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ABSTRACT

A job analysis was conducted to define the content domain in which newly licensed (certified) biology teachers must be knowledgeable in order to perform their jobs competently. Results of the job analysis will be used to develop test specifications for the Subject Assessment in Biology of the Praxis Series: Professional Assessments for Beginning Teachers. A draft domain of 11 content areas and 128 knowledge statements was constructed by test development staff at the Educational Testing Service. This domain was reviewed by 9 subject matter experts, who approved a revised domain of 179 statements in 10 content areas. This revised domain was then reviewed by an advisory panel of 8 biology subject matter experts who made numerous changes to arrive at a final inventory of 189 knowledge statements in 10 categories. This version was subjected to verification/refutation through a national survey of 540 teachers, 227 college faculty, and 88 school administrators (855 biology professionals). Survey participants rated the statements in terms of their importance for newly licensed teachers and indicated the level of understanding needed by the new teacher in each knowledge area. Importance ratings were computed, and correlations of the profiles of these mean importance ratings were computed across both groups of education professionals and among subgroups of respondents. These 2 analyses identified 29 statements that did not meet the inclusion criteria and 160 statements that should be used as the foundation for the test specifications. Seven appendixes provide additional information about study methodology and present the importance ratings by category and subgroup. (Contains 5 tables, 4 appendix tables, and 17 references.) (SLD)

RESEARCH REPORT

JOB ANALYSIS OF THE KNOWLEDGE IMPORTANT FOR NEWLY LICENSED BIOLOGY TEACHERS

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May 1996

Job Analysis of the Knowledge Important for Newly Licensed Biology Teachers

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Executive Summary

A job analysis was conducted to define the content domain in which newly licensed (certified) biology teachers must be knowledgeable to perform their jobs in a competent manner. The results of the job analysis will be used to develop test specifications for the Subject Assessment in Biology of the Praxis Series: Professional Assessments for Beginning Teachers™.

A draft domain of knowledge statements was constructed by Educational Testing Service (ETS) Test Development staff with subject-matter expertise in biology and ETS Research staff with expertise in job analysis methodology. In the process of developing the draft domain, ETS subject-matter experts reviewed previous National Teacher Examination (NTE) biology test specifications and items, state licensure and certification requirements for biology teachers, and relevant professional literature. The resultant draft domain consisted of 11 major content areas and 128 knowledge statements. The 11 content areas were: (a) History, Philosophy, and Methodology of Science, (b) The Cell, (c) Inheritance, (d) Evolution, (e) Diversity of Life, (f) Plants, (g) Animals, (h) Ecology, (i) Science, Technology, and Society, (j) Laboratory Techniques, and (k) Content-Specific Pedagogy.

This draft domain was then reviewed by an external review panel of nine biology subject-matter experts: four classroom teachers, four college faculty, and one consultant from the National Science Foundation. The panel reviewed the draft domain for (a) the appropriateness of its overall structure and (b) the appropriateness of the specific statements and their completeness and clarity. Revisions suggested by the panel were obtained via telephone interviews conducted by ETS research staff. Many changes were made to the draft domain, including the revision of the major content areas and the addition of several knowledge statements. The revised domain consisted of 179 statements grouped in the following 10 areas: (a) Basic Principles of Science, (b) Molecular and Cellular Biology, (c) Classical Genetics, (d) Evolution, (e) Diversity of Life, (f) Plants, (g) Animals, (h) Ecology, (i) Issues and Applications Relating to Science, Technology, and Society, and (j) Content-Specific Pedagogy.

This revised draft domain was then reviewed by an advisory/test development committee of eight biology subject matter experts. The committee included three classroom teachers, three college faculty, and two school administrators. Committee members were charged with modifying the revised draft domain so that it accurately reflected what they believed were the knowledge areas important for newly licensed (certified) biology teachers. This modification process occurred during a two-day meeting held in Princeton, New Jersey. The committee made numerous changes to the job analysis inventory, including changes to the directions and changes to the knowledge statements themselves. The final form of the job analysis inventory comprises 189 knowledge statements grouped into the same 10 categories.

This revised domain was then subjected to verification/refutation through a national survey of 540 teachers (approximately 10 per state and 10 from the District of Columbia), 227 college faculty (approximately 5 per state and 5 from the District of Columbia), and 88 school administrators (1 or 2 per state and the District of Columbia) for a total of 855 biology professionals. The mailing list was made up of names from the membership rosters of the National Association of Biology Teachers, the National Science Supervisors Association, and the National Science Teachers Association. Names from each roster were drawn at random in a way that satisfied the state participation requirements mentioned above.

The survey participants were asked to rate the statements in terms of their importance for newly licensed (certified) biology teachers to perform their jobs in a competent manner. The 5-point rating scale ranged from 0 (of no importance) to 4 (very important). The purpose of the survey administration was to identify a core of knowledge statements that relatively large numbers of biology professionals verified to

be important for newly licensed biology teachers. This objective is accomplished through analysis of the mean importance ratings provided by two groups of education professionals (i.e., teachers, and college faculty) and by appropriate subgroups of respondents (i.e., subgroups by gender, race/ethnicity, geographic region, teaching experience). Statements that are judged to be important by *all* respondent groups and subgroups define the core. The core becomes the primary data base for the development of test specifications. The derivation of test specifications from those statements verified to be important by the surveyed education professionals provides a substantial evidential basis for the content validity of The Praxis II Subject Assessment in Biology.

In addition to the importance ratings, respondents were also asked to judge the *level of understanding* needed by the newly licensed (certified) biology teacher for each knowledge area. The results of these judgments were used to guide item writing during the development of the biology examination. *Level of understanding* judgments were made using a 5-point scale ranging from 0 (an understanding of the knowledge area is not needed) to 5 (requires the ability to analyze the knowledge area into component parts and explain the interrelationships among the parts).

Two types of data analysis were conducted to support the development of content valid test specifications for the Subject Assessment in Biology. First, importance rating means on each knowledge statement for teachers and college faculty and for each of the relevant demographic subgroups were computed. Second, correlations of the profiles of these mean importance ratings were computed across both groups of education professionals and among the appropriate subgroups of respondents.

A mean importance rating cut point of 2.50 (the midpoint between moderately important [scale value 2] and important [scale value 3]) was established to identify the core of important statements. Statements that were judged by both groups of education professionals and all relevant demographic subgroups to be 2.50 or higher comprised the core and, therefore, were considered eligible for inclusion in the development of test specifications. (However, because the survey participants were not involved in the development of the survey, they may lack certain insights that the Advisory Committee members have due to their high level of involvement in the domain definition. As a consequence, if the committee believes that a knowledge statement rated below 2.50 should be included in the specifications and the committee can provide *compelling written rationales*, that knowledge statement may be reinstated for inclusion in the test specifications.)

The results of the mean analysis conducted for teachers and college faculty showed that 21 statements were rated less than 2.50. This represents 11.1% of the content domain. In the subgroup analyses, 29 statements (15.3%) were rated below 2.50. All of the statements identified in the prior analysis of employment category were also identified in the subgroup analysis. *Thus, the two analyses together identified 29 of the 189 statements (15.3%) that did not meet the 2.50 criterion for inclusion.* Of the 29, 9 statements were in the Molecular and Cellular Biology category, 6 were in the Animals category, and 5 each were in the Basic Principles of Science and Plants categories.

The computation of correlation coefficients to assess agreement in terms of perceived relative importance of the knowledge statements revealed a very high level of agreement. The correlation between teachers and college faculty was .94. Coefficients generated during the demographic subgroup analyses all exceeded .90. These findings indicate that there is substantial agreement on the relative importance given to the statements by a diverse group of biology professionals.

The 160 knowledge statements that were verified to be important by the surveyed teachers, college faculty, and demographic subgroups should be used as the foundation for the development of test specifications for the Subject Assessment in Biology. Test specifications that are linked to the results of a

job analysis provide support for the content validity of the derived assessment measure and should be seen as part of an initial step in ensuring fairness to subgroups of biology teacher candidates. It is reasonable to assume that, because of testing and psychometric constraints (e.g., time limits, ability to measure some content reliably), not all of the verified content can be included in the assessment measures. One source of information that may guide the Advisory Committee in their decision making is the mean importance rating. Although a rank ordering of the content by mean importance rating is not recommended, initial consideration should be given to content that is well above the cut point and represents the breadth of content coverage desired.

Evidence was also provided in this study of the comprehensiveness of the content domain within the ten major content areas. This information has implications for the adequacy of the content domain. If the domain was adequately defined, then the categories should be judged to have been well covered by their accompanying statements. Indeed, the results indicated that the major knowledge categories were reasonably well covered and that the overall content domain was comprehensive.

Finally, data were collected regarding the emphasis that should be given in the test to each of the 10 categories. This information will be used by the Advisory Committee in their decisions about the appropriate weighting of the test.

