the causative entities of arbovirus disease, hemorrhagic, spotted and tick fevers, plague, tularemia, malaria, filariasis, and tick paralysis were discussed. Tick paralysis, an ascending motor paralysis induced by tick salivary gland toxin, is an example of a disease considered in the first topic area. Female ticks from each of 14 generations of *Dermacentor andersoni* raised at the Rocky Mountain Laboratory failed to induce paralysis, whereas the opposite was true of ticks from each of 11 generations of the same species derived from a field site where frequency of paralysis was high. Such intraspecific variation in ability to cause or transmit disease, suggestive of single gene dominance, has been observed also in mosquito vectors of malaria and filariae. With arboviruses little is known beyond the laboratory observation that vector capability is related to the amount of virus ingested by the vector.

In the second topic area there is little information on intraspecific variability in the response of hosts to arthropods, although interesting initial studies on an apparent genetic variability in responses of mouse strains to the louse *Polyplax* were presented by the staff of the Rocky Mountain Laboratory.

The immune response of guinea pigs to the cat flea (*Ctenocephalides felis*) has provided a basis for understanding the responses to other blood-sucking arthropods with a discrete period of host contact; examples are mosquitoes, black flies, and biting midges. The response, which progresses from initial nonreactivity through delayed dermal hypersensitivity to immediate hypersensitivity and finally to nonreactivity, is mediated by a hapten of low molecular weight, which requires conjugation with skin collagen before it becomes immunogenic. Each phase of the host reaction may influence the ability of an arthropod-transmitted pathogen to become established. Thus, in a delayed hypersensitivity response to flea salivary hapten, the mononuclear cell infiltrate may provide a milieu that favors growth of the plague bacillus. In an immediate response, scratching and rubbing induced by pruritis may assist entry of disease agents, as in Chagas disease, or microvascular dilation may permit easier access for organisms to the systemic circulation.

In the case of arthropods with long-term host contact, such as ticks, host responses directly or indirectly reject the vector, although the mechanisms are poorly understood. Notwithstanding, these responses are important in disease transmission, especially with agents (for instance, *Babesia* and *Theileria*) that proliferate and reach the infective stage in the salivary glands during engorgement of the tick. With immune hosts, the stage of tick development required for disease transmission may not be reached.

Discussion of such topics identified future research areas with public health importance. With respect to the arthropod, study is needed of genetic variability in vector capacity. Techniques such as isoenzyme analysis were suggested to measure population heterozygosity in species in which conventional genetic analysis is not feasible. A closer study of arboviruses in mosquitoes (for example, genetic variation in the response of *Aedes triserialis* to the agent causing California encephalitis) or studies of *Plasmodium* species in *Anopheles* would be profitable. Greater emphasis is required on tick physiology, especially the neurosecretory and hormonal systems.

A special need is the isolation and chemical and neurophysiological characterization of tick toxin. With respect to the host's response to arthropod bites, delineation of the classes and subclasses of immunoglobulins in the immediate hypersensitivity reactions is required, as is the differentiation between delayed, cell-mediated hypersensitivity and basophil cell responses. Oral secretions of arthropods need to be isolated and characterized immunologically and pharmacologically. A closer study of the cell types and tissue reactions at the bite site is required and physiological studies of the microvascular changes at this site and the adjacent area are warranted.

Such research would add to an understanding of the infection process in systems of arthropod vector, parasite, and host. Novel measures for disease control might result through, for example, desensitization of hosts to arthropod bites, immunization against ticks or mites, and genetic manipulation of vectors. Multidisciplinary approaches are needed to these research problems through active collaboration of different scientists, especially of entomologists, insect physiologists, biochemists, geneticists, immunologists, microbiologists, or parasitologists. In view of the many unexplained significant differences in annual and regional occurrences of vector-borne infections, several systems of host, vector, and infectious agent require attention and research.

E. J. L. SOULSBY
WILLIAM R. HARVEY
School of Veterinary Medicine, University of Pennsylvania, Philadelphia 19104, and Department of Biology, Temple University, Philadelphia 19122

Spontaneously Hypertensive Rat

A seminar on the spontaneously hypertensive rat was sponsored jointly by the National Science Foundation and the Japanese Society for Promotion of Science. The seminar was held in Kyoto, Japan, from 18 to 22 October 1971. In addition to the participants from Japan and the United States, the seminar was also attended by observers from Czechoslovakia, New Zealand, Sweden, Switzerland, Yugoslavia, and West Germany.

Genetic strains of hypertensive animals offer certain advantages as experi-