the properties of the chain so that, for example, a difference of temperature of one-tenth of one degree or the presence of 0.0002*M* guanidine would notably affect the structure and function of the molecule.

Let us therefore assume that guanidine does not act directly on the nucleic acid. The hypothesis proposed by us a few years ago is the following. Guanidine, like temperature, affects the tertiary or quaternary structure of a protein. Today we would state that it is responsible for an allosteric modification.

What is this protein?

In the presence of guanidine, viral RNA is not synthesized, and it has been believed that guanidine acts in some manner on the viral RNA-replicase. This was a logical conclusion. However, we became aware that methionine and choline neutralize the inhibiting effects of guanidine. A number of experiments have led us to believe that the guanidine must block the activity of a virus-determined transmethylase. The simplest hypothesis is that this enzyme methylates the viral RNA.

The DNA of the polyoma virus contains 5-methylcytosine, and so does that of bacteriophage lambda. Methionine intervenes in the modification induced by the host of this bacteriophage. However, we do not know the physiological significance of such methylation. Investigation of the poliovirus has afforded an indication that methylation in certain cases may well control the course of the viral cycle. Such methylation would be effected by a virus-determined enzyme which is sensitive to guanidine and to cellular metabolites possessing a guanyl group. Thus the evolution of viral proteins, like the evolution of proteins in general, should terminate in the development of sites capable of accepting specific effectors, inhibitors and anti-inhibitors, which are cellular metabolites. I should like to draw attention to this conclusion.

A cell becomes cancerous under the action of a virus. The virus has introduced into the normal cell its genetic material, which brings with it new functions, and these functions are the cause of the malignancy. It is reasonable to assume that a viral protein carries the phenotypical responsibility of the malign transformation.

If the functions of the oncogenic viruses, like the functions of other viruses, depend on specific effectors, we may hope some day to convert a malignant cell into a phenotypically normal one.

This leads us to remark on methodology. It would seem that we have so far been occupied in finding substances which specifically kill the malignant cell in the culture to the exclusion of normal cells or which specifically prevent the malignant cell from multiplying. The experiments are generally made in environments which may contain anti-effectors, as is the case for the couple methionine/guanidine. A change in methodology might perhaps be profitable.

There is also another obvious theoretical possibility. Instead of attempting to repress the viral functions, we might attempt to intensify them in such a manner that the virus whose cycle is blocked develops and kills the host cell.

The search for specific effectors of the viral functions and of the viral development is empirical at the moment. Such research must be developed and extended. Our ignorance of the nature of the factors which govern the relations among oncogenic virus and the cells should not incline us to pessimism but should instead be a stimulant. We should declare war on oncogenic viruses and carry it to victory.

Acknowledgments and Bibliography

The experimental data and concepts discussed here encompass a vast field. There are very many who have made important contributions to this domain. It would have been impossible to do each of them justice within a lecture of 30 minutes. I have mentioned some names, and my selection has necessarily been arbitrary. I would have liked to and I should cite, among others, T. F. Anderson, L. Astrachan and E. Volkin, L. Barksdale, G. Bertani, A. Campbell, S. S. Cohen, V. J. Freeman, N. B. Groman, L. M. Kozloff, S. Lederberg, S. E. Luria, F. W. Putnam, G. Stent, Elie Wollman, and N. D. Zinder.

The bibliography concerning bacteriophages will be found in the excellent book by G. Stent, *Molecular Biology of Bacterial Viruses* (Freeman, San Francisco, 1963) and the no less excellent treatise of W. Hayes, *The Genetics of Bacteria and Their Viruses* (Blackwell Scientific Publication, Oxford; Wiley, New York, 1964). The data concerning the effectors of the development of animal viruses are discussed in A. Lwoff, "The specific effectors of viral development" (The First Keilin Memorial Lecture), *Biochem. J.* **96**, 289–301 (1965).