Table of Contents

	Page
Acknowledgments	i
Executive Summary	ii
List of Tables	vii
Introduction	1
Purpose of the Study	1
Standards for Educational and Psychological Testing	1
Job Analysis	1
Objectives of the Job Analysis Study	2
Methods	2
Definition of the Knowledge Domain	2
Development of a Draft Knowledge Domain	2
Evaluation of Draft Domain by External Review Panel	3
Advisory Committee Meeting	3
Pilot Test of the Job Analysis Inventory	4
Large-Scale Survey	5
Survey Instrument	5
Survey Participants	5
Survey Administration	5
Data Analysis	5
Means	6
Correlations	6
Criterion for Interpretation of Mean Importance Ratings	6
Results	7
Survey Respondents	7
Response Rate	7
Demographic Characteristics	7

Page

Mean Importance Ratings 7

Biology Professionals 7

Demographic Subgroups 7

Correlations of the Profiles of Mean Importance Ratings 11

Biology Professionals 11

Demographic Subgroups 11

Mean Ratings of Content Coverage 12

Mean Percentage Weights for Test Content Emphasis: Recommendations for Test Content 12

Summary and Conclusions 13

References 15

Appendix A: Subject Matter Experts A-1

Appendix B: Job Analysis Survey B-1

Appendix C: Survey Materials C-1

Appendix D: Demographic Distributions D-1

Appendix E: Overall Importance and Level of Understanding Ratings E-1

Appendix F: Importance Ratings by Emplyment Category F-1

Appendix G: Importance Ratings by Demographic Subgroups G-1

List of Tables

		Page
Table 1:	Mean Ratings Less Than 2.50 for Biology Teachers and College Faculty	8
Table 2:	Mean Ratings Less Than 2.50 for Demographic Subgroups	9
Table 3:	Correlations of the Mean Importance Ratings among Demographic Subgroups	11
Table 4:	Mean Ratings of Content Coverage	12
Table 5:	Mean Percentage Weights for Test Content Emphasis	13

Introduction

Purpose of the Study

The subject assessments for The Praxis Series: Professional Assessments for Beginning Teachers™ are designed to assess a prospective teacher's content knowledge of a specific subject area and, in some cases, subject-specific pedagogical knowledge. The focus of such tests is based on the premise that beginning teachers should demonstrate knowledge of the subjects they intend to teach (Grossman, Wilson, & Shulman, 1989) and, perhaps, demonstrate knowledge of teaching principles, strategies, and resources specific to those subjects (Grossman, 1989; McDiarmid, Ball, & Anderson, 1989; Reynolds, 1992). The Praxis Series can be used by state agencies as one of several criteria for initial teacher licensure. Included as part of the subject assessments is a licensure examination for biology teachers. To identify the content domain for this examination and to support the content validity and relevance of this examination, a job analysis was conducted to identify a knowledge base for newly licensed biology teachers. This report will describe the job analysis study. In particular, it will provide the rationale for conducting the job analysis, present the methods used to define job-related knowledge, describe the statistical analyses conducted, report the results of these analyses, and specify the implications for developing test specifications.

Standards for Educational and Psychological Testing

The *Standards for Educational and Psychological Testing* (1985) is a comprehensive technical guide that provides criteria for the evaluation of tests, testing practices, and the effects of test use. It was developed jointly by the American Psychological Association (APA), the American Educational Research Association (AERA), and the National Council on Measurement in Education (NCME). The guidelines presented in the *Standards* have, by professional consensus, come to define the necessary components of quality testing. As a consequence, a testing program that adheres to the *Standards* is more likely to be judged to be valid and defensible than one that does not.

There are two categories of criteria within the *Standards*, primary and secondary. Those classified as primary "should be met by all tests . . . Test developers and users . . . are expected to be able to explain why any primary standards have not been met" (AERA, APA, & NCME, 1985, p. 2). One of the primary standards is that the content domain of a licensure or certification test should be defined in terms of the importance of the content for competent performance in an occupation. "Job analyses provide the primary basis for defining the content domain." (p. 64).

The use of job analysis to define the content domain is a critical component in establishing the content validity of licensure and certification examinations. Content validity is the primary validation strategy used for these examinations. It refers to the extent to which content covered by an examination overlaps with the important components (tasks, knowledge, skills, or abilities) of a job (Arvey & Faley, 1988). Demonstration of content validity is accomplished through the judgments of subject-matter experts. It is enhanced by the inclusion of large numbers of subject-matter experts who represent the diversity of the relevant areas of expertise within the profession or job in question (Ghiselli, Campbell, & Zedeck, 1981). The lack of a well-designed job analysis has been cited by the courts as a cause of test invalidity (e.g., *Kirkland v. New York Department of Correctional Services* [1974]).

Job Analysis

Job analysis refers to procedures designed to obtain descriptive information about the tasks performed on a job and/or the knowledge, skills, and abilities thought necessary to adequately perform those tasks (Gael, 1983). The specific type of job information collected for a job analysis is determined by the

purpose for which the information will be used. For purposes of developing licensure and certification examinations, a job analysis should identify the *important knowledge or abilities necessary to protect the public* (AERA, APA, & NCME, 1985). In addition, a well-designed job analysis should include the participation of various subject-matter experts (Mehrens, 1987); and the data collected should be representative of the diversity within the job. Diversity refers to regional or job context factors and to subject-matter-expert factors such as race/ethnicity, experience, and gender (Kuehn, Stallings, & Holland, 1990). The job analysis conducted in the present study was designed to follow the guidelines presented in the *Standards* and to adhere to accepted professional practice.

Objectives of the Job Analysis Study

The objectives of this study were (a) to construct a comprehensive domain of knowledge that is important for newly licensed (certified) biology teachers and then (b) to obtain, using survey methodology, the independent judgments of a national sample of biology educators to verify or refute the importance of the domain of knowledge. The verification/refutation component plays a critical role in ensuring that the domain, in whole or in part, is judged to be relevant to the job of a newly licensed biology teacher by a wide array of education professionals. The components of the domain that are verified should be used to guide the development of test specifications for The Praxis II Subject Assessment in Biology.

Methods

The job analysis study described in this report involved a multi-method approach that included, as mentioned above, subject-matter experts and a national survey. First, groups of subject-matter experts defined a knowledge domain important for newly licensed/certified biology teachers. A description of this knowledge domain was then sent out to biology professionals through a large-scale national survey. The purpose of the survey administration was to obtain verification and/or refutation that the previous groups of subject-matter experts had defined a domain of knowledge that is important for newly licensed biology teachers. Through this process a core of important knowledge that is related to the job of the newly licensed biology teacher may be identified. Thus, the survey functions as a "check and balance" on the judgments of the subject-matter experts and reduces the likelihood that unimportant knowledge areas are included in the development of the test specifications. The use of a job analysis survey is also an efficient and cost-effective method of obtaining input from large numbers of subject-matter experts and makes it possible for ratings from various subgroups within the sample to be analyzed separately.

The survey participants were biology teachers, administrators, and college faculty whose names and addresses were obtained from the membership rosters of the National Association of Biology Teachers, the National Science Supervisors Association, and the National Science Teachers Association. The specific steps in the job analysis process are described below.

Definition of the Knowledge Domain

Development of a draft knowledge domain. The first step in the process of conducting the job analysis was the construction of a preliminary knowledge domain. The domain was developed by Educational Testing Service (ETS) Test Development staff who have subject-matter expertise in biology and ETS Research staff who have expertise in job analysis methodology. In the process of developing the draft, the ETS subject-matter experts reviewed state licensure and certification requirements for biology teachers, previous National Teacher Examination (NTE) biology test specifications and items, and relevant professional literature.

The resultant draft domain consisted of 11 major content areas and 128 knowledge statements. The 11 content areas were: (a) History, Philosophy, and Methodology of Science, (b) The Cell, (c) Inheritance, (d) Evolution, (e) Diversity of Life, (f) Plants, (g) Animals, (h) Ecology, (i) Science, Technology, and Society, (j) Laboratory Techniques, and (k) Content-Specific Pedagogy.

Evaluation of draft domain by External Review Panel. Consistent with a content validity framework, the job analysis study was designed to obtain input from many subject-matter experts at several critical points in the domain definition process. To this end, an External Review Panel of nine biology professionals was formed to review the draft domain.

The External Review Panel comprises four classroom teachers, four college faculty, and one consultant from the National Science Foundation. Individuals were considered for membership through a process of peer recommendation. All of the review panelists have experience either teaching biology or supervising teachers of biology. Generally, they are prominent and active in professional associations and/or teacher licensure. In addition to their subject-matter expertise, the panel was formed so as to have representation by gender, race/ethnicity, and geographic location. Members of the panel are listed in Appendix A.

The panelists were instructed to review the draft and to make modifications they felt were necessary to cover adequately the important aspects of teaching biology. They were further instructed that these modifications could include restructuring the content domain in terms of its major categories, adding important knowledge statements, deleting unimportant statements, elaborating statements with relevant examples, and revising statements into language that is clear and appropriate for individuals in biology. Revisions suggested by the panel were obtained via telephone interviews conducted by ETS Research staff.

Information from the interviews was compiled, discussed with ETS Test Development staff, and, subsequently, used to revise the knowledge domain draft. Many changes were made to the draft domain, including the revision of the major content areas and the addition of several knowledge statements. The revised domain consisted of 179 statements grouped in the following 10 areas: (a) Basic Principles of Science, (b) Molecular and Cellular Biology, (c) Classical Genetics, (d) Evolution, (e) Diversity of Life, (f) Plants, (g) Animals, (h) Ecology, (i) Issues and Applications Relating to Science, Technology, and Society, and (j) Content-Specific Pedagogy.

Advisory Committee meeting. The next step in the job analysis process was a meeting with an Advisory Committee of eight subject-matter specialists held in Princeton, New Jersey. The committee was charged with developing a final version of the job analysis inventory and with developing the specifications for the new test. The committee is also responsible for developing and revising test items and assembling the final form of the new examination. Like the External Review Panelists, members of the advisory committee have documented knowledge of and experience in biology. The committee was comprised of three classroom teachers, three college faculty members, and two school administrators and was representative in terms of gender, ethnicity, and geographic location. Members of the committee are also listed in Appendix A.

The Advisory Committee meeting was led jointly by ETS Test Development and Research staff. Prior to the meeting, committee members were mailed a copy of the draft domain to review. They were informed of the purpose of the meeting and asked to come prepared to discuss their review. Because they would use the results obtained from the survey administration of the content domain, it was critical that committee members clearly understood each statement. The group interaction during the meeting fostered discussions that generated suggestions not made during the individual interviews with the External Review Panelists.

The committee made numerous changes to the job analysis inventory, including changes to the directions and to the knowledge statements. The final form of the job analysis inventory was comprised of 189 knowledge statements. The committee did not, however, make changes to the 10 categories.

