MBM D65

SENATE MEETING

THURSDAY, APRIL 30, 1964

3:30 P.M.

MURPHY HALL AUDITORIUM

The voting membership of the Senate totals 155 including the President and 154 elected members. For a quorum, a majority of the voting membership (78) must be present. Constitution changes require advance publication and 104 affirmative votes. By-Law changes require 78 affirmative votes. Other actions require only a simple majority of members present and voting. The members of the Administrative Committee are ex officio nonvoting members of the Senate.

All members of the faculty who hold regular appointment as defined in the Regulations Concerning Academic Tenure may be present at Senate meetings and are entitled to speak and to offer motions for Senate action, but may not vote.

Members of standing committees who are not faculty, including student members, may be present at a meeting of the Senate during such time as a report of their committee is under discussion and may participate in such discussion, but shall not have the privilege of making motions or of voting.

A special section will be provided for the seating of such faculty and such members of standing committees.

Provision has been made for the University News Service to send the Senate Docket to the news media in advance of each meeting and to arrange a news conference at the close of each meeting with the vice chairman and others he may designate.

ATTENDANCE RECORD

A roll of elected and ex officio members will be circulated during the meeting. Members will please check their names to indicate their presence. If the list misses you, please stop afterward to check your name. The roll, after adjournment, will be on the rostrum.

An attendance record for nonmembers will also be circulated and will be on the rostrum after the meeting.

As voted by the Senate, a summary of the attendance of members elected for the current academic year will be included in the June minutes.

NOT FOR RELEASE PRIOR TO THE SENATE MEETING

Year 1963-64 No. 5

UNIVERSITY OF MINNESOTA
THE SENATE
DOCKET
April 30, 1964

Your Committee on Business and Rules respectfully presents the following matters for consideration:

I. MINUTES OF MARCH 12, 1964
Reported for Action

II. REPORT OF THE ADMINISTRATIVE COMMITTEE
Reported for Information

1. *Questions Concerning the 1964-65 Budget.* At the March 11, 1964, meeting, there were several questions on plans for the 1964-65 budget. Primarily, they concerned the schedule for submission of budgets and the use of funds for tuition scholarships for graduate students with instructor appointments. These questions were answered, or inquirers were referred to the appropriate documents.

2. *Name for the Library of the St. Anthony Falls Hydraulic Laboratory.* The Committee on University Honors had proposed naming the special book collection of the St. Anthony Falls Hydraulic Laboratory the Lorenz G. Straub Memorial Library. After investigation, it had been recommended not to rename, in his memory, the laboratory, but to name the library housed there, a portion of which came from Professor Straub's own collection. No operational problems in relation to the University library system were foreseen, and at its February 5 meeting, the committee voted unanimously to endorse the recommendation. (The Board of Regents later, at the President's recommendation, voted to approve the naming of the library the "Lorenz G. Straub Memorial Library.")

3. *Course Offerings and Course Enrollments at the Various Publicly Supported Colleges in Minnesota.* At the request of the Liaison Committee on Higher Education in Minnesota, the Bureau of Institutional Research had studied the course offerings and course enrollments at Minnesota public junior and state colleges and at the University and prepared tables summarizing lower division instruction in these institutions. Copies of the tables were distributed to the committee, and at the March 11 meeting, Earl N. Ringo, from the Bureau's Administrative Research section, discussed the absolute, comparative, and changing values shown.

While he referred to many sections of the tables, Mr. Ringo made the point that although these data provided the liaison committe with certain general background, they might be most useful for internal analyses and comparisons by the institutions themselves. He pointed out the number of different lower division courses offered in the different types of institutions, noting that the junior colleges average about 170 courses offerings each, compared to averages of 262 at the state colleges and 163 at the Morris Campus, 343 at the Duluth Campus, and 962 at the Minneapolis-St. Paul Campuses of the University. He called attention to the proportion of courses and course enrollments in liberal arts, professional and vocational fields, and health and physical education in each type of institution. After noting changes in the various study areas and in several colleges from the 1957-59 to the 1961-63 biennium, he drew certain comparisons between changes at the University and at the other state institutions of higher education.

John E. Stecklein undertook an analysis of possible general uses of the data for over-all, long-range educational planning in the state. He discussed the curriculum data in relation to talent goals set in the report of the President's Commission on Higher Education (1947), i.e., that 49 per cent of the population could successfully complete 2 years and 32 per cent, 4 years, of post–high school education. This, he said, might suggest one basis for determining to what extent educational provisions at the lower division level in Minnesota are adequate. He then considered the distribution of students and programs between liberal arts courses and what is sometimes characterized as "vocational" or "terminal" work at the college level, using the survey's results to illustrate disparities between provision of and demand for lower division courses and the basic need for such courses in Minnesota. It seemed apparent (and Mr. Stecklein postulated) that there may be in this state a sizable need for the development of post–high school vocational education. In any case, he suggested that developing or new junior colleges give substantial attention to including instruction in this area as well as in academic and preprofessional areas. Much more realistic and effective student counseling may be required to serve Minnesota youth more fully.

Numerous questions were raised about the assumptions, the value of liberal arts courses for all students, definitions of terms, implications of the interpretations, and sources of additional data and of other practical comparisons. Comments related to the trend of admissions in certain areas of the University, to the need for intensive study of some of our student bodies, and to ways in which the institution may or may not be able to close gaps in the provision of educational opportunity for Minnesota youths.

R. E. SUMMERS, Secretary

(There will be a pause in the proceedings to permit the seating of the nonfaculty members of the Committee on Educational Policy and of the Committee on Intercollegiate Athletics for the discussion of their reports.)

III. REPORT OF THE COMMITTEE ON EDUCATIONAL POLICY
Reported for Information

The Senate Committee on Educational Policy received, at its meeting of April 2, 1964, the attached Report and Recommendations of the special Committee on the Development of the Biological Sciences. The Senate Committee on Educational Policy will be reviewing this report during the spring quarter, and may be in a position to make some recommendation to the Senate by the time of the final Senate meeting of the present academic year. Because of the importance of the issues involved, the Senate Committee on Educational Policy has asked that this report be printed in the Senate docket for information and discussion at this time.

JOHN G. DARLEY, Chairman

COMMITTEE ON THE DEVELOPMENT
OF THE BIOLOGICAL SCIENCES
MEMBERS OF THE COMMITTEE

*Professor Richard Caldecott
Dean Bryce L. Crawford, Jr.
Professor A. Orville Dahl
*Professor Archie L. Good
Professor Alexander C. Hodson
Professor Samuel Kirkwood
**Professor Arnold Lazarow
Professor Albert J. Linck
Professor Rufus Lumry
Professor Ernest H. Rinke
Professor L. Edward Scriven
Professor John Spizizen
Professor William G. Shepherd (Chairman)
Professor Nelson T. Spratt
Professor Tracy F. Tyler (Secretary)
*Professor Richard L. Varco

*New members (since December, 1963).
**Replacing Professor John Johnson.

REPORT AND RECOMMENDATIONS

I INTRODUCTION

In its Report on University Reorganization submitted by the Senate Committee on Education on November 1, 1962, the following recommendation was made:

> "The President shall appoint a study group, with the Academic Vice President as chairman, and including representatives of the biological sciences departments in all units of the University. This group would have as its mission the development of information and policy proposals for the Senate Committee on Education, the relevant Colleges and the University Administration concerning development of the biological sciences at Minnesota . . ."*

*Senate Minutes, November 1, 1962, p. 26.

Such a study group, under the chairmanship of the Vice President for Academic Administration, was appointed by President Wilson on January 17, 1963. This group, calling itself the "Committee on the Development of the Biological Sciences," has met regularly since February, 1963. In addition, four outside consultants—Dr. H. O. Halvorson of Illinios, Dr. R. G. Hansen of Michigan State, Dr. Ernest C. Pollard of Pennsylvania State, and Dr. Paul B. Sears of Yale—met with the committee on a two-day session on June 28 and 29, 1963. The written comments of these consultants are given in Appendix A.

The Committee prepared a first report which, under date of December 6, 1963, was circulated to colleges and departments with biological interests; this report presented several organizational plans which the Committee had discussed, and requested comments and reactions from these colleges and departments. The Committee has now had the benefit of the many thoughtful comments and responses from its colleagues; it has also in its most recent meetings had additional representatives from relevant areas in the University.

Most significant of all, the Committee has found that other universities have recently had similar groups studying the same problem of the proper organization of modern academic biology, and has had the benefit of interacting with them; though the local details are different from one institution to another, the central considerations are the same. We have been helped especially by the thoughts of the groups at Cornell and at California.

The Committee now presents the fruit of its further deliberations, with its recommendations, adopted unanimously, for the "development of the biological sciences at Minnesota."

II THE NATURE OF MODERN BIOLOGY

The existence of similar study groups in several universities underscores the the fact that we are not facing a purely local Minnesota problem, still less a problem concerning only one or two departments; rather we face the problem of the emerging reorientation of the conceptual structure of biology. And indeed it is not so much a problem to be solved as it is a challenge to be met, an opportunity to be grasped.

It is this conceptual revolution in biology which lies at the root of our recommendations; and the nature of this revolution is something which every educated man today should understand, and which any scholar will find stimulating. The Committee has nowhere found a better exposition of this topic than in a report prepared for the California conference; with the kind permission of President Kerr, we include it as Appendix B. The reader is urged to read this lucid and fascinating document before proceeding further.