NEWS AND COMMENT

The Berkeley Scene, 1966 (II): Educational Reform

One of the more provocative questions about last year's disorders at Berkeley is the extent to which they represented the uprising of an abused academic proletariat against an educational factory. Evidence on this point is inconclusive. Studies made during the crisis reported, for example, that nine-tenths of a representative sample of students agreed with the statement "Taking everything into account, Cal is a good place to go to school." But the same studies also found that 42 percent of the students said professors were more interested in research than in teaching, another 42 percent said the grading system "only slightly" reflects the student's knowledge of the subject, and one-third said classes were so large that students learned very little in them. Nearly four-fifths accepted the often-heard cliché that the university operated as a "factory."

Whatever the inconsistencies in student attitudes toward the university, one result of the Free Speech Movement was to stimulate faculty and administration introspection about the nature of the education Berkeley provides. "They felt educationally naked," commented one observer, "and they looked about for a fig leaf to help them cover up." One such fig leaf was rapid approval for a previously stalled proposal by philosophy department chairman Joseph Tussman to set up a small experimental college for lower-division students. Another was the appointment of a faculty Select Committee on Education to explore, among other things, ways of enlarging the variety of educational opportunities the university could offer. The driving force behind the proposal to reevaluate Berkeley education came from acting chancellor Martin Meyerson, but the skeleton in the closet was Mario Savio's. "If I had to name the man who has done

most for this university in 20 years," observed one member of the committee, "I'd name Savio. Without him our work would not have been possible."

Around the country, the committee's report—known as the Muscatine report* after English professor Charles Muscatine, who chaired the nine-man group—is being hailed as the most important study of higher education since Harvard issued its "General Education in a Free Society" in 1945. At Berkeley, where the report implies specific changes—the forsaking of certain prerogatives, and accommodation to new forces and values—the reaction tells a good deal about the practical possibilities of educational reform in a huge public university.

A New Kind of Student

One of the premises of the Muscatine committee—a premise that many faculty members, and not just at Berkeley, will find disquieting—is that the university is faced with educating a new kind of student. To those accustomed to a straight 4-year path to a degree, one of the more astonishing characteristics of today's students is the erratic nature of their careers. The report points out that, according to the traditional picture, most students who entered college in September 1961 would have graduated in June 1965. In fact, the report states, "only 50 percent of them have graduated by January 1966 or are still on the campus. The other half (54 percent of the women and 46 percent of the men) have left; many of them will later complete their education here or elsewhere. On the other hand, 38 percent of the class that did graduate from Letters and Science in 1965 . . . had done half or more of their work elsewhere. That is to say that only half of our freshmen graduate here within five years, while about two-fifths of the graduating class . . . consist of transfer students who were at Berkeley only as upper-division students."

In discussing the students, the Muscatine report does not oversimplify. It acknowledges that many undergraduates are there seeking traditional vocational training, and that many others have already fixed their eyes on the Ph.D. and have traditional academic values. These students, the committee feels, present the university with comparatively few problems. But the question in which the committee was obviously most interested is how to win back to the fold the kind of students whom they label rebels, dropouts, or nonconformists. The nonconformists are taken to be important not only intrinsically, because of the values they are holding out for—values to which many members of the committee, as well as other faculty members, feel susceptible—but for the practical reason that they are coming to have increased influence on the Berkeley campus. The number of adherents to traditional collegiate culture, as measured by participation in fraternities, for example, is declining, and the rising ratio of graduate to undergraduate students at Berkeley is associated with the rising number of malcontents. In addition, the committee believes that "even the large number of generally satisfied students cannot isolate themselves from non-conformist attitudes and ideas; they react positively or negatively. In the middle ground, there are many more students who share with the non-conformists their doubts about some aspects of the University. Educational changes that will affect the attitudes of the more intelligent and often more discontented minority will affect the attitudes of the entire student body toward the University."