During the meeting, the Advisory Committee also reviewed and approved two rating scales for the inventory. The first rating scale required respondents to make judgments regarding importance for the newly licensed teacher. The importance scale, which is shown below, is in compliance with professional standards (cf. AERA, APA, & NCME, 1985) and is frequently used in licensure and certification job analysis studies.

> How important is the knowledge and understanding of this topic to the competent performance of a newly licensed (certified) biology teacher?
>
> (0) Of no importance
> (1) Of little importance
> (2) Moderately important
> (3) Important
> (4) Very important

In addition to the importance scale, the committee reviewed and approved a *level of understanding* scale (shown below). Responses on this scale will be used to guide item writing during the development of the biology examination.

> What level of understanding of the knowledge area is typically needed by newly licensed (certified) biology teachers?
>
> (0) An understanding of the knowledge area is not needed.
> (1) Requires the ability to define the terms used in the knowledge area.
> (2) Requires the ability to comprehend the essential properties of the knowledge area.
> (3) Requires the ability to apply/utilize the knowledge area to address problems or questions.
> (4) Requires the ability to analyze the knowledge area into component parts and explain the interrelationships among the parts.

The committee also reviewed and approved items concerning demographic and background information (e.g., gender, teaching experience, geographic location). Such items were included so that we could describe the composition of the survey respondent group and conduct analyses of the survey responses by various subgroups of respondents (e.g., males and females).

Pilot test of the job analysis inventory. After the meeting, a revised job analysis inventory was given to the committee members for final approval. Once approval was obtained, the inventory was pilot tested on a group of four classroom teachers and two college faculty. The pilot participants were asked to review the survey for clarity of wording, ease of use, and comprehensiveness of content coverage. The pilot test indicated that no one had difficulty completing the inventory and that no additional changes were necessary.

Large-Scale Survey

Survey instrument. The finalized survey consisted of three parts. Part I included the 10 major knowledge categories and the 189 specific knowledge statements. Survey respondents were asked to rate the statements using the importance and level of understanding scales shown above.

For each major knowledge category, there was also a content coverage question in Part I. Survey participants were asked to indicate how well each major category was covered by its knowledge statements. Respondents made their judgments using a 5-point rating scale (1=Poorly, 2=Somewhat, 3=Adequately, 4=Well, 5=Very well). The participants also had an opportunity to identify and write in knowledge statements that they believed should be added to the domain.

In Part II of the survey, participants were asked to indicate the weight (emphasis) that each of the major knowledge categories should receive on the assessment. This was accomplished by distributing 100 total points across the major categories. These point distributions were converted into percentages, representing the percentage of items that the survey respondents believed should be devoted to each area.

In Part III, participants were asked for demographic and background information. As previously noted, these items are used to describe the respondents and to perform subgroup analyses. A copy of the final version of the survey is provided in Appendix B.

Survey participants. The primary sample for this study consisted of 540 teachers (approximately 11 per state and the District of Columbia), 227 college faculty (approximately 5 per state and the District of Columbia), and 88 school administrators (1 or 2 per state and the District of Columbia) for a total of 855 education professionals (approximately 17 per state and the District of Columbia). The mailing list was made up of names from the membership rosters of the National Association of Biology Teachers, the National Science Supervisors Association, and the National Science Teachers Association so that appropriate people could be reached. Names from each roster were drawn at random in such a way as to satisfy the state participation requirements noted above.

Survey administration. The surveys were administered to the sample in October 1990. Each survey was accompanied by a letter of invitation to participate and a postage-paid envelope for return of the completed survey. A reminder postcard was mailed approximately one week after the survey mailing. The cover letter and follow-up postcard are provided in Appendix C.

The purpose of the survey administration was to identify a core of knowledge statements that relatively large numbers of biology professionals judged to be relevant (verified as important) to newly licensed biology teachers. This objective was accomplished through an analysis of the mean importance ratings provided by teachers, college faculty, and by demographic subgroups. Knowledge statements that were judged to be important by both groups of education professionals and each of the demographic subgroups define the core. The core will become the primary data base for the development of test specifications for the Subject Assessment in Biology. The derivation of test specifications from those knowledge statements verified as important by the surveyed professionals will provide substantial evidence for the content validity of the assessment.

Data Analysis

Two types of data analysis were conducted to support the development of content valid test specifications for the Subject Assessment in Biology: (a) Means were computed of the importance ratings for each knowledge statement by the two groups of biology professionals and by the appropriate subgroups

of respondents, and (b) correlations of the profiles of these mean importance ratings were computed across the two groups of professionals and the appropriate subgroups of respondents.

Means. The mean analysis is used to determine the level (absolute value) of importance attributed to each knowledge statement. Means were computed for teachers and college faculty and for subgroups of respondents (subgroups by gender, race/ethnicity, geographic region, and biology teaching experience). An analysis of importance ratings by geographic region is consistent with the recent legal emphasis on addressing regional job variability when job analyses are conducted for content domain specification purposes (Kuehn et al., 1990). We used the regional categorizations established by the National Association of State Directors of Teacher Education and Certification (NASDTEC) in our analysis. Gender and race/ethnicity subgroups were included because they represent protected "classes" under Title VII of the Civil Rights Act of 1964. We used a dichotomous breakdown of teaching experience at the five-year point so that the judgments of less experienced teachers and more experienced teachers could each be represented. Only classroom teachers, not administrators or college faculty, were included in the analysis of teaching experience.

A respondent category was required to have at least 25 respondents to be included in the mean analysis (e.g., $\geq$ 25 college faculty, $\geq$ 25 females). This number of respondents provides some assurance that the sample mean is a reasonable estimate of the corresponding population mean (Walpole, 1974). Due to the minimum number requirement, data for administrators were not analyzed separately.

In addition, mean ratings were computed for the responses to the content coverage questions and the Recommendation for Test Content section of the job analysis survey. These analyses were computed for both teachers and college faculty.

Correlations. The correlational analysis was used in this study to determine the extent of agreement among teachers and college faculty and among the demographic subgroups of respondents on the relative importance of the knowledge statements. Relative importance refers to the similarity of the pattern of mean ratings generated by the different respondent groups. For example, the profile of 189 mean ratings for teachers is correlated with the profile of 189 mean ratings for faculty. If these two profiles are similar (the shapes of the profiles correspond), the value of the correlation coefficient will be close to 1.00.

Criterion for Interpretation of Mean Importance Ratings

Since the purpose of a job analysis is to ensure that only the most important knowledge statements are included in the development of test specifications, a criterion (cut point) for inclusion is needed. For the importance rating scale used in the present job analysis, the value of this criterion is 2.50 (midpoint between moderately important and important). This criterion is consistent with the intent of content validity, which is to measure only important knowledge with the assessment instrument. Therefore, knowledge statements that receive a mean importance rating of 2.50 or more may be considered eligible for inclusion in the development of test specifications; knowledge statements that receive a mean rating of less than 2.50 may not be considered for inclusion. This criterion has been used in similar studies (Rosenfeld & Tannenbaum, 1991; Wesley, 1993). Because survey participants were not involved in the development of the content domain, however, they may lack certain insights that the Advisory Committee members have due to their high level of involvement in the definition of the domain. Consequently, if the committee believes that a knowledge statement rated below 2.50 should be included in the specifications and the committee can provide *compelling written rationales*, those knowledge statements may be reinstated for inclusion in the test specifications.

Results

Survey Respondents

Response rate. Of the 855 inventories mailed, 15 were returned incomplete for a variety of reasons (e.g., wrong address, individual was retired and declined to participate). Of the remaining 810, 338 (40.2%) were completed and returned. This is a typical rate of return for a voluntary survey of considerable length conducted through the mail.

Demographic characteristics. Results of the analyses of the responses to the demographic questions in the inventory are summarized in Appendix D. The survey respondents tended to be over 35 years old (87.3%), male (63.9%), White (89.6%), have at least a master's degree (81.7%), and have more than five years of experience teaching biology (85.2%). In general, it appears that the demographic composition of the survey respondents is representative of the teaching profession at large (cf. Feistritzer, 1986). In terms of geographic location, the survey respondents were reasonably well distributed across the four regions: Northeast -- 22.2%, Central -- 25.4%, South -- 26.6%, and Far West -- 25.4%.

Respondents tended to teach Grades 9-12 (58.6%) and College (37.3%). Oft-cited teaching assignments included General Biology (68.6%), Honors or AP Biology (31.7%), College (26.6%), Anatomy and Physiology (25.1%), and Ecology (16.9%).[1]

Mean Importance Ratings

Biology professionals. Means were computed on the importance and level of understanding ratings for the overall (total) respondent group. Also, the percentage distribution for the level of understanding ratings was tabulated. Because of space limitations, these data are provided in Appendix E.

Means and standard deviations of the importance ratings were also computed for teachers and college faculty survey respondents. These data are provided in Appendix F. Those knowledge statements rated less than 2.50 by any of the two groups are provided in Table 1. An empty cell in Table 1 indicates that the mean rating is 2.50 or higher. Of the 189 individual knowledge statements, 21 (11.1%) were rated below 2.50 by one or both of the groups. This indicates that the iterative process undertaken to develop the survey was effective in identifying knowledge areas that are important for newly licensed biology teachers.

Demographic subgroups. Means were computed for demographic subgroups based on gender, race/ethnicity, geographic region, and teaching experience. These data are presented in table format in Appendix G.

Those knowledge statements rated less than 2.50 by any of the 10 demographic subgroups are provided in Table 2. In this analysis, 29 statements (15.3%) were rated below 2.50. All of the statements identified in the prior analysis of employment category were also identified in the subgroup analysis. *Thus, the two analyses together identified 29 of the 189 statements (15.3%) that did not meet the 2.50 criterion*

[1] Respondents could indicate multiple responses to this question. Hence, the summed percentages exceed 100%.