* * * * * * * * * * *

The recent advances described in Appendix B have revealed the basic logical structure of biological science, so that topics which historically have been grouped under descriptive or phenomenological names now fall into place in a unified hierarchy, in categories such as molecular, cellular, organismal, evolutionary, or populational biology. This unity of the field calls for a unity of approach in teaching; it calls for a unified "core curriculum" in biology which will provide the student the clearest introduction and the soundest base, no matter what particular area of specialization he may ultimately seek. And this unified curriculum should contain significant grounding in the physical sciences. The desirability of such a unified curriculum for basic biology implies the need for an organization of faculty in the biological areas which will bring together those responsible for basic biology instruction, so that they may develop course offerings with this unified viewpoint.

The existence of such a "core faculty" and such a curriculum, both focused on the unity of modern basic biology, should benefit many areas of the University beyond basic biology and its specialized advanced fields. The professional fields which rest upon a biological base—agricultural science, medical science, veterinary science, and other areas—should profit from better course offerings and from wider stimulation. And, since some acquaintance with the life sciences is surely a desirable part of liberal education, students pursuing careers outside biology should also profit from an introduction to biology as a unified and logical subject.

III THE CORE CURRICULUM

Our recommendations come from our conviction that biology should be presented as a unified subject; and one major purpose of the administrative organization we are recommending is to develop and implement this pattern of instruction. The Committee is clearly not a proper group to formulate either the core curriculum or the specialized advanced offerings. But the nature of the curricula envisioned gives the clearest indication of the character we seek in the collegiate structure, and we shall therefore sketch here the general pattern of curricula which we would hope to see developed.

An integrated sequence of courses is needed, organized around the closely interrelated levels of molecular, cellular, organismal, evolutionary, and populational biology, with the goal of providing a general understanding of the principles and structure of modern biology, and a common background for biology majors. To develop such a sequence requires contributions from a broad range of specialties, and closer coordination than can be provided by loose cooperation between traditional departments from several colleges.

Clearly more than one core sequence in biology will be needed, when we consider the different needs of the student fitting himself for professional biology, the student interested in biology only as a component of a liberal education, or the student aiming for a profession in which biology is an important but not dominant base. It is not appropriate here to suggest any core curriculum in detail, much less to attempt course specifications. But some comments can be made, especially with regard to the core curriculum for biologists.

Modern biology relies heavily on the concepts and techniques of physical science. For a core curriculum to be effective in educating future biologists it must give them a broader and deeper background in mathematics, physics, and chemistry than has hitherto been customary in undergradate programs, and this should be provided concurrently with the basic biological sequence. As in any undergraduate curriculum, it is important to include a broad education in the humanities and the social sciences. Combining these requirements with those in biological subjects themselves, we may recommend that a reasonable curriculum for biologists should include the following:

General chemistry	15	(quarter credits)
Calculus and statistics	18-30	
Physics	9-15	
Physical chemistry	6-12	
Organic chemistry	9	
Biochemistry	9	
Integrated biology sequence	36-45	
Biology electives	9	
Social science		Credit as prescribed by College requirements
Humanities		Credit as prescribed by College requirements

We would expect the core sequence in biology itself to be organized around the hierarchy of levels—molecular, cellular, organismal, populational, and evolutionary, not necessarily in that order—with particular regard for establishing an attractive first course at the sophomore or freshman level. Many courses in the sequence will probably involve the cooperative effort of several staff members who may come from distinct traditional disciplines, with biochemistry, biophysics, botany, zoology, microbiology, genetics, physiology, and so on all represented.

There is little opportunity for professional specialization in such a four-year undergraduate program in biology; significant specialization would have to come in a fifth undergraduate year or in graduate work. It may be that professionally oriented five-year curricula should be considered, perhaps in conjunction with departments in other units of the University.

It is worth repeating that the Committee recognizes the need for other core sequences in biology, fitting into other curricula than that of the basic biologist, and that we feel that these courses also will be improved if offered in a setting of unified biology. There will be need for such courses in preprofessional curricula in biological fields in many parts of the University; and it is essential in the development of the undergraduate biology offerings that the new programs proposed be coordinated from the beginning with those in such colleges as the Institute of Agriculture, the College of Medical Sciences, and the College of Veterinary Science. Similarly, the biologists of this University should cooperate with their colleagues in the College of Liberal Arts to provide a stimulating non-professional course in biology, treated as a unified subject, as a component for liberal education.

IV RECOMMENDATIONS

The Committee recommends that the University of Minnesota establish a College of Biological Science, with its chief administrative officer a Dean reporting directly to the President.

Responsibilities

The responsibilities of the new College would be:

to provide leadership in the development in the University of a unified undergraduate program in biology, leading to an appropriate Bachelor's degree, and providing also course sequences to serve in the curricula of other colleges;

to provide a new and significantly attractive visible structure for the recruitment of faculty and students for the development of biology;

to provide a home for a well-integrated group of biologists representing the molecular, cellular, organismal, evolutionary, and populational approaches within biology; and thus to provide a base for increased development of research and professional and graduate training programs both in the new College and in other areas of the University.

Two Basic Factors

The Committee stresses that biologists must continue to work in other colleges of the University, usually with obligations or orientations involving the close interaction of biology with other disciplines. One important factor in the ultimate success of the new College will be its ability, at the administrative level and throughout its faculty, to foster and maintain a bilateral and extensive rapport with biologists in all units of the University. Specifically this means a stated intent at the outset to include appropriate faculty from other units as full members of this new College and to use cooperatively the courses and biology programs of other administrative units on an equal basis with courses in the new College. The success of a core curriculum in biology will depend not only on the excellence of the program but also on involvement and contribution of biologists throughout the University.

A second essential factor for the success of the new College will be the commitment of the central University administration to provide strong and continued support. It is appropriate, and the Committee would recommend, that outside support be sought especially from federal agencies for the initial program in the new College, for expanding needs of buildings and facilities, and for continuing support of research and training programs. But the University's decision to create and to develop the College must not be contingent on such outside funds.

The Core Faculty

The responsibilities outlined would require the activity of a "core faculty" of biologists within the new College. The Committee estimates that the proper development of the new College would call for some 100 to 150 faculty members within ten years; this number includes perhaps 40 who are presently at the University. New positions will be needed on both Minneapolis and St. Paul Campuses. This development of the new College should not be at the expense of other colleges, who will also have legitimate needs for expansion.

The Committee would recommend that the College faculty be structured, in terms of divisional or departmental lines, in terms of the molecular, cellular, organismal, evolutionary, and populational approaches.

How to Begin

The Committee recommends that immediate steps be taken to recruit the Dean of the new College, and that the College be formed initially by the administrative and budgetary inclusion of faculty members in the existing Departments of Botany, Zoology, and Biochemistry (St. Paul) and of certain faculty members in the areas of genetics and biophysics. In appropriate instances budgetary support may be joint between the new College and existing colleges.

We would assume that protection would be given to the interests both of individual facutly members and of departments and colleges. On the one hand, no faculty member should be included in the new College against his own wishes. On the other hand, where there are obligations of a department not in the "biological core" which clearly require the participation of a biologist so closely interwoven that he must be administratively in that department, and where the present incumbent would move to the new College, provision should be made for his replacement by a biologist of appropriate competence and interests.

Certain existing areas such as the Cedar Creek Natural History Area would fall within the jurisdiction of the new College. Some of the activities of the Museum of Natural History and the Itasca Forestry and Biological Station would also form a part of the program of the new College. The Committee would assume that appropriate relations would be worked out with these units.

Relationship to Activities in other Colleges

As indicated earlier, the Committee assumes that the formation of the new College would not preclude the continuation and the further development of biology where it is needed as part of the activities of other colleges of the University, as in Agriculture, Medicine, and Veterinary Medicine; rather, it wuold materially facilitate the over-all growth of biology throughout the University. Moreover, the impact of an improved University activity in basic biology would not be limited to those professional colleges based partly on biology; it would also benefit the College of Liberal Arts by providing improved offerings in biology for the liberal-arts student, whether as a major field or as a part of liberal education.

The Committee recommends that a Consultative Council for Biology be appointed by the President with the advice of the Deans of the Colleges of Biological Science, Liberal Arts, Medical Science, and Veterinary Medicine; of the Institutes of Agriculture and Technology; and of the Graduate School. This Council would provide for cooperative discussion of needs, plans, and developments in the several areas, so that the biological sciences might develop in proper balance over the entire University. Its position relative to the Dean of the new College, as to the other Deans, would be advisory. Because of its all-University responsibility, the Council should be chaired by an all-University officer; the Dean of the Graduate School might be an appropriate person.

Graduate Programs

The Committee assumes the continued existence and further development of graduate offerings and degrees in specialized biological fields such as microbiology, genetics, botany, agronomy, and others, under the normal policies and procedures of the Graduate School. The members of the graduate faculties in these areas could include biological scholars from any college of the University. The structure of the new College might provide a favorable environment for the development of less specialized graduate degrees such as a Master's degree in Biology.

V GEOGRAPHY AND FACILITIES

Thus far we have addressed ourselves to the challenge raised by the nature of modern biology. We also face in this University another challenge arising from the oncoming growth in student enrollment and the need to make new use of the St. Paul Campus in response to this growth as well as to the dramatic changes in the science of agriculture. We believe that we can meet these challenges—as well as the problem of two campuses four miles apart, with increasing needs for basic biology on both—and indeed that here again we find in these challenges an opportunity to be grasped.