The committee's characterization of the nonconformist students is lucid and subtle, the product of close contact and interviews as well as of a serious study of the students' culture, including the music and literature most popular with them. In some ways its theme was expressed most succinctly by chemistry professor George Pimentel, the only member of the committee to produce a dissenting report. "In the affluence of the last two generations," Pimentel observed, "many of our students have never suffered want. The question isn't 'How will I be able to assure security for myself and my family?' but rather 'Why isn't the world a better place when security is so easily acquired?'" The committee's majority came to similar conclusions. "The most obvious feature of [the students' outlook . . . is their outright rejection of many aspects of present-day America. . . . Essentially they see our society as controlled by a group which has abandoned the public welfare in its own self-interest and has resorted to many techniques to disguise its activities and to manipulate the general public. As these students see it, while the dominant group claims to champion freedom, religion, patriotism, and morality, it produces and condones slums, racial segregation, migrant farm laborers, false advertising, American economic imperialism, and the bomb." The consequences of student alienation, the report notes, include not only political action but drug-taking, certain forms of antirational thought, a search for "instant love."

Discontent and the University

"Okay, okay, so we've all got our problems," commented one researcher whose feelings about the Muscatine report—and the students it describes—are negative. "But why can't they leave the university out of it?" To that question, the select committee gives a perceptive answer.

> The University takes pride in its devotion to finding and teaching truth and knowledge. Accepting it on these terms, the potentially alienated student expects to find within its walls idealism silencing cant and hypocrisy. Disillusioned with his elders, he comes to the faculty seeking a "prophet" or "wise man". . . . Here he expects to fill his need for a community in which he can participate, find satisfactory communication with adults, and enlist their support in his struggle to right the wrongs of society. With such high, if unformulated, expectations, this kind of student is bound to be disappointed. Communication with the older generation often fails to materialize in large lecture courses. Few if any of his teachers even know his name. He comes to believe that his worth is measured in answers to mass examinations, not in personal assessment of his work and ideas. He learns to play a game within the University, to select his courses according to the grade he is likely to receive, to write ritual papers, and to second-guess the instructor. He decides that the University is too busy conforming to the needs of the establishment to produce men capable of opposing its evils.
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> In the critical student's eyes, the professors turn out to have their own system and play their own game. He sees their research as a means for their own advancement rather than as a search for truth. They turn out to be neither prophets nor wise men, only specialists in one area with all their prejudices in other areas intact. . . .

Translating perceptions about student alienation into a program that will not evoke faculty alienation is by no means an easy job. And, having given the students as sensitive an appraisal

*The report is formally titled "Education at Berkeley." Members of the committee, in addition to Muscatine, were Richard Herr (history), David Krech (psychology), Leo Lowenthal (sociology), Roderic Park (botany), Samuel Schaaf (mechanical engineering), Peter Scott (speech), and Theodore Vermeulen (chemical engineering). George Pimentel (chemistry), another committee member, filed a minority report. The report is available in many college bookstores for $3.25, or from the Academic Senate, University of California, Berkeley.

as they are likely to get from a generation with different commitments and priorities, the Muscatine committee fell back rather decisively on its own academic values. The report is not a blueprint for a radical utopia. But it does recommend certain practical innovations that will make life at Berkeley more palatable for undergraduates without seriously destabilizing the faculty. In this sense the Muscatine report is frankly a "political" document: "We deliberately excluded the impossible," Muscatine commented in a recent interview with *Science*. "There is nothing in our report which we felt would be impossible to get through the faculty senate."

The committee's proposals rest essentially on three pillars: increased contact between faculty and students, decrease in the rigidity of course and grading requirements, and increased emphasis on experimental programs. A number of specific proposals represent extensions to Berkeley of experiments already being made at other universities, such as the recommendation—already endorsed by the faculty—that students be allowed to take one course each term on a pass-fail basis. Other recommendations which have already passed include a proposal for individual student evaluation of undergraduate classes and for greater faculty-administration consultation with students about educational policies. In a related move, the Berkeley faculty last week authorized three students to serve on the faculty's Student Affairs Committee—the first time any Berkeley students have ever served on a basis of equality on faculty committees—and established a regular procedure by which the president of the student government could address faculty meetings.