Table 1
Mean Ratings Less Than 2.50 for Biology Teachers and College Faculty

	Teachers (N=188)	College Faculty (N=99)
A. BASIC PRINCIPLES OF SCIENCE		
Scientific Methodology/Techniques/History		
10 History and philosophy of science	2.36	2.42
Mathematics, Measurement, and Data Manipulation		
14 Unit conversion/dimensional analysis	2.29	2.46
18 Measures of central tendency and dispersion	2.13	
B. MOLECULAR AND CELLULAR BIOLOGY		
Chemical Basis of Life		
36 Coupled reactions, free-energy changes, thermodynamics	2.37	
38 Chemiosmosis in respiration		2.41
41 Chemiosmosis in photosynthesis	2.42	2.44
42 Interrelationships of anabolic and catabolic pathways	2.48	
Cell Structure and Function		
51 Fungal cells		2.43
Molecular Genetics		
59 Transposable elements	2.32	2.19
63 Microbial genetics	2.44	2.34
F. PLANTS		
Physiology		
99 C3 and C4 photosynthesis	2.38	2.26
100 CAM (Crassulacean acid metabolism)	1.83	1.73
103 Water potential		2.46
105 Mycorrhizae	2.00	2.02
G. ANIMALS		
Reproduction and Development		
128 Parthenogenesis	2.30	2.22
Behavior		
133 Taxes	2.35	2.34
134 Instincts	2.49	2.40
135 Learned behaviors (e.g., imprinting, conditioning, insight)		2.46
H. ECOLOGY		
Populations		
142 Patterns of dispersion (e.g., random, clumped, uniform)	2.49	2.31
143 Life-history patterns (e.g., r and k strategies, mortality)	2.28	2.31
I. ISSUES AND APPLICATIONS RELATING TO SCIENCE, TECHNOLOGY, AND SOCIETY		
166 Prediction and preparation for natural disasters	2.27	2.13

Table 2
Mean Ratings Less Than 2.50 for Demographic Subgroups

	Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
	Female	Male	POC	White	NE	C	S	FW	≤5	>5
A. BASIC PRINCIPLES OF SCIENCE										
Scientific Methodology/Techniques/History										
9 Important scientific findings, scientist(s)							2.45	2.42		
10 History and philosophy of science	2.38	2.38	2.37	2.38	2.35	2.46	2.37	2.33	2.38	2.36
Mathematics, Measurement, and Data Manipulation										
14 Unit conversion/dimensional analysis	2.37	2.36	2.46	2.36	2.27	2.33	2.40	2.45		2.23
16 Estimation/approximation			2.43							
18 Measures of central tendency and dispersion	2.28	2.43	2.21	2.39	2.36	2.23	2.41		2.06	2.16
B. MOLECULAR AND CELLULAR BIOLOGY										
Chemical Basis of Life										
36 Coupled reactions, free-energy changes, thermodynamics		2.48		2.46	2.46		2.47			2.34
38 Chemiosmosis in respiration		2.49		2.47	2.41					
41 Chemiosmosis in photosynthesis	2.46	2.44		2.42	2.44	2.46		2.41		2.39
42 Interrelationships of anabolic and catabolic pathways					2.48					2.48
43 Structure of enzymes									2.47	
Cell Structure and Function										
51 Fungal cells		2.46			2.45	2.44				
Molecular Genetics										
59 Transposable elements	2.24	2.40		2.32	2.37	2.30	2.39	2.31	2.25	2.34
63 Microbial genetics	2.36	2.49		2.41	2.45	2.38		2.38	2.29	2.47
64 Recombinant DNA technology									2.48	
F. PLANTS										
Evolution										
94 Major divisions (e.g., bryophytes, pteridophytes)	2.48			2.48	2.39					

	Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
	Female	Male	POC	White	NE	C	S	FW	≤5	>5
Physiology										
99 C3 and C4 photosynthesis	2.28	2.39	2.48	2.33	2.33	2.29	2.38	2.40		2.35
100 CAM (Crassulacean acid metabolism)	1.82	1.81	2.15	1.78	1.73	1.80	1.86	1.86	2.00	1.81
103 Water potential						2.40				
105 Mycorrhizae	2.01	2.03	2.15	2.00	1.89	2.06	2.01	2.12	2.39	1.93
G. ANIMALS										
Reproduction and Development										
128 Parthenogenesis	2.19	2.33	2.44	2.25	2.26	2.23	2.25	2.39		2.25
130 Growth and differentiation (e.g., homeotic genes, induction)	2.42									
131 Metamorphosis	2.48									
Behavior										
133 Taxes	2.30	2.41	2.44	2.35	2.34	2.34	2.35	2.44		2.32
134 Instincts	2.41			2.44	2.45	2.43	2.46			2.45
135 Learned behaviors (e.g., imprinting, conditioning, insight)						2.49				
H. ECOLOGY										
Populations										
142 Patterns of dispersion (e.g., random, clumped, uniform)	2.45	2.44		2.43	2.33	2.34	2.44			2.43
143 Life-history patterns (e.g., r and k strategies, mortality)	2.24	2.31	2.29	2.27	2.16	2.24	2.26	2.45		2.21
I. ISSUES AND APPLICATIONS RELATING TO SCIENCE, TECHNOLOGY, AND SOCIETY										
166 Prediction and preparation for natural disasters	2.30	2.18		2.16	2.03	2.20	2.36	2.27		2.20
J. CONTENT-SPECIFIC PEDAGOGY										
Factors That Influence Learning and Instruction										
172 The impact of learning theories on the teaching of biology	2.49								2.41	

for inclusion. Of the 29, 9 statements were in the Molecular and Cellular Biology category, 6 were in the Animals category, and 5 each were in the Basic Principles of Science and Plants categories.

Correlations of the Profiles of Mean Importance Ratings

Biology professionals. Correlations were computed among the mean important ratings given by teachers and college faculty. The obtained correlation was .94, which indicates a substantial level of agreement across the two groups on the relative importance of the knowledge statements.

Demographic subgroups. Correlations were computed among arrays of means for the selected subgroups of respondents (e.g., males and females). This is done as a way of evaluating agreement among subgroups. The resulting correlations are provided in Table 3. Note that all values are above .90. This indicates a high level of agreement among subgroups and is consistent with general findings in the job analysis literature (e.g., Rosenfeld & Tannenbaum, 1991; Schmitt & Cohen, 1989).

Table 3
Correlations of Mean Importance Ratings Among Demographic Subgroups

	1	2	3	4
Gender				
1. Female (N=122)	1.00			
2. Male (N=216)	.98	1.00		
Racial/Ethnic Background				
1. People of Color (N=28)	1.00			
2. White (N=303)	.94	1.00		
Geographic Region				
1. Northeast (N=75)	1.00			
2. Central (N=86)	.97	1.00		
3. South (N=90)	.97	.97	1.00	
4. Far West (N=86)	.97	.97	.97	1.00
Teaching Experience (teachers only)				
1. 1 - 5 years (N=32)	1.00			
2. Greater than 5 years (N=155)	.92	1.00		

Mean Ratings of Content Coverage

The survey participants were asked to indicate, using a five-point rating scale, how well the statements within each of the major knowledge categories covered the important aspects of the category. Responses to these questions provide an indication of the adequacy (comprehensiveness) of the content domain. The scale values were 1 = Poorly, 2 = Somewhat, 3 = Adequately, 4 = Well, 5 = Very well. The mean ratings for the teachers and college faculty are presented in Table 4. The mean ratings exceed 4.00 in all but one instance (Diversity of Life for College Faculty). This supports the notion that the major knowledge categories were reasonably well covered and that the overall content domain was comprehensive.

Table 4
Mean Ratings of Content Coverage

Knowledge Category	Teachers (N= 188)	College Faculty (N=99)
Basic Principles of Science	4.25	4.17
Molecular and Cellular Biology	4.48	4.31
Classical Genetics	4.31	4.10
Evolution	4.14	4.00
Diversity of Life	4.21	3.96
Plants	4.27	4.11
Animals	4.40	4.13
Ecology	4.36	4.25
Issues and Applications Relating to Science, Technology, and Society	4.35	4.16
Content-Specific Pedagogy	4.36	4.22

Mean Percentage Weights for Test Content Emphasis: Recommendations for Test Content

In Part III of the survey, Recommendations for Test Content, participants are asked to indicate how many test questions (out of 100) should be included from each of the knowledge categories. This information may be used by the Advisory Committee to assist them in making decisions about how much emphasis the knowledge categories should receive in the test specifications. The mean weights for the teachers and college faculty respondents are presented in Table 5. In general, the categories received very similar weights from the survey respondents. Molecular and Cellular Biology, Basic Principles of Science, and Ecology, however, had slightly higher mean weights than the other categories.

Table 5
Mean Percentage Weights for Test Content Emphasis

Knowledge Category	Teachers (N= 188)	College Faculty (N=110)
Basic Principles of Science	11.58	12.15
Molecular and Cellular Biology	12.65	11.63
Classical Genetics	9.54	9.09
Evolution	8.46	10.14
Diversity of Life	8.10	7.95
Plants	10.05	9.09
Animals	11.57	9.73
Ecology	11.28	11.45
Issues and Applications Relating to Science, Technology, and Society	9.49	9.60
Content-Specific Pedagogy	7.29	9.17

Summary and Conclusions

A job analysis was conducted to define a content domain in which newly licensed (certified) biology teachers must be knowledgeable to perform their jobs in a competent manner. A draft domain of important knowledge statements was constructed by ETS Test Development staff with expertise in biology and ETS Research staff with expertise in job analysis. This draft domain was reviewed by an External Review Panel of subject-matter experts and revised as they judged necessary. The revised draft was then reviewed, modified, and approved during a meeting of the Biology Advisory Committee. The revised knowledge domain was then subjected to verification/refutation through the use of a national survey of biology teachers, administrators, and college faculty. The survey participants were asked to rate specific knowledge statements of the domain using a five-point importance scale and a five-point level of understanding scale. A cut point of 2.50 on the importance scale (midpoint between moderately important and important) was chosen to designate knowledge statements as eligible ($\geq$ 2.50) or ineligible ($<$ 2.50) for inclusion in the development of test specifications.