The University envisions the development of the St. Paul Campus as a general University campus with a student population of some 10,000 students by 1970. This population will include not only students oriented toward the professional colleges presently in St. Paul, but also students following preprofessional curricula in preparation for other colleges, and students working towards a Bachelor of Arts degree. Course offerings must be broad enough to provide all, or a major part, of these programs. This will require among other new offerings instruction in basic chemistry and physics on the St. Paul Campus, which will call for a significant expansion of physical facilities.

It will also call for faculty to teach such chemistry and physics courses on the St. Paul Campus; the Committee believes that a reasonable and efficient way to provide this is through the use of biochemical and biophysical groups on that campus. Moreover, this would give us a unique opportunity to give biochemical and biophysical groups an important teaching responsibility which will assure them an adequate base of support and thus permit them to achieve "critical size." This does not mean that the courses in physics and chemistry in St. Paul would be biophysics and biochemistry courses, any more than those presently offered in Minneapolis are courses in nuclear physics or crystal chemistry; the Committee would assume that the responsibility for the teaching of basic chemistry and physics would remain with the existing Chemistry and Physics Departments. But the Committee would also assume that the Chemistry Department, for example, and the new College could work together to identify a faculty member whose teaching would contribute to the course offerings in basic chemistry and whose research would be oriented toward the biology program of the new College in St. Paul, so that both groups would find him a welcome colleague.

Additional buildings and facilities will be needed for basic biology on both campuses. There are at present plans under way for proposed Life Science facilities in Minneapolis, and for an addition to Snyder Hall in St. Paul; and there are other St. Paul buildings in the early planning stages which need reconsideration in connection with the proposed core biology program. We recommend that all these plans for buildings on both campuses be carefully re-evaluated by an appropriate faculty committee including biologists resident in both locations.

Whether the Dean's office for the new College should be in St. Paul or in Minneapolis is a matter which could be settled either way, and which indeed may be answered differently ten years from now, depending on the growth patterns which emerge. In the initial phases, because of the more experimental nature of the mission of the biochemical and biophysical groups in St. Paul, the Committee would prefer to see the new Dean establish his office on that campus. There would be good reason to establish an Associate Dean with an office in Minneapolis. For one thing, though the Committee has no charge to recommend regarding the organization of the College of Liberal Arts, such an officer of the core biology college might usefully serve the College of Liberal Arts with regard to biological science in the same way that the Associate Dean of the Institute of Technology serves with regard to physical science.

VI SUMMARY OF RECOMMENDATIONS

The recommendations of the Committee may be collected in skeleton form as follows:

1. The University should establish a College of Biological Science, with its chief administrative officer a Dean reporting directly to the President. This College should provide the home for the "core faculty" in biology, with a recommended intra-college organization in terms of molecular, cellular, organismal, evolutionary, and populational biology.
2. Initially, the College should be formed by the administrative and budgetary inclusion of faculty members of the existing departments of Botany, Zoology, and Biochemistry (St. Paul) and of certain faculty members in the areas of genetics and biophysics; this should provide an initial group of some 40, and the Committee believes that proper development of the basic biology program would develop the College faculty to 100 to 150 within ten years.
3. A Consultative Council for Biology should be set up, appointed by the President with the advice of the Deans of the several colleges with relations to biology, with an all-University officer as chairman. This Council, advisory to the Dean of the new College, would provide a channel for cooperative planning of programs relating to biology throughout the University.
4. The need for teaching basic chemistry and physics on the St. Paul Campus should be met in such a way as to strengthen the biochemical and biophysical activity in the new College.
5. Additional buildings and facilities for biology are needed on both Minneapolis and St. Paul Campuses; the Committee recommends that all planning for such facilities should be evaluated by a faculty committee including biologists from both locations.
6. The Committee would prefer that the Dean of the new College establish his office initially on the St. Paul Campus; it also recommends consideration of an Associate Dean with an office in Minenapolis, who might among his duties serve the College of Liberal Arts with regard to biology in the same way that the Associate Dean of the Institute of Technology serves with regard to physical science.

APPENDIX A

Comments of Dr. Paul B. Sears, Biology Department, Yale University, New Haven, Connecticut

I have in mind the fact that this problem is one of more than local interest. It bears upon at least two matters of national concern—the need for a higher level of scientific literacy and interest among citizens, and the danger to scientific advance from too great a compartmentalization among and within the various sciences.

Minnesota enjoys an initial advantage in its superb record in biology, its present excellent personnel, and what impressed me, at least, as a hopeful and constructive attitude. I was pleased by my conversation with the Dean of Agriculture and wish to register my personal judgment that his discipline, properly coordinated with other segments of the University, has much to contribute beyond technology, to the education of citizens in a state whose basic resources are so largely biological.

The ultimate expansion of the St. Paul campus into a more general enterprise offers much promise. Meanwhile the obvious handicaps of space and convenience in zoology and botany—which probably would not have occurred with a unified campus—call for early attention.

My recommendations are few and simple in principle, however difficult they may prove in execution. I suggest the prompt organization of an inclusive faculty of the biological sciences. Pending the selection of a suitable director I would be inclined to risk the appointment of a small executive committee, with clear understanding of its *ad hoc* role. A new administrator should have the utmost freedom to pick his own cabinet, if he needs one.

It will not be easy to find the right kind of a director. He need not be a "star" or "big name" providing he can command the respect of his faculty. He should, in addition to the more obvious qualities of scientific and administrative leadership, be sympathetic with the obligation of the university to give adequate attention to the students who will not be professional scientists. Needless to say he should have strong administrative support and be provided with what corresponds to an executive officer.

Meanwhile I should like to see the present faculty committee continue as a seminar to discuss, not matters of privilege, but problems of common interest among the groups concerned. I have seen this work very effectively under similar conditions at another great state university.

Comments of Dr. R. G. Hansen, Chairman, Department of Biochemistry, Michigan State University, July 2, 1963

It was a pleasure to meet with you and the representatives of your staff and discuss the problems of a rapidly changing biological science. Many problems discussed are general in nature, but others are peculiar to Minnesota. Of particular concern is the limited staff in such key departments as Zoology, Botany and Biochemistry. During the last twenty years when student commitments have greatly expanded there has been no increase in staff or facilities in these departmentts. Thus, this does not even represent status quo but backward movement relative to developments in the rest of the University. In spite of the handicaps, from the point of view of the outsider there are many fine biologists at Minnesota. The loss and imminent loss of internationally recognized biologists from the staff should be viewed with alarm since it is undoubtedly a contributing factor to the low morale which appears to be developing.

In assessing problems which are peculiar to Minnesota, I sensed that faculities and organization or direction were of major concern. While there may be some immediate relief in sight for expanded facilities in biochemistry, there was no such optimism for other departments which also have significant need.

The organizational alternatives that were discussed to place more significant emphasis upon the biological sciences can be listed as follows:

1) The formation a new institute or college of biological science, to include the departments of Zoology, Botany, Biochemistry, Physiology, Microbiology and new departments of molecular biology, genetics and biophysics.
2) The expansion of the biological sciences as a division of Arts and Letters under an associate dean.
3) Expand the biological sciences as a division of one of the following:
   a) Institute of Agriculture
   b) Institute of Technology
   c) Division of Medical Sciences

In my view, only the first alternative should be considered if the biological sciences are to receive proper emphasis. In all of the other situations the general mission is so diffuse and broad already as to have little in common with the general objectives of the biologists.

In a new college or institute with the departments of Botany and Zoology should be biochemistry, microbiology and physiology, since these are now mature and significant disciplines. As these latter three departments at Minnesota have responsibilities and a mission in the institutes of Agriculture and/or Medicine, they may be joint departments in the sense that expanded budgetary support for the whole department could come from the new biological science institute as well as from the traditional sources. This is justified since a department such as biochemistry has a much broader mission to perform than training medical students or agricultural students. This includes research and training of the vast number of the student body who need a working knowledge of this discipline as part of a general education in modern biology.

Biochemistry has a particular problem as there are already two departments of the same name and, in many respects, with the same general academic objectives. Since this discipline is of the utmost importance to the modern biologist, existing departments should be a part of this institute budgetarily, to preclude the development of a third biochemistry department and to give the necessary fundamental orientation and direction to the discipline, which is sometimes difficult to do as strictly an applied agricultural or medical science. Biochemistry should be represented budgetarily and homogeneously in a new institute. It will be to the advantage of both the agricultural and medical divisions to keep the research and teaching available for professional and graduate students as fundamental as possible.

Existing programs may serve somewhat as a basis for new departments of biophysics, genetics, and molecular biology, but obviously additional resources will be required to give these disciplines the emphasis which is currently justified.

Most of the personnel and facility changes should follow, and not precede, the appointment of a director for the biological science institute.

It is difficult for me to assess the amount of emphasis which the University administration wishes to place upon biology, but this is obviously a major factor to be considered. It is also not possible to appreciate the significance or effect of the divided campus, but it is my personal feeling that the physical barriers are more imaginary than real. With modern transportation the distance separating Minneapolis and St. Paul does not represent much more of a physical barrier than now exists between buildings on some other campuses of 3,000 acres and 30,000 students. Thus, this problem is not just peculiar to Minnesota. Depending upon the treatment this physical problem receives at Minnesota, most of the expansion in biology, including undergraduate and graduate instruction and research, could develop on the St. Paul campus, providing the staff and students were not considered to be second-class citizens.