Board of Educational Development

At the heart of the Muscatine report, however, is its invention of new machinery for introducing experimentation on the Berkeley campus. The device, known as the Board of Educational Development (BED), is essentially a college of experimentation. Its job is to promote and authorize experimental programs that the colleges or the departments are unwilling or unable to take on; it can keep the programs going for 5 years without the explicit approval of the faculty as a whole. In addition, through the creation of a subsidiary unit, the Board has the power to ensure that

Crarles Muscatine, chairman of Berkeley's Select Committee on Education.

participants in its educational experiments will be given Berkeley degrees. The Board is, in short, a means of circumventing existing faculty committees and attitudes that, as the report notes, have made "our institutions seem only too well adapted to withstand the virus of rapid innovation." BED is not a program for a particular kind of education or experiment; it is a machine for helping would-be innovators of all kinds run the hurdles.

The first thing to be said about the Board is that it was approved by the faculty; it is a reality. The second thing to be said about it is that it is divisive. The clearest argument against the Board is found in the minority report by George Pimentel: "The Board of Educational Development," Pimental wrote, "has an awesome aspect that defies comparison with any existing unit within the University. . . . The Board has the preconceived mission of soliciting from external sources most of the funds which will ultimately define its scope and impact upon the campus. . . . There is no specific provision for periodic review. Nor is there opportunity for faculty influence, in the interests of educational impact, to limit or control the extent of its activities. It has powers to set up courses subject to no control whatsoever by our conventional means of validating the educational merit of a proposed new course. The Board can establish courses that no College is willing to house and which the Committee on Courses has not even viewed. Faculty salaries can be provided outside of any department for educational experiments that might have five year duration, posing difficult questions of faculty advancement in rank and to the tenure level. To complete this rather strange organism, the Board even has access to degree-granting authority. . . . We have here a University within a University—its own Vice-Chancellor—its own (and probably lucrative) fund sources—its own courses subject to no prior review—its own faculty insofar as it chooses to establish curricula that are incompatible with existing Colleges—even its own degrees. . . . We may well find it difficult to live with our own creation."

Pimentel's views seem to be shared in particular by a significant number of Berkeley's chemists and engineers, who led the opposition to the Board. They have also opposed another proposal (referred back to committee) to create a new degree, known as Doctor of Arts, for students who complete all Ph.D. requirements with the exception of a dissertation. The opposition appears to rest in part on fears of a threat to the traditional autonomy of chemists at Berkeley, where they form a close-knit unit known as the College of Chemistry, which is extremely influential in campus affairs. It may also have to do with the traditional involvement of chemists and engineers in commerce and industry, where the "value of a degree" as a known commodity takes on a certain economic importance. One member of the committee sees the chemistry-engineering opposition to the new degree as analogous to the situation in the South, where the "poor whites" feel the threat of integration most keenly. "It seems ironic that the engineers are most against the new doctorate," he commented, "when it would mostly be used to produce more teachers in the social sciences and humanities."

Besides opposition on concrete issues, a number of people on the Berkeley faculty—particularly in the sciences—disagree with the general tone and emphasis of the report. There are some major proposals which have not yet come up for a vote: these include offering students credit for field study; developing ad hoc courses on subjects of topical interest to students, such as Vietnam or civil rights; and requiring that every departmental recommendation for promotion to tenure be accompanied by a formal dossier on the candidate's teaching performance (in-

cluding a statement from the candidate describing the rationale of his teaching efforts). But the undercurrent of uneasiness rests less on specifics than on a general feeling that the extreme emphasis on undergraduate education is misplaced. "It is research and graduate education that have made Berkeley great," commented one eminent physicist, "and they're the only things that will keep it that way." Recent plaudits for Berkeley's graduate programs (discussed elsewhere in these pages) tend to reinforce this view.