The results of the mean analysis conducted for teachers and college faculty yielded only 21 of 189 knowledge statements with ratings less than 2.50. This represents 11.1% of the proposed content domain. When the same analysis was conducted for demographic subgroups, very similar results were obtained (i.e., 29 statements yielded mean ratings below 2.50). All of the statements identified in the prior analysis of employment category were also identified in the subgroup analysis. Thus, the data analyses yielded only 29 statements (15.3%) that did not meet the 2.50 criterion for inclusion. This supports the premise that the iterative process undertaken to develop the survey and the use of subject-matter experts during the process were effective in identifying knowledge areas that are important for newly licensed biology teachers.

The 160 knowledge statements that were verified to be important by those surveyed should be used as the foundation for the development of test specifications for the biology examination. Test specifications that are linked to the results of a job analysis provide support for the content validity of the derived assessment measures and may be considered part of an initial step in ensuring the fairness of the derived assessment measures to subgroups of biology teacher candidates. It is reasonable to assume that because of testing and psychometric constraints (e.g., time limits, ability to measure some content reliably) not all of the verified content will be included in the new assessment measure. One source of information that may be used to guide the Advisory Committee in their decision as to what verified content to include is the mean importance rating. While a strict rank ordering of the content by mean rating is not implied, it is recommended that initial consideration be given to content that is well above the criterion and represents the appropriate breadth of content coverage as stipulated in the test specifications.

Correlation coefficients were used to assess relative agreement in terms of perceived importance of the knowledge statements. All coefficients exceeded .90. These findings indicate that there is substantial agreement in the importance ratings given to these statements across a wide array of biology professionals.

Evidence was also provided in this study of the comprehensiveness of the content domain within each of the 10 major knowledge categories. The results indicated that the survey respondents thought the categories were reasonably well covered by their statements.

Finally, data were collected in the Recommendations for Test Content section of the survey regarding the emphasis that should be given in the test to each of the 10 categories. This information will be used by the Advisory Committee in their decisions about the appropriate weighting of the test.

In summary, this study utilized a multi-method approach to identify a content domain that is related to the job of the newly licensed biology teacher. The job analysis process allowed for input from many practicing professionals in biology. The results of the study will be used to develop specifications for the biology test that will be included as part of the subject assessments of The Praxis Series: Professional Assessments for Beginning Teachers™.

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Appendix A

Subject Matter Experts

External Review Panel
Advisory Committee

External Review Panel

Classroom Teachers

Alton Biggs
Science Chairman
Allen High School
PO Box 1017
601 East Main Street
Allen, TX 75002

Mr. Biggs is the Science Chairman at Allen High School, where he teaches Sophomore and Advanced Placement Biology. He has 16 years of high school teaching experience. Mr.Biggs was awarded the Texas Outstanding Teacher Award in 1982 and was a Texas Teacher of the Year finalist in 1988. He was recommended by Pat McWethy of the National Association of Biology Teachers. Mr. Biggs received B.S. and M.S. degrees from East Texas State University.

David Ely
Champlain Valley Union High School
Science Department
RR #2, Box 160
Hinesburg, VT 05461

Mr. Ely has taught high school biology for the past 18 years. He currently teaches both Freshman Biology and Advanced Placement Biology. Mr. Ely is a Presidential Award winner (1985). In addition, he was named Vermont Teacher of the Year in 1989. He was recommended by Pat McWethy of the National Association of Biology Teachers. Mr. Ely received B.A. and M.A.T. degrees from the University of Vermont.

John Fedors
Greenwich High School
10 Hillside Road
Greenwich, Ct 06830

Mr. Fedors currently teaches biology at Greenwich High School. He has 28 years of teaching experience. During that time, he has taught biology, chemistry, and oceanography in grades 9-12 and has instructed elementary science and high school biology teachers. He is a Past President of the Connecticut Science Teachers Association. Mr. Fedors received a B.S. degree from Fairfield University and a M.S. degree from Yale University.

George Zahrobsky
Glenbard West High School
670 Crescent Boulevard
Glen Ellyn, IL 60137

Mr. Zahrobsky is the Chairman of the Science Department at Glenbard West High School. He teaches Freshman Honors Biology, Sophomore Biology, and Advanced Placement Biology. Mr. Zahrobsky has 30 years of science teaching experience. He is a Past President of The National Association of Biology Teachers and was a Presidential Award winner in 1984. In addition, Mr. Zahrobsky served as the Vice President of the Board for the Friends of Fermilab Education Group. He received a B.S. from the University of Illinois and a M.S. from Chicago State University. Mr. Zahrobsky was recommended by Pat McWethy of the National Association of Biology Teachers.

College Faculty

Ricardo A. Garciá, PhD
Associate Professor
Department of Biology
Clemson University
330 Long Hall
Clemson, SC 29634

Dr. Garciá currently teaches college level biology courses at Clemson University. He has 20 years of college teaching experience. Dr. Garciá B.S. and M.Ed. degrees from the University of Houston and a PhD from Texas A&M University.

Sandra Gottfried, PhD
Assistant Professor of Biology and Education
University of Missouri at St. Louis
Department of Biology
8001 Natural Bridge Road
St. Louis, MO 63121

Dr. Gottfried teaches college level biology courses at the University of Missouri at St. Louis. She also teaches methods courses in biology education. She has 14 years of teaching experience. Dr. Gottfried earned a B.A. in biology from St. Joseph College in 1968, a M.A. in biology from Wesleyan University in 1978, and her PhD in Science Education from the University of Connecticut in 1988. She was recommended by Pat McWethy of the National Association of Biology Teachers.

Cheryl Mason, PhD
Assistant Professor
School of Teacher Education
San Diego State University
120 Education
San Diego, CA 92182-0139

Dr. Mason currently teaches methods courses in science education at San Diego State University. She has also taught college and high school biology and middle school general science. In total, Dr. Mason has 19 years of teaching experience. She is a Presidential Award Winner (1983). In addition, Dr. Mason was awarded the First National Space Educator Award. She received a M.A.T. from Indiana University and a PhD from Purdue University.

John Penick, PhD
University of Iowa
Science Education
Iowa City, IA 52242

Dr. Penick has been a Professor of Science Education at the University of Iowa since 1975. He has also taught at Loyola University, Florida State University, and Miami Dade Community College. He has published over 160 monographs, chapters, and articles in science education. Dr. Penick is also quite active in professional associations. He was President of the National Association of Biology Teachers (1989), Board Member of the National Science Teachers Association (1986-1988), and served on the Board and Executive Committee on the International Council of Associations for Science Education (1985-1989). Dr. Penick received B.S. and M.A. degrees from the University of Miami and a PhD from Florida State University.

Consultant

Russell Aiuto, PhD
Director of Research and Development
National Science Foundation
1742 Connecticut Avenue, N.W.
Washington, D.C. 20009

Dr. Aiuto has served as the Director of the Division of Teacher Preparation and Enhancement at the National Science Foundation since 1988. As division director, he is responsible for a grants program of 82.5 million dollars (FY 90). Grants are made to educational institutions for the purpose of improving the teaching of science and mathematics in the United States. Prior to working at NSF, Dr. Aiuto was President of Hiram College (July, 1985 to July, 1988) and Provost of Albion College (May, 1982 to June, 1985). He also served as Assistant Dean to the Faculty (June, 1980 to May, 1982) and Director of the Honors Program (January, 1978 to May, 1980) at Albion. In addition to his administrative experience, Dr. Aiuto has 25 years experience teaching college level courses in Biology, Botany, and Genetics. He was recommended by Paul Barton of Educational Testing Service. Dr. Penick received a B.A. from Eastern Michigan University and M.A. and PhD degrees from the University of North Carolina.

Advisory Committee

Classroom Teachers

John Evans, Ed.D.
Fitzsimons Middle School
25th & Cumberland Street
Philadelphia, PA 19132

Dr. Evans is the House Director and Science Teacher at the Fitzsimons Middle School where he teaches Biology, General Science, and Earth and Space Science. He has received an Award of Achievement in Science Education. He earned his Ed.D. degree from Temple University in 1980 and has 24 years teaching experience. He was recommended by Sam Chattin of the National Science Teachers Association. Dr. Evans is a member of AFT.

Polly Franz
Boise High School
1010 West Washington Street
Boise, ID 83702

Ms. Franz is a member of the NTE Biology and General Science Committee and of the NTE General Science Committee (Stage II). She teaches AP Chemistry and Biology to grades 10-12 and has 22 years teaching experience. Ms. Franz earned her B.S. from the University of Vermont and her M.S. from Boise State University in 1981. She was a NEWMAST Participant in 1987. Ms. Franz was recommended from the National Education Association List.

Ms. Cherry Sprague
Princeton High School
151 Moore Street
Princeton, NJ 08540

Ms. Sprague is a member of the NTE Biology and General Science Committee. She is a former member of the Achievement Biology Committee and an AP Biology reader, and was recommended by Marshall Freedman. She teaches AP Biology (grades 11-12), and Genetics (grades 10-12). Ms. Sprague earned her Ed.M. at Rutgers in 1977 and her B.A. at West Virginia University in 1972. She is a member of NEA.

College Faculty

William Barstow, PhD
Botany Department
University of Georgia
Athens, GA 30605

Professor Barstow is a member of the NTE Biology and General Science Committee. He is a former member and chair of the AP Biology Committee and was recommended by Marshall Freedman. Professor Barstow has taught Biology at both the high school and college level and has 29 years teaching experience. He received a B.S. from the University of Bridgeport, and an M.S. and a Ph.D. from Purdue University. He has also received the UGA awards for Research and Teaching.