Comments of Dr. H. O. Halvorson, Director, School of Life Sciences, University of Illinois

The outside consultants, Professors Halvorson, from the University of Illinois; Hansen, from Michigan State; Pollard, from Pennsylvania University; and Sears, from Yale University, met with Vice President Malcolm Willey and Dean Crawford of the Graduate School, and the University of Minnesota Senate Committee on Biology. Following the briefing, the consultants met in executive session and decided that each should submit his own individual report. The following is my report.

I do not intend to review the various schemes that were proposed but shall make comments only on the proposal that I believe to be the most appropriate solution to your problems. I also wish to make some comments on proposals which I believe to be unsuitable.

It is my recommendation to the University that they create a unit of biology which could be called a college, school, or institute—the actual name used is quite immaterial. This group should be headed by a dean or director—again it is not important just what title is given this person. The group should include the Departments of Botany and Zoology which are now in the College of Liberal Arts, the Department of Microbiology which is now in the College of Medicine, the Department of Biochemistry which is now in the College of Agriculture—and eventually the Department of Physiology which is in the College of Medicine.

After the unit has been organized and a director appointed, it will very likely be desirable to establish one or more new departments. These could be the Departments of Biophysics, Genetics, and/or Molecular Biology. I believe it would be a mistake to establish these departments at the present time. If they are to be established, it should be done after the new director or dean is on the grounds so that he can select the staff and work out the details with existing faculty.

If, and when, the departments mentioned above are transferred to the new biology unit, this must be done in such a way that the departments do not relinquish their responsibilities to the colleges from which they are transferred. For example, it would still be a function of the Department of Microbiology to serve the College of Medicine;

therefore the Head of this department would have responsibilities to two deans—Dean of Biology unit and the Dean of the College of Medicine. Likewise, the Head of the Department of Biochemistry would have responsibilities to their Administrative officers—Deans of Agriculture, Medicine, and Biology.

Special mention needs to be made concerning the Department of Biochemistry. In the past there has been two such departments at Minnesota. One in the College of Agriculture and one in the College of Medicine known as the Department of Physiological Chemistry. The department in the College of Agriculture has a history of being the basic department and students seeking fundamental training in biochemistry have generally procured it from this department. The Department of Physiological Chemistry in the Medical School has been more generally orientated towards the medical aspects. Because of this, I recommend that the Department of Biochemistry should, to a large extent, be housed on the Agricultural Campus, but the new Head of Biochemistry, which would now be a department head in the college, school, or institute of biology, should institute joint appointments for at least some of the staff in the Department of Physiological Chemistry in the Medical School.

The department heads that have responsibilities in more than one college will also have budgetary ties to these same colleges.

If a new college, school, or institute of biology is established, it must have close contact or liaison with the Institute of Technology and it may be desirable to arrange joint appointments of staff between the departments in the biology unit with departments within the Institute of Technology. It is my opinion, however, that it would be unwise to place the new biology unit within the Institute of Technology.

It is my considered opinion that it would be a mistake for the University of Minnesota to attempt to solve their problems in Biology by establishing a Department or Division of Biology within the College of Liberal Arts, including only Botany, Zoology, and perhaps a new Department of Biophysics or Genetics.

After the new director or dean has been selected, steps should be taken to plan for new buildings and I am confident if a proposal is properly presented, matching funds can be obtained for this purpose from the National Science Foundation and the National Institutes of Health.

Comments of Dr. Ernest C. Pollard, Pennsylvania University, July 2, 1963

Abnormal and Normal Features

Before outlining the tentative conclusions that I have reached, I would like to call attention to areas that seem to me to be abnormal in the university set-up and areas which seem to be normal.

Abnormal factors are the existence of two campuses close together, and the relatively strong position of the Institute of Agriculture. In a great many states Agriculture is under considerable pressure, but in the State of Minnesota it is still very well supported by the legislature and obviously is still a very strong body.

Another abnormal situation is the presence in one community of the three areas of medicine, agriculture and liberal arts. Thus, the normal separation of, for example, biochemistry into two or three departments seem to be unreasonable in the University of Minnesota, whereas it would be expected in the State of Washington or the State of Oregon or the State of Pennsylvania or many other states.

It is also abnormal that there is no thrust from the Physics Department into biological sciences. For example, in the University of Michigan Physics Department three successive strong individuals have developed, namely Robley Williams, Cyrus Levinthal, and S. Krimm. At Yale there was a group of three physicists who showed interest in biology; at Cornell a group including Philip Morrison; and at Berkeley there has always been this kind of relationship. It is likely that there is a special local circumstance which diverts this normally developed interest, but it is a serious factor in seeing what should operate at the University of Minnesota.

Influential factors, which are normal, are the presence of strong physics and chemistry department, set up to be aggressive and moving rapidly, and a rather conservative attitude of biologists.

Specific Proposal

While I find I have a good deal of bias moving Zoology, Botany, and Biochemistry in with the Institute of Technology, I am swayed by the fact that the local conditions may not make this wise at all. The abnormal factors that I have listed do tend to operate against this being successful, in that it may prove that a strong separate existence may be needed for biology than would be normally the case in a University. Therefore, I tend to think that the formation of a College of Biology, with a Dean who would presumably be given a budget, and a clear mandate, would be the wisest thing under circumstances. The organization that he encounters should not be frozen, so that he should have a chance to say, for example, whether there be a department of Biophysics, and whether there be Physiology in the College of Biology, and he should also have some say in the mechanism of direction as to whether new faculty should be appointed only by department heads, or whether something much broader would be possible; and that new faculty could be brought in by him without special consideration for the department heads. He should be given a clear administration support. The administration should make up its mind as to the fraction of budget that he should have both initially, and as a continuing thing, and it would be a worthwhile exercise to imagine the "shadow" dean and see what it would take to support him really adequately. If the whole situation were made to have a lot of challenge, and there was every indication of a lot of support on the part of the administration, there is no question that the faculty-backing for the new dean would be very considerable.

I therefore recommend as the best thing for the local situation a formation of a college of biology, to include five or six departments, and that the formal organization of this college be left somewhat open until a new dean is appointed for the purpose of operating it.

The Situation with Regard to Biophysics

A few paragraphs might perhaps be of some use. I detect an undertone of thinking that in a college that does not have actual contact with the chemistry and physics department, a department of biophysics might serve to hold down this function, of keeping the "rigorous" sciences in contact with the rest of biology. I would like to say that this might prove to be a very false hope if the department were not very carefully set up and if quite new factors, are not present in the present scene, be introduced.

The science of biophysics must ultimately be concerned with the application of physics to living things. If one looks back sixty years when the very beginnings of biochemistry were to be seen, one would confidently say that the science of biochemistry lay in the application of chemistry to living things. At that time it must have seemed strange and only remotely hopeful that there be any chemistry involved with living things, that would have any resemblance to the normal chemistry which has developed as a science of the centuries. Yet in fact, due to many patient endeavors and much faith, a very prominent science has come out, which is at the moment a candidate for the leading science in biology. Exactly the same kind of faith has to be held with regard to the emerging science of biophysics. It is not sufficient to say that we can already see so much about the cell or the living system that we cannot see any possible strong use for physics in describing living systems. This would probably be as misleading as the reasoning which said in 1903 that the chemistry of living things was not profitable to study.

A few illustrations can already be given: if we consider the structure of a virus, it consists of a very large single unit of nucleic acid which is accurately positioned within a precise, almost crystalline coating of protein, made up of identical sub units, probably organized in a definite array. This small element of the living system has to be put together structurally. That is to say the nucleic acid has to fold or coil in some quite definite way and the protein has to form itself around it. These processes, which can be seen in this very elementary way, *must* occur in order to cause a virus to form and yet none of these processes are understood or even described in more than the sketchiest form at the present time. As soon as various kinds of precision behavior in the molecular units begin to show, they will be seen to be a very promising area in which physics can be used. This use of physics will extend, and the same kind of thinking will be applied to the actual form of a bacterial chromosome, and to the organized systems of enzymes in membranes, and to the whole ultra structure of living cells. Nor is living cell the end of this system which we have to consider. It may well prove that the kind of statistical physics necessary for such aggregates of different things may be a very exciting challenge and may involve theoretical mechanisms which are new, and which even have application outside the living cell and living systems. This is the area in which biophysics can really contribute to a strong philosophical guidance to the remainder of biology. If biophysics is looked on in a limited way, as the use of specific instrumentation to get information on nerve networks or some of the much more restricted areas in which biophysics is at present operating, it will *not* be of much use for the basic subject for the development of all of biology. Since there is a vacuum in Minnesota in this kind of physical interest extra care will have to be exercised to fit it properly. It will not do simply to open the stop cock and let the nearest gases go in. What will have to be done will be to isolate consciously a region in the new college and to fill it with those individuals who will really contribute to this new area of biological thought. Therefore, it is very desirable to go rather slowly on the organization of biophysics, looking particularly for perceptive and interested physically trained people, rather than to look for "old-line" biophysicists to do a job which is really new and hardly even established. For this reason I would recommend that much more attention be paid in the near future to the establishing of departments of *genetics* and *molecular biology*, possibly unifying them in one department, and that provisions for a biophysics department be made with a number of young trained biophysicists who will become available in the next four or five years, and that a truly fresh and dynamic approach could be brought in at that time rather than at the present moment.