The emphasis on research, so natural to the scientists, has two aspects. One is a suspicion that people turn to teaching because they are not good researchers: "The educational reformers are rarely leaders in their fields," observed one scientist. "I can write a hell of a good essay on education and still not know a thing about teaching physics." A second aspect involves a rather frank elitism. "By catering to the mass you have to neglect the best," remarked another researcher, "and even if you don't neglect them you debase the whole currency by giving credit for less scholarly work."

Whether elitism can find a comfortable home in a university specifically charged with serving a mass public is not by any means clear. In any case, by no means all the opposition to the Muscatine report has come from academic traditionalists. A number of members of the faculty—inevitably those most interested in educational reform—feel that the committee failed by not laying out concrete proposals for particular experiments and not developing the organizational structure for carrying them out. Quite a few would agree with the criticism by former FSM leader Michael Rossman, a teaching assistant in the Tussman experimental program, that "the measure of their imagination has been to add a machine to the Machine."

The criticism of the reformers rests on three major grounds. First, there is a feeling that the select committee was too optimistic in assuming that, once the facilitating machinery comes into existence, imaginative proposals will be forthcoming. Members of the committee, perhaps because they have so many ideas of their own, believe, as one of them put it, that "the woodwork is bursting with new ideas." Many of their colleagues are more skeptical. "With few exceptions people around here like the way things are done," one sociologist commented, "and they are not about to take the initiative for change. The Board is a mandate to act, but it's not going to make things happen." This criticism grows partly out of experience. Both the Tussman college and an innovative interdepartmental course in the social sciences have run into difficulties in recruiting faculty members willing to take part in their experiments. "If we couldn't get the people before," asks one disappointed reformer, "where are they going to come from now?"

A second criticism is the argument that, having developed interesting experimental programs, BED will find it difficult to make them available to large numbers of students. "The difficulty with demonstration projects," one faculty member commented, "is that they tend to stay demonstration projects. We wanted something that would affect the character of life for all undergraduates here." Committee members have little use for this argument. "If something we do works out well, pressure from the students will feed back into the regular departments," one member observed. "No department is going to stand still while it loses undergraduates to a new program. They'll adapt. They'll have to."

Finally, there is the criticism of disappointed visionaries who imagined that the Berkeley campus could be transformed from a mass-production factory to a cluster of cottage industries, each with its own product and purpose, something for everybody—one campus having the unique facilities of a great university but containing a series of separate Swarthmores or Antiochs.

The absence of such dramatic proposals is not merely a reflection of the pragmatism of the select committee but a reflection of the feeling the committee's members appear to share with much of the faculty—that, as one of them put it, "when all is said and done, this is a pretty good life and we wouldn't want to do anything to jeopardize it." As one of the students pointed out, it is a pretty good life—for the faculty. Whether it is also a good life for undergraduates is something the students themselves will have to tell us. And, to judge from the explosive effects of the Free Speech Movement, next time around someone had better be listening.

—ELINOR LANGER

LBJ at Princeton: Some Words about Intellectuals and Government

Two weeks ago the President went to Princeton to receive an honorary degree, and used the occasion to touch upon one of the paradoxes of the Johnson era: he has probably exceeded all his predecessors in bringing learned men to the service of government and in bestowing money and homage upon the nation's academic and cultural communities. Put simply, because of Johnson, intellectuals have never had it so good. Nevertheless, while the dimensions of the disaffection are disputable, there is no doubt that the community of scholars is not wholly enamored of Lyndon Johnson.

Vietnam, of course, is the focus of the most raucous discontent, and it is academic dissent from our Vietnam policy to which the President mainly spoke. But, though Vietnam may be the principal occasion, it is only in part the cause of the academic community's reserve toward Johnson. For, like it or not, it might as well be recorded that a good many academicians feel rather snooty and condescending toward the man in the White House, and it would be naive to think the sensitively attuned, affection-craving President is unaware of this.

To some extent the Princeton address constituted a pained and exasperated