Deidre D. Labat, PhD
Department of Biology
Xavier University of Louisiana
7325 Plametto Street
New Orleans, LA 70125

Dr. Labat is a member of the NTE Biology and General Science Committee and the NTE General Science Committee (Stage II). She is the chairperson and Professor of Biology at Xavier University of Louisiana. She has taught all college level courses for General Biology, Virology, and Molecular Genetics and she has 12 years teaching experience. Dr. Labat received a B.S. from Newcomb College, Tulane in 1966, an M.S. from Tulane Graduate School in 1967, and a Ph.D. from LSU Medical Center in 1976. She has been a reviewer for several granting agencies.

Howard Yarbrough, Ed.D.
Department of Natural Science
Chattanooga State Technical Community College
Chattanooga, TN 37406

Professor Yarbrough is a member of the NTE Biology and General Science Committee. He has taught college level General Biology, Environmental Science, Microbiology, and Anatomy and Physiology. He has 23 years teaching experience. In 1986 he received his Ed.D. from the University of Tennessee-Knoxville. He also has an M.A. from Austin Peay State University and a B.S. from Austin Peay State University. Professor Yarbrough's recognition/awards included Phi Delta Kappa, and he is a member of NEA.

School Administrators

Linda Sanders
Long Beach Unified School District
701 Locust Avenue
Long Beach, CA 90813

Ms. Sanders is a member of the NTE Biology and General Science Committee. She has 20 years teaching experience in the areas of elementary science, general science, math, advanced science, physical science, biology, and anatomy and physiology. She has been the curriculum specialist for the sciences in the Long Branch Unified School District since 1984. Ms. Sanders is a member of several committees that are concerned with teacher credentialing, curriculum, textbook selection, and other teaching related activities. She was recommended by the Commission on Teacher Credentialing.

Ray Thiess
Specialist in Science Education
Oregon Department of Education
700 Pringle Parkway, S.E.
Salem, OR 97310-0290

Mr. Thiess has 12 years teaching experience. He taught Biology and Physical Science at the high school level and Educational Methods and Marine Science for Elementary Teachers at the college level. Mr. Thiess earned a B.S. from Southern Oregon College in 1957, and an M.S. from the University of Pennsylvania in 1962. In 1969 he received the NABT Outstanding Biology Aware; in 1985, the Oregon Education Award; in 1986 the Eastern Oregon State College Distinguished Service to Science Education Award; and in 1987 the Southern Oregon College Distinguished Alumni Award. Mr. Thiess was recommended by the National Association of Biology Teachers.

Appendix B

Job Analysis Survey

JOB ANALYSIS INVENTORY

FOR TEACHERS

OF BIOLOGY

By

Educational Testing Service
Princeton, New Jersey

INTRODUCTION

Educational Testing Service (ETS) is developing a new generation of assessments for the purpose of licensing (certifying) teachers. The inventory that follows is part of our development effort and is designed to gather information concerning the job of a **newly licensed biology teacher**. It was developed by high school teachers, college faculty, and state department of education officials, along with ETS staff.

Those who constructed this inventory recognize that biology teachers are required to teach students with varying backgrounds and levels of ability. For this reason, the collaborators believe that teachers should have a broad and deep understanding of biology in order to teach it. The inventory asks you to respond to a list of knowledge statements and to judge (a) the importance of the knowledge statements for newly licensed (certified) biology teacher and (b) the level of understanding needed by newly licensed (certified) biology teachers. **Please do not relate the statements to your own job but rather to what you believe a newly licensed biology teacher should know.**

The information you provide will guide the development of the NTE Biology examination. It is expected that the new examination will differ from the current examination in both content and design. In addition to the development of a new examination, this study will contribute to our understanding of biology teaching as a profession. We expect the results of the study to be widely disseminated and should be very useful to the profession.

The inventory has been mailed to a group of approximately 800 professionals. Its value is directly related to the number of individuals who return their completed inventories. Because you represent a large number of professionals, your responses are extremely important. The inventory requires approximately 60 minutes to complete. Please return your completed inventory within 10 days.

PART I -- KNOWLEDGE AREAS

The purpose of this section is to determine what you believe newly licensed (certified) biology teachers should know if they are to perform their jobs in a competent manner. On the following pages you will find ten major content areas and, beneath each, a list of knowledge and ability statements that define the particular content area.

The content areas are:

BASIC PRINCIPLES OF SCIENCE
A. **MOLECULAR AND CELLULAR BIOLOGY**
B. **CLASSICAL GENETICS**
C. **EVOLUTION**
D. **DIVERSITY OF LIFE**
E. **PLANTS**
F. **ANIMALS**
G. **ECOLOGY**
H. **ISSUES AND APPLICATIONS RELATING TO SCIENCE, TECHNOLOGY, AND SOCIETY**
I. **CONTENT-SPECIFIC PEDAGOGY**

For each knowledge statement you will be asked to make the following judgments:

How important is an understanding of this knowledge area for newly licensed (certified) biology teachers if they are to perform their jobs in a competent manner?

(0) Of no importance
(1) Of little importance
(2) Moderately important
(3) Important
(4) Very important

What level of understanding of the knowledge area is typically needed by newly licensed (certified) biology teachers?

(Note: These levels are hierarchically arranged: level #2 subsumes level #1; level #3 subsumes levels #2 and #1; level #4 subsumes levels #3, #2, and #1. The zero point is not subsumed by any other scale point.)

(0) An understanding of the knowledge area is not needed.
(1) Requires the ability to define the terms used in the knowledge area.
(2) Requires the ability to comprehend the essential properties of the knowledge area.
(3) Requires the ability to apply/utilize the knowledge area to address problems or questions.
(4) Requires the ability to analyze the knowledge area into component parts and explain the interrelationships among the parts.

Circle your responses using the scales adjacent to each statement. To familiarize yourself with the content areas and statements, you may wish to glance through Part I before making your judgments.

Evaluate each knowledge area in terms of IMPORTANCE for and LEVEL OF UNDERSTANDING needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

A. BASIC PRINCIPLES OF SCIENCE	IMPORTANCE	LEVEL OF UNDERSTANDING
Scientific Methodology/Techniques/History		
1. Processes involved in scientific inquiry (e.g., hypothesizing, controls, deductive and inductive reasoning, analyzing and evaluating data, making predictions)	0 1 2 3 4	0 1 2 3 4
2. Science process skills (e.g., observe, interpret, communicate, infer, apply)	0 1 2 3 4	0 1 2 3 4
3. Evaluating and drawing conclusions from scientific studies	0 1 2 3 4	0 1 2 3 4
4. Application of scientific principles and theories to familiar situations	0 1 2 3 4	0 1 2 3 4
5. Role of concepts in integrating science (e.g., cause and effect, cycles, feedback, homeostasis)	0 1 2 3 4	0 1 2 3 4
6. Identification of problems that are appropriate for scientific investigation	0 1 2 3 4	0 1 2 3 4
7. The role of models (conceptual and physical) in scientific investigations	0 1 2 3 4	0 1 2 3 4
8. Commonly shared values of the scientific community (e.g., curiosity, open-mindedness, skepticism, objectivity)	0 1 2 3 4	0 1 2 3 4
9. Important scientific findings and the contributions of individual scientist(s) and various cultures in making them	0 1 2 3 4	0 1 2 3 4
10. History and philosophy of science	0 1 2 3 4	0 1 2 3 4
Mathematics, Measurement, and Data Manipulation		
11. The metric system	0 1 2 3 4	0 1 2 3 4
12. Scientific notation (exponential form)	0 1 2 3 4	0 1 2 3 4
13. Significant figures in measurement and calculation	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of **IMPORTANCE** for and **LEVEL OF UNDERSTANDING** needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE

(0) Of no importance
(1) Of little importance
(2) Moderately important
(3) Important
(4) Very important

LEVEL OF UNDERSTANDING

(0) An understanding of the knowledge area is not needed
(1) DEFINE the terms used in the knowledge area
(2) COMPREHEND the essential properties of the knowledge area
(3) APPLY/UTILIZE the knowledge area to address problems or questions
(4) ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

A. BASIC PRINCIPLES OF SCIENCE (cont.)	IMPORTANCE	LEVEL OF UNDERSTANDING
14. Unit conversion/dimensional analysis (e.g., How many grams of a solid would be needed to produce *x* liters of gas?)	0 1 2 3 4	0 1 2 3 4
15. Experimental errors (e.g., sources, quantifications, precision, accuracy)	0 1 2 3 4	0 1 2 3 4
16. Estimation/approximation	0 1 2 3 4	0 1 2 3 4
17. Generation of laboratory and field data	0 1 2 3 4	0 1 2 3 4
18. Measures of central tendency and dispersion (e.g., mean, median, mode, standard deviation)	0 1 2 3 4	0 1 2 3 4
19. Data manipulation and generation of tables, graphs, or charts	0 1 2 3 4	0 1 2 3 4
20. Interpretation of information presented in tables, graphs, or charts	0 1 2 3 4	0 1 2 3 4
Laboratory, Field Activities, and Safety		
21. Use of laboratory and field equipment (e.g., balances, scales, glassware, thermometers, burners, microscopes, stopwatches)	0 1 2 3 4	0 1 2 3 4
22. Preparation of specimens and materials (e.g., biological specimens, solutions)	0 1 2 3 4	0 1 2 3 4
23. Legal responsibilities and liabilities	0 1 2 3 4	0 1 2 3 4
24. Safety procedures	0 1 2 3 4	0 1 2 3 4
25. Emergency procedures for laboratory accidents	0 1 2 3 4	0 1 2 3 4
26. Laboratory and field hazards	0 1 2 3 4	0 1 2 3 4
27. Storage and disposal of materials	0 1 2 3 4	0 1 2 3 4
28. **Overall evaluation of the importance of Basic Principles of Science**	0 1 2 3 4	

Evaluate each knowledge area in terms of IMPORTANCE for and LEVEL OF UNDERSTANDING needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

A. BASIC PRINCIPLES OF SCIENCE (cont.)

29. How well do the knowledge areas in section A cover the important aspects of Basic Principles of Science?

1	2	3	4	5
Very Poorly	Poorly	Adequately	Well	Very Well

What important aspects, if any, are not covered?