I sometimes illustrate the subjects of biology and chemistry and physics by a triangular structure in which biology is at the top of the apex and chemistry at the bottom left and physics at the bottom right. The line connecting biology and physics is direct and does not necessarily go through chemistry at all. There is no doubt that this direct line has really not been used very much, probably because the description of cells has not become complete enough for its use. It is probable that in the next fifteen years our description of cells will get much more exact, and then this direct line will be one which will be needed to be open and active. This is why I again recommend a little delay in the setting up of biophysics and a preference being given to the activity in molecular biology and genetics.

When the new department of biophysics is set up, it should contain at least one person who is a pure theoretical physicist.

APPENDIX B

REPORT OF STUDY COMMITTEE NO. 1

Roger Y. Stanier, Chairman; Ralph Emerson, E. William Fager, Richard C. Strohman

WHAT IS INCLUDED IN MODERN BIOLOGY?*

If a group of chemists or physicists met to consider the problems of teaching and administration in their field, it is improbable that they would spend much time discussing the content of their science. The fact that biologists feel impelled to put such an item on their agenda reflects the diverse and multileveled nature of biology, as well as its tenuous logical structure. In terms of training, methodology, and conceptual background, it is hard to find much that is apparently shared by the whole biological community today. The reasons for this curious situation can be understood only through an analysis of the historical development of our science.

The complexity of the living world automatically set the initial task of post-Renaissance biology, which was to prepare an inventory. The Period of Natural History (ca. 1600-1860) was primarily devoted to the phenomenological description of the unit objects of biology, and to the search for satisfactory ways to catalogue them. This period saw the first collecting expeditions, and the establishment of repositories for biological specimens, both living and dead: the botanical garden, the zoological park, the museum, and the herbarium. Studies were in the main descriptive; causal relationships were generally not looked for.

The publication of the Origin of Species abruptly ushered in the second major period in the growth of biology, the Evolutionary Period (1860-1900). The impact of the Darwinian revolution was felt far beyond the realm of biology; after 1860, the universe could no longer be considered static, and the parameter of time had to be taken into account in the interpretation of every aspect of the material world. Insofar as biology itself was concerned, recognition of the fact of evolution suddenly gave a cohesive significance to the continuing task of description. The evolutionary biologist no longer simply asked *what?*, but *what* and *why?* For the first time, explanation assumed a paramount position in biological research. The *kinds* of explanation that were sought in the light of evolutionary theory were ones that had not previously been considered relevant in a scientific context. They were either *historical* (how did this arise?) or *teleonomic* (what is the adaptative value of this? how does it contribute to survival?). Teleonomic explanation still remains valid exclusively in a biological context; it has no meaning in the context of physical science. Historical explanation, on the other hand, now bulks large in geology and cosmology; this is a direct consequence of the diffusion of evolutionary thought.

As it grew during the second half of the nineteenth century, evolutionary biology had a single broad scientific goal: the analysis of organismal diversity, and the explanation of its origin through natural selection. The comparative approach to the study of structure was systematically developed; both to elucidate the historical development of specific biological patterns, and to determine how natural selection brings about modulations of an initially common pattern. The fields of biogeography and paleontology assumed a new importance, since they provided the clues necessary to place biological evolution in the frame of geological history. Lastly, inventorying the biological world received a new impetus through its association with concepts of evolution.

* BIOLOGY IN THE UNIVERSITY, PROBLEMS AND PROSPECTS. Proceedings of the University of California Special All-University Faculty Conference on Biology, June 8-10, 1963, University of California, Davis.

The expansion of biology in the nineteenth century led to its first subdivision. The obvious line of cleavage was organismal, in view of prevailing interests. Botany and zoology emerged from the parent field of natural history, to become the two main foci of teaching and research in biology, a position that they still hold in most universities. This separation took place before the microbial world had been much explored, and hence before it was realized that the two classical kingdoms lose their definition at the microbial level. The problem of what to do with microorganisms was solved by partitioning them more or less arbitrarily between botany and zoology, with the result that microbiology never received its due recognition as a third major field of organismal biology. Only bacteriology achieved separate status, a consequence in part of its practical importance, and in part of its highly specialized methodology.

In the meantime, another approach to the study of living systems had been assuming an increasingly important place on the scientific scene. There is no generally accepted name for this kind of biology, but it can be termed *fnuctional* biology, since the basic question that it asks is: *how does it work?* This question can be asked about a biological system completely without reference to the concepts of evolutionary biology. Characteristically, it focuses attention on an individual biological object at a single point in time, or over a relatively short time span. Since even the simplest organism is far too complex to permit the design of experiments that show how it works as a whole, a single facet of organismal structure and function is normally abstracted for analytical purposes.

This approach asks for the explanation of a complex biological phenomenon—homeostasis, inheritance, movement, or vision, for example—in terms of concepts derived from a lower level of complexity. In other words, a satisfying explanation must be reductive. Ultimately, though not necessarily in the first instance, reductive explanation in biology leads to the description of biological phenomena in terms of the concepts of physical science. It should be specifically noted that the reductive analysis of a

particular biological phenomenon may very well be followed by an analysis in historical or teleonomic terms; in fact, such analyses are essential for full understanding of it. They are, however, necessarily secondary, and not primary.

Being primarily independent of evolutionary theory, functional biology already had roots in eighteenth century science, in the work of such men as Spallanzani. It continued to develop through the nineteenth century. By the beginning of the twentieth century, the work of the pioneers had laid the foundations for the creation of a whole series of new biological fields concerned with the analysis of specific aspects of function: biochemistry, physiology, genetics, experimental cytology, development. Some of these new fields could be fitted without too much strain into the existing organismal framework of biology, others, notably genetics, physiology, and biochemistry, frequently came to be represented by new departments. The terminal addition of these new departments to the administrative structure of biology led to many difficulties, since they cut across the science in a wholly different plane from the primary taxonomic cut.

The new biological fields developed in isolation. Between 1900 and 1930 biological science lost its unity, and broke up into a series of separate streams, each moving forward at its own pace. Each field developed its own techniques, and, as knowledge accumulated, its own language and concepts. Genetics affords the most extraordinary example. During the first decades of our century, its imposing theoretical structure rose like a newly-formed island out of the surrounding sea of empiricism. Strictly biological, in the sense that it could not then be expressed in terms of concepts derived from physical science, genetic theory was also at first isolated from the other major body of biological theory, evolutionary theory.

With the establishment of physiology and biochemistry as recognized biological fields, a new kind of biologist, who was trained to use physico-chemical techniques as his primary working tools, made his appearance. Furthermore, as knowledge about the physico-chemical properties of biological systems accumulated, those biologists who were not well versed in the concepts of physical science progressively lost the ability to comprehend developments in these fields. As even moderate mastery of the concepts of physical science became an ever more arduous undertaking, a new line of cleavage tended to develop in the biological fraternity, separating biologists well versed in evolutionary biology from those who were well versed in physical science.

In the nineteenth century, biology had emphasized the unique features of special living groups; its leitmotif was diversity. Each after its own fashion, the various functional biologies of the early twentieth century were concerned with universal properties of living systems; their leitmotif was unity. This is taken so much for granted today that it is easy to lose sight of the fact that the underlying unity of biology was by no means evident *a priori*. The general validity of the laws of inheritance, the basic homologies of cellular construction, the universality of central biochemical mechanisms, all had to be demonstrated; they could not be taken for granted. These demonstrations were severally provided during the early decades of the present century.

About 1930, interpenetration of functional and evolutionary biology began at a number of points. The most important and fruitful bridge was established from genetics, when it was perceived that genetic theory could be effectively applied to the interpretation of evolutionary mechanisms and of the behavior of populations. As a by-product of this approach, an objective definition of the species could be offered for the first time, thus providing a firmly grounded point of departure for taxonomy. Also about this time, some biologists recognized that the comparative approach need not be the exclusive possession of morphologists, and began to explore the evolution of function by the newly developed techniques of physiology and biochemistry.

This brings us to the present time. All biologists are aware that since 1950 our science has entered a new and revolutionary phase of development. In some circles, it is assumed that the revolution is primarily technical, a consequence of the ever-increasing rate at which new instruments and methods are being introduced into biology from physical science. However, this invasion of physico-chemical methodology is nothing new; it has been going on for well over fifty years, and is not in itself sufficient to explain the profound changes now occurring in biology. In fact, the contemporary revolution is conceptual, just like its predecessor of 100 years ago. We are witnessing an incredibly rapid fusion of the previously isolated concepts of genetics, cytology, biochemistry, and cell physiology into a coherent body of theory which explains in physico-chemical terms how living systems operate at the level of the cell. A complete reductive explanation of the nature of simple living systems is now within our grasp.

At the cellular level, the originally isolated fields of functional biology are losing their separate identity; it is no longer possible to draw sharp lines between genetics, biochemistry, and cytology. Much of the formal structure of "classical" genetics can be redescribed at a lower level in terms of the physico-chemical properties and behavior of deoxyribonucleic acid; and cellular phenotypes can be more precisely defined in terms of specific, genetically determined protein structures. Some of the central areas of biochemistry are now equally dependent on genetics: the description of protein synthesis is meaningless without reference to the source of specific structural information, resident in the genome of the cell, and the way in which this information is translated for the purpose of directing protein synthesis. Furthermore, genetic and biochemical studies combined are beginning to show how marvelously precise regulatory processes in the cell are operated. As for cytology, the electron microscope now makes it possible to visualize and identify structurally the macromolecular entities that participate in this elaborate functional interplay.