_____

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B. MOLECULAR AND CELLULAR BIOLOGY	IMPORTANCE	LEVEL OF UNDERSTANDING
Chemical Basis of Life		
30. Atoms, molecules, and bonding	0 1 2 3 4	0 1 2 3 4
31. Ions, pH, buffers, and water	0 1 2 3 4	0 1 2 3 4
32. Biologically important inorganic molecules (e.g., CO_2, NH_3, O_2)	0 1 2 3 4	0 1 2 3 4
33. Functional groups in organic molecules (e.g., NH_2, COOH, C=O)	0 1 2 3 4	0 1 2 3 4
34. Carbohydrates, lipids, proteins, nucleic acids . .	0 1 2 3 4	0 1 2 3 4
35. Important compounds in energy transformations (e.g., ATP, NADP)	0 1 2 3 4	0 1 2 3 4
36. Coupled reactions, free-energy changes, thermodynamics, equilibrium	0 1 2 3 4	0 1 2 3 4
37. Chemical reactions in fermentation, glycolysis, and respiration	0 1 2 3 4	0 1 2 3 4
38. Chemiosmosis in respiration	0 1 2 3 4	0 1 2 3 4
39. Light-dependent reactions in photosynthesis . . .	0 1 2 3 4	0 1 2 3 4
40. Carbon fixation in photosynthesis	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of IMPORTANCE for and LEVEL OF UNDERSTANDING needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

B. MOLECULAR AND CELLULAR BIOLOGY (cont.)	IMPORTANCE	LEVEL OF UNDERSTANDING
41. Chemiosmosis in photosynthesis	0 1 2 3 4	0 1 2 3 4
42. Interrelationships of anabolic and catabolic pathways	0 1 2 3 4	0 1 2 3 4
43. Structure of enzymes	0 1 2 3 4	0 1 2 3 4
44. Function of enzymes	0 1 2 3 4	0 1 2 3 4
45. Factors influencing enzyme activity (e.g., temperature, pH, substrate concentrations)	0 1 2 3 4	0 1 2 3 4
46. Regulation of enzyme function (e.g., feedback mechanisms, cofactors, inhibitors)	0 1 2 3 4	0 1 2 3 4
Cell Structure and Function		
47. Membranes	0 1 2 3 4	0 1 2 3 4
48. Prokaryotic cells (subcellular components)	0 1 2 3 4	0 1 2 3 4
49. Eukaryotic cells (organelles and subcellular components)	0 1 2 3 4	0 1 2 3 4
50. Plant and animal cells	0 1 2 3 4	0 1 2 3 4
51. Fungal cells	0 1 2 3 4	0 1 2 3 4
52. Cell cycle including mitosis	0 1 2 3 4	0 1 2 3 4
53. Cytokinesis	0 1 2 3 4	0 1 2 3 4
54. Meiosis	0 1 2 3 4	0 1 2 3 4
Molecular Genetics		
55. Structure of DNA and RNA	0 1 2 3 4	0 1 2 3 4
56. Replication of DNA	0 1 2 3 4	0 1 2 3 4
57. Protein synthesis (transcription, translation, processing)	0 1 2 3 4	0 1 2 3 4
58. Gene regulation (e.g., lac operon)	0 1 2 3 4	0 1 2 3 4
59. Transposable elements	0 1 2 3 4	0 1 2 3 4
60. Mutations	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of **IMPORTANCE** for and **LEVEL OF UNDERSTANDING** needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

B. MOLECULAR AND CELLULAR BIOLOGY (cont.)	IMPORTANCE	LEVEL OF UNDERSTANDING
61. Oncogenes and cancer	0 1 2 3 4	0 1 2 3 4
62. Viruses and viroids	0 1 2 3 4	0 1 2 3 4
63. Microbial genetics	0 1 2 3 4	0 1 2 3 4
64. Recombinant DNA technology	0 1 2 3 4	0 1 2 3 4
65. **Overall evaluation of the importance of Molecular and Cellular Biology**	0 1 2 3 4	

66. How well do the knowledge areas in section B cover the important aspects of Molecular and Cellular Biology?

1	2	3	4	5
Very Poorly	Poorly	Adequately	Well	Very Well

What important aspects, if any, are not covered?

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C. CLASSICAL GENETICS		
67. Mendel's Law	0 1 2 3 4	0 1 2 3 4
68. Probability and prediction of inherited characteristics	0 1 2 3 4	0 1 2 3 4
69. Mechanisms and results of genetic linkage and recombination	0 1 2 3 4	0 1 2 3 4
70. Non-Mendelian inheritance (e.g., co-dominance, multiple alleles, polygenic inheritance, sex-linked traits)	0 1 2 3 4	0 1 2 3 4
71. Causes of human genetic disorders (e.g., chromosomal aberration)	0 1 2 3 4	0 1 2 3 4
72. Environmental influences on expression of phenotype	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of **IMPORTANCE** for and **LEVEL OF UNDERSTANDING** needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE

(0) Of no importance
(1) Of little importance
(2) Moderately important
(3) Important
(4) Very important

LEVEL OF UNDERSTANDING

(0) An understanding of the knowledge area is not needed
(1) DEFINE the terms used in the knowledge area
(2) COMPREHEND the essential properties of the knowledge area
(3) APPLY/UTILIZE the knowledge area to address problems or questions
(4) ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

C. CLASSICAL GENETICS (cont.)

	IMPORTANCE
73. **Overall evaluation of the importance of Classical Genetics**	0 1 2 3 4

74. How well do the knowledge areas in section C cover the important aspects of Classical Genetics?

1	2	3	4	5
Very Poorly	Poorly	Adequately	Well	Very Well

What important aspects, if any, are not covered?

D. EVOLUTION

	IMPORTANCE	LEVEL OF UNDERSTANDING
75. Evidence supporting evolution (e.g., molecular, fossil record, homologous structures, embryological)	0 1 2 3 4	0 1 2 3 4
76. Evolutionary mechanisms (e.g., natural selection, punctuated equilibrium)	0 1 2 3 4	0 1 2 3 4
77. Population genetics (e.g., Hardy-Weinberg Principle, genetic drift, gene flow)	0 1 2 3 4	0 1 2 3 4
78. Adaptive radiation and speciation	0 1 2 3 4	0 1 2 3 4
79. Diversity of life forms and evolutionary basis for classification	0 1 2 3 4	0 1 2 3 4
80. Principles of phylogeny	0 1 2 3 4	0 1 2 3 4
81. Origin of life	0 1 2 3 4	0 1 2 3 4
82. **Overall evaluation of the importance of Evolution**	0 1 2 3 4	

Evaluate each knowledge area in terms of IMPORTANCE for and LEVEL OF UNDERSTANDING needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

D. EVOLUTION (cont.)

83. How well do the knowledge areas in section D cover the important aspects of Evolution?

1	2	3	4	5
Very Poorly	Poorly	Adequately	Well	Very Well

What important aspects, if any, are not covered?

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E. DIVERSITY OF LIFE

	IMPORTANCE	LEVEL OF UNDERSTANDING
Taxonomy		
84. Classification schemes	0 1 2 3 4	0 1 2 3 4
85. Defining characteristics between and within the five kingdoms	0 1 2 3 4	0 1 2 3 4
Characteristics and Representatives of Kingdoms		
86. Monerans (prokaryotes)	0 1 2 3 4	0 1 2 3 4
87. Protists	0 1 2 3 4	0 1 2 3 4
88. Fungi	0 1 2 3 4	0 1 2 3 4
89. Plants	0 1 2 3 4	0 1 2 3 4
90. Animals	0 1 2 3 4	0 1 2 3 4
91. **Overall evaluation of the importance of Diversity of Life**	0 1 2 3 4	

Evaluate each knowledge area in terms of **IMPORTANCE** for and **LEVEL OF UNDERSTANDING** needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

E. DIVERSITY OF LIFE (cont.)

92. How well do the knowledge areas in section E cover the important aspects of Diversity of Life?

1	2	3	4	5
Very Poorly	Poorly	Adequately	Well	Very Well

What important aspects, if any, are not covered?

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F. PLANTS	IMPORTANCE	LEVEL OF UNDERSTANDING
Evolution		
93. Adaptation to land	0 1 2 3 4	0 1 2 3 4
94. Major divisions (e.g., bryophytes, pteridophytes)	0 1 2 3 4	0 1 2 3 4
Anatomy		
95. Roots	0 1 2 3 4	0 1 2 3 4
96. Stems	0 1 2 3 4	0 1 2 3 4
97. Leaves	0 1 2 3 4	0 1 2 3 4
98. Reproductive structures	0 1 2 3 4	0 1 2 3 4
Physiology		
99. C_3 and C_4 photosynthesis	0 1 2 3 4	0 1 2 3 4
100. CAM (Crassulacean acid metabolism)	0 1 2 3 4	0 1 2 3 4
101. Control Mechanisms (e.g., hormones, photoperiods, tropisms)	0 1 2 3 4	0 1 2 3 4
102. Water and nutrient transport	0 1 2 3 4	0 1 2 3 4
103. Water potential	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of **IMPORTANCE** for and **LEVEL OF UNDERSTANDING** needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

F. PLANTS (cont.)	IMPORTANCE	LEVEL OF UNDERSTANDING
104. Nutrition	0 1 2 3 4	0 1 2 3 4
105. Mycorrhizae	0 1 2 3 4	0 1 2 3 4
Reproduction		
106. Alternation of generations	0 1 2 3 4	0 1 2 3 4
107. Fertilization and zygote formation	0 1 2 3 4	0 1 2 3 4
108. Flowers, fruits, and seeds	0 1 2 3 4	0 1 2 3 4
109. Dispersal and germination	0 1 2 3 4	0 1 2 3 4
110. Vegetative propagation (asexual reproduction)	0 1 2 3 4	0 1 2 3 4
111. Development and differentiation	0 1 2 3 4	0 1 2 3 4
112. **Overall evaluation of the importance of Plants**	0 1 2 3 4	

113. How well do the knowledge areas in section F cover the important aspects of Plants?

1	2	3	4	5
Very Poorly	Poorly	Adequately	Well	Very Well

What important aspects, if any, are not covered?