There is another field of biology which has, since about 1930, been building up a body of theory more or less independently of functional and evolutionary concepts. This has been concerned with the mechanisms of increase and decrease in single species populations and with the properties of multispecies systems. The theory of mechanisms of control in single species populations is mathematical. It has been developed both in a deterministic framework and, more realistically, with the addition of stochastic components. Experiment has not kept up with theory, but a large enough part has been confirmed experimentally to indicate its essential correctness. It is a general theory, independent of the type of organism to which it is applied. It, therefore, emphasizes the unity of biology at the population level much as functional theory does at the cellular level. The theory for systems of two species is also well developed, but experimental confirmation is minimal at present. The mathematics of systems of more than two species (communities) have not been explored in as great detail, but, apart from somewhat greater complexity, there would seem to be no inherent difficulty in their development. Another approach to communities has emphasized their structure in terms of the distribution of individuals among species and the paths and amounts of energy flowing through them. A sufficient body of evidence is now available to indicate that a general theory covering these aspects can be constructed, using concepts from probability theory, the thermodynamics of open systems, etc. In order to understand and use these concepts, it is necessary for the biologists to have much more background in mathematics and physics than has been expected or offered in the past.

It would be folly to close our eyes to the academic implications of these recent changes in the structure of our science. At the level of the cell and of populations, biology has once again become a single field. That part of biology which is concerned with the *nature of living systems* has a newly-found conceptual unity which demands a unified exposition; yet this is something that is almost impossible to offer to the student within the traditional framework of departmental divisions as they now exist in most universities.

However, this unity does not yet extend to the organismal level. Powerful as the new concepts about the cell may be, we still do not really understand how to apply them to the complex, multicellular organism. At this point, they suddenly lose their power, and the logical structure of biology becomes tenuous again until we reach the point at which the concepts of evolutionary and population biology become relevant. If effect, therefore, biology now has two sets of theory, one primarily relevant at the cellular level, and one primarily relevant at the population level, with a large intermediate area that is highly empirical. Much of organismal biology hovers uneasily in a kind of no man's land between evolutionary and functional theory. This is an awkward and unstable situation, productive of intense internal conflict; many organismal biologists feel that they are backed against the wall, unable by virtue of their training to understand modern functional theory, and unable by virtue of the level at which they operate to make extensive use of modern evolutionary theory. The inferiority complexes so engendered have not been soothed by the loudly expressed opinions of many functional biologists about the worthlessness of organismal biology. This situation is extremely dangerous for the future of our science. The real danger lies in the possibility that organismal biology may retreat into its citadel of conservative empiricism, rejecting the new concepts of functional biology as inapplicable at the organismal level. Quite obviously, progress in organismal biology now demands the most rapid possible upward extension of cellular functional theory. Only when we know how far the cellular concepts can be applied to the organism will we be in a position to discover the truly significant and unique aspects of biological systems at the organismal level. However, if the path of progress is to be followed, a complete revision of training for work at the organismal level is imperative. The concepts and methods of contemporary functional biology are deeply rooted in physical science, and are consequently closed to the biologist who lacks an understanding of physical science. Similarly, modern population and community theory has its roots in mathematics and physical science. What we need therefore is an environment which will produce a new kind of biologist, trained and competent to bring physico-chemical and mathematical insights to bear on biological problems at all levels, as and when such insights can be usefully applied.

Eventually, a further profound conceptual advance must occur in biology: functional and evolutionary concepts must be fused into a single body of theory. As a matter of fact, this goal is perhaps not so remote as it might seem at first sight. With our recent insights into the nature of the physiological control mechanisms that operate in cellular populations, some biological homeostatic mechanisms are becoming comprehensible in molecular terms: we can begin to offer teleonomic explanations, so characteristic of evolutionary theory, in the language of modern functional biology. Furthermore, the prospects are brightening for the expression of historical explanations in this language; chemical genetics is opening the way for the interpretation of evolutionary change in molecular terms.

If the above analysis of the structure of contemporary biology is correct, some important conclusions about our training program follow. Certainly at the undergraduate level, no one of the existing special departments can pretend today to offer a broad and up-to-date training in biology. What should our goal at the undergraduate level be? Here we should like to cite some remarks of Clifford Grobstein (American Scientist, March, 1962):

"The system of training of a biologist must reflect, as it did in the nineteenth century, the generally common knowldge and concepts of the biological community as a whole. This community is now a very different one from that of the nineteenth century, or of the first half of the twentieth . . . As a population the biological community is multi-leveled and engaged in a multi-leveled task. The community *will be* more effective and more cohesive as a larger proportion of its members share a multi-leveled training.

"If this is so, and I have no illusions that there is general agreement that it is, then it is not enough to break the archaic mold of training within taxonomic departments, a feat which, itself, yet remains to be accomplished in many institutions. We must also resist the inclination toward training limited to particular levels, which is accepted in some instances as the convenient enlightened alternative."

Unless we wish to perpetuate the present fragmentation of biology, we have got to start inculcating into undergradate biology majors a general understanding of the structure of our science at the cellular, organismal, and population levels. This goal cannot be approached, however, unless we can preface it with a common basic training in physical science and mathematics. Accordingly, a unified undergraduate curriculum would leave little place for the kind of specialization characteristic of most biology majors today; specialization could hardly begin before the senior year. The multitude of specialized courses in biology that now fill our catalogues should for the most part be moved to the graduate level.

The kind of undergraduate training that we envisage could not be efficiently developed—if, indeed, it could be developed at all—as a result of loose cooperation between specialized departments. Ideally, the only satisfactory undergraduate instructional unit would be a single department of biology; and on a newly-established campus, no other academic structure should even be contemplated. The older campuses, where specialized biology departments each having a strongly-marked collective personality have developed over many decades, face a far more difficult problem. Fusion into a single department seems almost impossible, for both administrative and psychological reasons. (Parenthetically, it may be noted that the psychological obstacles far outweigh the administrative ones.) Nevertheless, some satisfactory solution to the problem of undergraduate training in biology has to be found sooner or later; and any solution along the lines suggested above will profoundly affect departmental function. Perhaps the time has come to recognize that our existing special biology departments should properly be regarded as foci of graduate instruction and research. If we could agree on this, it might be possible on large campuses to place the responsibility for undergraduate instruction in the hands of a council or committee, with the power to determine what courses should be offered at the undergraduate level, and to staff them by selecting from the whole faculty those members best equipped by interest, outlook, and knowledge to participate in this particular enterprise.

The centralization of authority for undergraduate instruction in biology, and the requirement of a common basic training in mathematics and physical science, would also make it possible at last to tackle the long-neglected problem of how biologists should be trained in these latter fields. At present, mathematicians and physical scientists have no way of becoming aware of the common needs of biologists in their areas, since each biology department acts autonomously in setting requirements for its students. Typically, departments of physics and chemistry offer two sets of undergraduate courses: a rigorous set designed for their own majors; and a watered-down set, designed as best it can be to meet the general needs of undergraduate education in other fields. Most biology students now take the watered-down series, the extent of their training through this series being determined by their own departmental requirements. As a result, they are confronted with serious difficulties if they desire to pursue more advanced work in physics and chemistry at a later point in their career. Biology students should certainly have a more rigorous training in physical science than most of them now obtain. This would necessarily require a more rigorous training in mathematics. However, rigor need not imply putting all biology students through the basic courses which have been designed to train physics and chemistry majors. Some aspects of physical scieince which are given heavy stress in the training of physics and chemistry majors are not particularly relevant to biology, whereas other aspects which are lightly treated or ignored by physical scientists are of paramount importance in biology. To take the most obvious example, the subject matter of a course in organic chemistry could be chosen in such a way as to familiarize the student with those classes of simple organic compounds that are biologically important; and it should also include treatment of organic polymers. Courses in physics and physical chemistry could be far more useful to the biologist than most of them now are if certain changes of emphasis were made, and if illustrative material more relevant to biology were chosen. Hence, if all undergraduates in biology were required to take a common basic training in physical science, the problem of course content would become a meaningful subject for discussion between biologists and physical scientists.

Finally, we should like to return to the question of what role, if any, our traditional special biology departments have to play in modern biology. As we have attempted to show, they are not satisfactory vehicles for present-day undergraduate instruction. In fact, the maintenance of departmental autonomy in the area of undergraduate teaching is the major obstacle on certain campuses to the establishment of a curriculum which adequately reflects the structure of contemporary biology. At the graduate level, the situation is less clear.

Since this is the level at which specialization in biology should now begin, the traditional departments could perhaps be justified as units for graduate instruction. It is certainly arguable, however, whether as at present constituted they represent the *most effective* constellations of biological talent for training on the graduate level. This cannot really be decided on *a priori* grounds. The answer would no doubt become

evident if and when undergraduate instruction was removed from the individual departments and brought under unified control. Biologists would then have to re-examine their departmental structures in terms of a different primary mission, and might well discover that major regroupings were desirable.

Conclusions

1. Insofar as undergraduate instruction in biology is concerned, radical revision of the traditional curricula is required in order to present students with an adequate picture of the structure of contemporary biology.

2. At least in broad outline, a satisfactory undergraduate curriculum can now be formulated. Its goal should be to provide all undergraduate majors with a general understanding of the principles of biology at the cellular, organismal, and population levels. This goal can be achieved only if all students share a common background of training in mathematics and physical science. Such a curriculum would leave little or no place for specialization at the undergraduate level.

3. The traditional special departments of biology are not suitable vehicles for a modern undergraduate training. On campuses where biology is being newly developed, a single department of biology is the only academically justifiable structure for undergraduate instruction. On campuses where traditional departmental subdivisions now exist, some administrative device must be found for the unification of undergraduate instruction.

4. The academic role of the various traditional biology departments should be to provide centers of specialized graduate instruction and training in research. It is by no means clear that their present composition, which was dictated primarily by other needs, is the most suitable one for the purposes of graduate training. However, it is difficult to formulate any better regrouping in advance of the reform of undergraduate training. Such reform is therefore the key to a satisfactory reorganizaton of the academic structure of biology.

IV. REPORT OF THE COMMITTEE ON INTERCOLLEGIATE ATHLETICS

Reported for Information

1. *Concerning the 60-day period for review of Conference legislation enacted under the White Resolution Procedure:*

Due to peculiarities of scheduling, the interval between adoption, in December, of substantive changes in the rules and regulations of the Conference and the next regularly scheduled meeting of the University of Minnesota Senate may exceed the 60-day period during which an adopted measure can be rejected under the White Resolution Procedure. This problem having been called to their attention, the Faculty Representatives voted, "that it is the sense of the Faculty Representatives that in scheduling the Conference meetings for December, account shall be taken of the date of meeting of the University of Minnesota Senate so that that body will have the opportunity to cast a meaningful vote within the 60-day period on White Resolution matters. If, in any particular year, it is impossible to schedule the December meeting of the Conference 60 days or less prior to the Minnesota Senate meeting, the period for rejection of White Resolution measures will be extended until the Minnesota Senate has had an opportunity to meet and consider them."

2. *Approved Schedules*

TENNIS 1964

Mar.	23	Houston—Houston
	24	St. Edwards—Houston
	25	Texas A & M—Houston
	26	Southeastern State of Oklahoma—Houston
	27	Rice—Houston
	28	Houston U.—Houston
Apr.	4	Iowa State—Ames
		Wheaton College
	7	Carleton
	10-11	Wisconsin—Madison
		Illinois—Madison
	18	Iowa
	25	Iowa—Iowa City
May	1-2	Northwestern—Evanston
		Michigan—Evanston
		Purdue—Evanston
	8	Northwestern—Evanston
		Ohio State
	9	Wheaton College—Wheaton
	15-16	Indiana
		Michigan State
		Wisconsin
	21-22-23	Conference—Illinois
June	15-30	NCAA—Michigan State

3. *Approved Change in Schedule*

TRACK 1964

Mar.	9	Milwaukee Journal Invitational
		Meet added
Mar.	13	Chicago Relays
		Canceled

Reported for Action

Changes in Conference Legislation

At the meetings of the conference on March 12-13, 1964, and at the initiative of Minnesota, Section 5 of Rule 3 of the rules of eligibility was amended under the White Resolution procedure so that it now provides as follows:

"Section 2. Alien Students. Participation experienced in a foreign country by an alien after his nineteenth birthday and prior to matriculation at a Conference institution as a representative of any team whatever, or as an individual, shall count as 'varsity competition' for the purpose of this rule. In this case a 'college year' shall consist of successive twelve-month periods following the date of his nineteenth birthday."

Heretofore, an exception had been made in the case of ice hockey competition to which the twentieth birthday was applied.

Recommendation: No objection be filed.

A. L. VAUGHAN, Chairman

(There will be a pause in the proceedings to permit the withdrawal of nonfaculty committee members.)

V. REPORT OF THE COMMITTEE ON FACULTY WELFARE

Reported for Information

At the February 6 meeting of the University Senate, the Senate Committee on Faculty Welfare reported, among other things, on the University world-wide travel accident insurance policy. According to the contract then in force, a faculty member was covered if (a) he was at the time furthering the interests of the University of Minnesota, (b) he was traveling with the approval of the University of Minnesota, and (c) he was reimbursed for his travel expenses, although not necessarily by the University. Several questions were asked at that meeting which indicated the need for clarification of this condition.

At the next meeting of the Senate on March 5, the committee reported that it had consulted with Mr. Archer, director of insurance and retirement, concerning this condition in the contract. Mr. Archer agreed to reopen negotiations with the insurance company in order to clarify this condition and perhaps liberalize it. The negotiations were still in process at that time, but one important liberalization had already been approved by the insurance company. As a result of this change, faculty members are covered when they travel to professional meetings even if they pay their own way.

The negotiations between the University and the insurance company are now complete. Faculty members are covered under the new agreement if they are traveling on assignment by or with the authorization of the University for the purpose of furthering the business of the University. Their expenses need not be reimbursed by the University and the authorization need not be explicit. Faculty members on leave of absence without pay are not covered. The scope of the coverage can be illustrated by three examples which the insurance company has specifically agreed to cover:

(1) A faculty member attending a professional meeting, regardless of who pays his expenses and even if the professional meeting occurs during the summer months.

(2) A faculty member rendering the government professional services even if he collects a fee.

(3) A faculty member on leave with pay to conduct research while he is actually traveling in connection with that research.

Further details are provided on an information sheet which can be obtained from the director of insurance and retirement.

C. A. WILLIAMS, Chairman

VI. NEW BUSINESS

VII. NECROLOGY

ALBERT COMPTON BRODERS
1885-1964

Dr. Albert Compton Broders, a member of the staff of the Mayo Clinic from 1912 to 1950, and internationally recognized for the grading system for malignant tumors which bears his name, died in the hospital of the Scott and White Clinic, Temple, Texas, on March 27, 1964, of the effects of a stroke some time earlier. Since 1950, Dr. Broders had been a senior consultant in surgical pathology and pathologic anatomy at the Scott and White Clinic, where his two sons, Dr. Albert C. Broders, Jr., and Dr. C. W. Broders, are members of the staff.

Dr. Broders was born in Fairfax County, Virginia, on August 8, 1885, the son of Virginia Woodyard Broders and John Broders. He was graduated from the Pontomac Academy in Alexandria, Virginia, in 1905, and he received the degree of doctor of medicine from the Medical College of Virginia in 1910. He was an intern at the Memorial Hospital in Richmond, Virginia, from 1910 to 1912. During parts of 1911 and 1912 he was also an assistant to Dr. Charles R. Robins, professor of gynecology in the Medical College of Virginia. In the summer of 1911 and part of 1912 he was a graduate student in pathology in the Johns Hopkins Hospital in Baltimore, under the direction of Dr. Joseph Colt Bloodgood.

Dr. Broders came to Rochester, Minnesota, on August 12, 1912, as an assistant in surgical pathology in the Mayo Clinic. He was appointed an associate in pathology in 1919 and head of Section B of Surgical Pathology in 1922. He also carried out graduate work in pathology for which the University of Minnesota in 1920 awarded him the degree of master of science in pathology. Dr. Broders was appointed an instructor in pathology in the Mayo Foundation, Graduate School, University of Minnesota, in 1920, and was advanced to assistant professor in 1921, associate professor in 1923, and professor in 1936.

Dr. Broders was granted a year's leave of absence on August 1, 1935, to serve as professor of surgical pathology and director of cancer research at the Medical College of Virginia. On August 1, 1936, he returned to his former duties and positions in the Mayo Clinic and Mayo Foundation. In 1945 he was made director of the division of surgical pathology in the Mayo Clinic, a post he occupied until he retired in 1950.

Dr. Broders achieved international recognition for his studies in pathology, and particularly for his system of the grading of cancer on a numerical basis, in which 1 denotes a cancer of least malignancy and 4 denotes a cancer of utmost malignancy. He first published a description of this system of grading in *The Journal of the American Medical Association* in 1920, entitled "Squamous-Cell Epithelioma of the Lip: A Study of 537 Cases," and since that time the system has been adopted by laboratories of hospitals all over the world. Another paper, entitled "Carcinoma in Situ Contrasted With Benign Penetrating Epithelium," published in 1932 in the same journal, provoked much discussion in medical circles and is regarded as a classic contribution to the literature on pathology. He also devised a modification of the late Dr. Louis B. Wilson's technic for the rapid making of fresh-frozen section of tissue for microscopic study, orginated by Dr. Wilson in 1905. Dr. Broders had given his attention to a variety of diseases earlier in his career, but after about 1918 he devoted more and more time to researches in cancer.

Dr. Broders was certified as a specialist in pathology by the American Board of Pathology, Inc., in 1937. Many honors came to him during his long career in pathology: the Medical College of Virginia awarded him the honorary degree of doctor of science in 1929 and in 1949 Washington and Lee University conferred the same degree upon him. He was made an honorary member of the faculty of biology and medical sciences of the University of Chile in 1948, and in the same year was given honorary membership in the National Academy of Medicine of Buenos Aires and the Chilean Society of Normal and Pathologic Anatomy.

Dr. Broders was a fellow of the American College of Physicians and of the College of American Pathologists, and a member of the American Medical Association, the Medical Society of Virginia, the Bell County Medical Society, the Texas Medical Association, the American Association of Pathologists and Bacteriologists, the American Society of Clinical Pathologists, the Southern Medical Association, the American Association for the Advancement of Science, the Alumni Association of the Mayo Foundation, the Society of the Sigma Xi, and the Omega Upsilon Phi professional medical fraternity. He was an honorary member of the Alpha Omega Alpha medical honor society, and a corresponding member of the Argentine Medical Association and the Argentine Society of Normal and Pathologic Anatomy.

He was president of the Mayo Foundation chapter of the Society of the Sigma Xi in 1942 and 1943.

On March 1, 1951, Dr. Broders joined the staff of the Scott and White Clinic, Temple, Texas, as senior consultant in the department of surgical pathology and pathologic anatomy, a position he held until his death. In 1951 he was made professor of surgical pathology and pathologic anatomy of the Scott, Sherwood and Brindley Foundation, University of Texas Postgraduate School of Medicine, Temple Division. He held this appointment until 1955. He was also senior consultant in pathology in the M. D. Anderson Hospital for Cancer Research of the University of Texas in Houston.

Dr. Broders was married to Miss Adlene Zimmerman, of Buena Vista, Virginia, on September 8, 1915. Three children were born to them: Dr. Albert C. Broders, Jr., and Dr. Charles William Broders, of Temple, Texas; and Elizabeth Fairfax (Mrs. Armour T. Beckstrand) of Alexandria, Virginia.

WILLIAM ELLSWORTH BROOKE
1870-1963

William E. Brooke, professor emeritus of the Institute of Technology, was born October 7, 1870, in Minier, Illinois, and died December 22, 1963 at the age of 93, in the hospital at Kankakee, Illinois.

When he was 2 years old, his family moved to Ashland, Nebraska, where Professor Brooke attended the public schools. After graduation from high school, he attended the University of Nebraska where he graduated with the degree of B.C.E. in 1892 and went to work surveying for the Burlington Railroad throughout the states of Nebraska and Wyoming. By 1894, he had developed an interest in teaching, which was to be the driving force in his life, so he returned to the University of Nebraska as a fellow and assistant in mathematics and physics where he completed his M.A. degree in 1896. He then took a position in the Omaha High School where he remained until 1901. While there he married Helen Francis Langer on August 22, 1898.

Professor Brooke, better known to his colleagues as "Billy Brooke," came to the College of Engineering at the University of Minnesota in 1901 as an instructor in mathematics. In those early days, the college was so small that he was called on from time to time to teach other engineering subjects such as thermodynamics in addition to his beloved mathematics and mechanics. He became an assistant professor in 1905, full professor in 1907 and professor and head of the Department of Mathematics and Mechanics in 1912, which position he held until his retirement on June 17, 1939. He filled in as assistant dean and acting dean for a brief period in 1917.

Realizing there was much more mathematics and mechanics to learn, Professor Brooke attended summer school at the University of Chicago in 1906 and then took a leave of absence to study at the University of Gottingen in Germany in 1908-1909. Even more important, he continued his study of mathematics and mechanics both with his colleagues and alone the rest of his active life on campus and long after his retirement. He never lost his interest in all aspects of the subject.

Professor Brooke wrote several textbooks including *Plane and Spherical Trigonometry* with G. N. Bauer and *Engineering Mechanics* with H. B. Wilcox, both of which were widely accepted in engineering schools.

He was a member of Sigma Xi, Tau Beta Pi, and Triangle Fraternities, a fellow of the American Association for the Advancement of Science, a member of the American Mathematics Association and the Society for the Promotion of Engineering Education. He also belonged to the Minnesota Engineering Society, Circolo Matematics di Palermo and Deutches Mathematiker Vereingung.

Those who knew Professor Brooke well realized his devoted interest in mathematics and mechanics and continued effort to convey these subjects to his students. He was never too busy to help a freshman with his algebra or trigonometry or a graduate student or colleague with a much deeper problem. He was always available and willing to help and took a special interest in trying to solve some of the problems students encounter on entering college. He served on the freshman student work committee for many years counseling students who got into difficulties of one kind or another. His students revered him and respected him and always looked him up when they returned to campus. In 1950, on his 80th birthday, a group of his colleagues and former students held a dinner honoring Professor Brooke and talked over many incidents of his long and useful career.

Among his hobbies, Professor Brooke was a very able and active musician specializing on the oboe, English horn, and bassoon. He was a charter member of the Minneapolis Symphony Orchestra and played with them for many years. When complications in scheduling developed, Professor Brooke filled in at the opening of the Minnesota Theatre.

He was a student of religions, past and present, and devoted a great deal of time reading about them and studying their beliefs and practices.

After his wife died, Professor Brooke left Minneapolis in July 1958 to live with his brother, Irving Brooke, at River Forest, Illinois. He entered a rest home in Kankakee, Illinois, December 7, 1962. He is survived by his brother and a niece, Mrs. Leslie Jennings, of Kankakee, Illinois.

SAMUEL EDWARD SWEITZER
1877-1964

Unexpected in spite of his advanced years was the death in Minneapolis on February 14, 1964 of Dr. Samuel F. Sweitzer in his 86th year, a Medical School graduate in 1901 and long-time clinical teacher of dermatology. Born in Dennison, Ohio, on December 14, 1877, he was first appointed to the faculty of the Medical School in 1905; and he was emeritus professor in recent years, having been in charge of all dermatologic teaching for a period of years prior to the establishment of the Division of Dermatology in the Department of Medicine. Subsequently, he was in charge of the clinical service and teaching program at the Minneapolis General Hospital until his retirement there in 1947. He continued actively in practice in Minneapolis until shortly before his final illness. Dr. Sweitzer was an enthusiastic and entertaining teacher who will be remembered by all who spent any time in his outpatient clinic at the General Hospital. He had augmented his dermatologic experience by visiting European clinics on trips in 1904 and 1907, bringing back to Minnesota the information and concepts which led to an expanded and more effective instructional program here.

Dr. Sweitzer achieved national recognition among dermatologists, being elected to the American Dermatological Association in 1921; he was later its vice president. He was a loyal member of the Minnesota Dermatological Society and was honored at a special meeting of that group some years ago. Probably no member of the Minnesota Academy of Medicine was more loyal and regular in attendance at its meetings. He had served as its president and he was in attendance at the regular meeting of the month before his death.

NEWELL R. ZIEGLER
1899-1964

Doctor Newell R. Ziegler died in the University of Minnesota Hospitals on January 20, 1964. He is survived by his wife, Leah (nee Whitmer).

Doctor Ziegler was born in Bippus, Indiana on July 5, 1899. He received his bachelor of science degree at the University of Minnesota in 1925. Following this he took a Master's degree in bacteriology and immunology with a physiological chemistry minor. Concurrently with this, he took the medical school course at this university, his Master's degree being received in 1926 and his doctor of medicine degree in 1928. He continued in the Department of Bacteriology and Immunology and received his doctoral degree in 1930. Working with Doctor H. Orin Halvorson, Doctor Ziegler did important work in the application of statistics to problems in bacteriology. This had an important influence in the field and the Halvorson-Ziegler tables were widely referred to.

Doctor Ziegler occupied a graduate scholarship from the Department of Bacteriology and Immunology for the year 1925-26; was a teaching assistant in 1926-27; and on a teaching fellowship during 1927-30. Leaving the University of Minnesota he became assistant professor of bacteriology at Washington College at Pullman, Washington, after which he became associate professor of Bacteriology and Preventive Medicine at the University of Missouri Medical School, Columbia, Missouri. In 1932 he was made chairman of the department at Columbia.

Doctor Ziegler's stay at the University of Missouri was interrupted by four years of service in the Army Medical Corps from September 1942 to September 1946. He entered with the rank of Captain and rose to the rank of Lt. Colonel. During this period he was Assistant Chief of Laboratory Service at Kennedy General Hospital for two years and then was promoted to the position of Chief. He returned to the University of Missouri Medical

School in 1946, still as chairman, and was promoted to the rank of full professor. While there, Doctor Ziegler made important contributions in epidemiological studies involving bacteriological pathogens spread by inadequately chlorinated water supplies. In 1947 he returned to the University of Minnesota Medical School as associate professor in the Department of Bacteriology and Immunology, of which at that time Dr. C. P. Larson was chairman. At this time he was active in the special medical courses arranged for doctors of medicine returning from the service. During the years 1947-59 Doctor Ziegler developed the Clinical Bacteriology Laboratory and later the Blood Bank at the University of Minnesota Hospitals, having successively the titles of director of these laboratories. In 1959 Doctor Ziegler surrendered his direct service duties in this respect and continued as director of special immunology in the Department of Laboratory Medicine in the Medical School.

Doctor Ziegler was a well-trained individual of meticulous habits and his influence upon those people training in the hospital laboratories, both physicians and others, was of great value. He was critical and demanded a high level of performance. He was quiet and dignified in behavior and commanded the respect of those about him. Doctor Ziegler's work in developing the techniques that permitted the mixing of many bloods to be used in the difficult techniques of intra-cardiac surgery was of great importance. He continued in the Medical School to be a source of valuable information on the elaborate practical problems of immunohematology. He took a special interest in erythroblastosis fetalis, the condition in infants determined by incompatibility of the infant with the mother due to the nature of the father's blood group. Doctor Ziegler was a member of the American Society of Microbiologists, the American Association for the Advancement of Science, the Society of the Sigma Xi, the American Association of Blood Banks, and the International Society of Blood Transfusion. He was an ardent field sportsman.

At various times since coming to the University of Minnesota Doctor Ziegler was in ill health. In the fall of 1962 it was obvious to his friends around him that his health was suffering further and in December he sought specific medical advice. Unfortunately, his illness was due to a rapidly spreading cancer of the colon.