_____

_____

G. ANIMALS		
Evolution		
114. Classification based on phylogeny	0 1 2 3 4	0 1 2 3 4
115. Major phyla (e.g., platyhelminthes, annelida, chordata)	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of IMPORTANCE for and LEVEL OF UNDERSTANDING needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

G. ANIMALS (cont.)	IMPORTANCE	LEVEL OF UNDERSTANDING
Life Functions and Associated Structures		
116. Digestion	0 1 2 3 4	0 1 2 3 4
117. Circulation	0 1 2 3 4	0 1 2 3 4
118. Respiration	0 1 2 3 4	0 1 2 3 4
119. Excretion	0 1 2 3 4	0 1 2 3 4
120. Nervous control	0 1 2 3 4	0 1 2 3 4
121. Contractile systems and movement (e.g., muscles)	0 1 2 3 4	0 1 2 3 4
122. Support	0 1 2 3 4	0 1 2 3 4
123. Integument	0 1 2 3 4	0 1 2 3 4
124. Immunity	0 1 2 3 4	0 1 2 3 4
125. Chemical control (e.g., hormones)	0 1 2 3 4	0 1 2 3 4
Reproduction and Development		
126. Gamete production	0 1 2 3 4	0 1 2 3 4
127. Fertilization	0 1 2 3 4	0 1 2 3 4
128. Parthenogenesis	0 1 2 3 4	0 1 2 3 4
129. Embryogenesis	0 1 2 3 4	0 1 2 3 4
130. Growth and differentiation (e.g., homeotic genes, induction, morphogenesis)	0 1 2 3 4	0 1 2 3 4
131. Metamorphosis	0 1 2 3 4	0 1 2 3 4
132. Aging	0 1 2 3 4	0 1 2 3 4
Behavior		
133. Taxes	0 1 2 3 4	0 1 2 3 4
134. Instincts	0 1 2 3 4	0 1 2 3 4
135. Learned behaviors (e.g., imprinting, conditioning, insight)	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of IMPORTANCE for and LEVEL OF UNDERSTANDING needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

G. ANIMALS (cont.)	IMPORTANCE	LEVEL OF UNDERSTANDING
136. Communication (e.g., pheromones, vision, sound)	0 1 2 3 4	0 1 2 3 4
137. **Overall evaluation of the importance of Animals**	0 1 2 3 4	

138. How well do the knowledge areas in section G cover the important aspects of Animals?

1	2	3	4	5
Very Poorly	Poorly	Adequately	Well	Very Well

What important aspects, if any, are not covered?

_____

_____

H. ECOLOGY

Populations

139. Intraspecific competitions	0 1 2 3 4	0 1 2 3 4
140. Density-dependent and density-independent factors	0 1 2 3 4	0 1 2 3 4
141. Population growth (e.g., biotic potential, environmental resistance, carrying capacity)	0 1 2 3 4	0 1 2 3 4
142. Patterns of dispersion (e.g., random, clumped, uniform)	0 1 2 3 4	0 1 2 3 4
143. Life-history patterns (e.g., r and k strategies, mortality)	0 1 2 3 4	0 1 2 3 4
144. Social behavior (e.g., dominance, territoriality, hierarchy, altruism)	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of **IMPORTANCE** for and **LEVEL OF UNDERSTANDING** needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE

(0) Of no importance
(1) Of little importance
(2) Moderately important
(3) Important
(4) Very important

LEVEL OF UNDERSTANDING

(0) An understanding of the knowledge area is not needed
(1) DEFINE the terms used in the knowledge area
(2) COMPREHEND the essential properties of the knowledge area
(3) APPLY/UTILIZE the knowledge area to address problems or questions
(4) ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

H. ECOLOGY (cont.)	IMPORTANCE	LEVEL OF UNDERSTANDING
Communities		
145. Niche	0 1 2 3 4	0 1 2 3 4
146. Interspecific relationships (e.g., commensalism, mutualism, competition, predation, parasitism)	0 1 2 3 4	0 1 2 3 4
147. Species diversity	0 1 2 3 4	0 1 2 3 4
148. Succession	0 1 2 3 4	0 1 2 3 4
Ecosystems		
149. Terrestrial biomes (e.g., rain forests, tundra, desert, grasslands)	0 1 2 3 4	0 1 2 3 4
150. Aquatic ecosystems	0 1 2 3 4	0 1 2 3 4
151. Energy flow (e.g., trophic levels, food webs, productivity, measurement)	0 1 2 3 4	0 1 2 3 4
152. Biogeochemical cycles (e.g., nitrogen, carbon, water)	0 1 2 3 4	0 1 2 3 4
153. Stability and disturbances (resistance to and recovery from change)	0 1 2 3 4	0 1 2 3 4
154. Interrelationships among ecosystems	0 1 2 3 4	0 1 2 3 4
155. Human impact (e.g., deforestation, pesticides, pollution, population growth)	0 1 2 3 4	0 1 2 3 4
156. **Overall evaluation of the importance of Ecology**	0 1 2 3 4	

Evaluate each knowledge area in terms of IMPORTANCE for and LEVEL OF UNDERSTANDING needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

H. ECOLOGY (cont.)

157. How well do the knowledge areas in section H cover the important aspects of Ecology?

1	2	3	4	5
Very Poorly	Poorly	Adequately	Well	Very Well

What important aspects, if any, are not covered?

_____

_____

I. ISSUES AND APPLICATIONS RELATING TO SCIENCE, TECHNOLOGY, AND SOCIETY

		IMPORTANCE	LEVEL OF UNDERSTANDING
158.	Human population growth	0 1 2 3 4	0 1 2 3 4
159.	Energy production and use (e.g., deforestation, acid rain, greenhouse effect, dams and water diversion)	0 1 2 3 4	0 1 2 3 4
160.	Production and use of consumer products (e.g., ozone degradation, non-biodegradable products, medical waste)	0 1 2 3 4	0 1 2 3 4
161.	Biological magnification of toxic materials in food chains	0 1 2 3 4	0 1 2 3 4
162.	Resource management (e.g., wildlife, forests, soil, water, metals, fossil fuels)	0 1 2 3 4	0 1 2 3 4
163.	Relationship of geographic distribution of natural resources, population patterns, and global politics (including habitat destruction and preservation of species diversity)	0 1 2 3 4	0 1 2 3 4
164.	Ethics and biology (e.g., gene cloning, in vitro fertilization, prolonging life, birth control, prenatal testing, abortion, radiation, use of hormones in agriculture)	0 1 2 3 4	0 1 2 3 4
165.	Effects of agricultural practices on the environment	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of IMPORTANCE for and LEVEL OF UNDERSTANDING needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

I. ISSUES AND APPLICATIONS RELATING TO SCIENCE, TECHNOLOGY, AND SOCIETY (cont.)

	IMPORTANCE	LEVEL OF UNDERSTANDING
166. Prediction and preparation for natural disasters (e.g., earthquakes, volcanic eruptions, floods and severe weather patterns)	0 1 2 3 4	0 1 2 3 4
167. Current developments in biology and other sciences	0 1 2 3 4	0 1 2 3 4
168. **Overall evaluation of the importance of Issues and Applications Relating to Science, Technology, and Society**	0 1 2 3 4	

169. How well do the knowledge areas in section I cover the important aspects of Issues and Applications Relating to Science, Technology, and Society?

1	2	3	4	5
Very Poorly	Poorly	Adequately	Well	Very Well

What important aspects, if any, are not covered?

_____

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J. CONTENT-SPECIFIC PEDAGOGY

Factors that Influence Learning and Instruction

170. Recognition of and compensation for complex factors that may specifically affect the teaching of biology	0 1 2 3 4	0 1 2 3 4
171. Recognition of and compensation for complex factors that may affect student's learning of biology	0 1 2 3 4	0 1 2 3 4
172. The impact of learning theories on the teaching of biology (e.g., Piagetian theory)	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of IMPORTANCE for and LEVEL OF UNDERSTANDING needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

J. CONTENT-SPECIFIC PEDAGOGY (cont.)	IMPORTANCE	LEVEL OF UNDERSTANDING
Curriculum: Organization, Materials and Management		
173. Themes and concepts central to the science of biology	0 1 2 3 4	0 1 2 3 4
174. Current goals in teaching biology	0 1 2 3 4	0 1 2 3 4
175. Purposes for learning biology	0 1 2 3 4	0 1 2 3 4
176. Purposes for teaching a particular topic in biology	0 1 2 3 4	0 1 2 3 4
177. Relationships among topics in biology	0 1 2 3 4	0 1 2 3 4
178. Relationships between biology and other disciplines	0 1 2 3 4	0 1 2 3 4
179. Scope and sequence of topics in biology curriculum for a particular group of students and justification for the scope and sequence	0 1 2 3 4	0 1 2 3 4
180. Spacing of biology instruction (incorporation of biology into the curriculum during each secondary year, each year building on knowledge obtained in the previous year)	0 1 2 3 4	0 1 2 3 4
181. Lesson plans in biology curriculum for a particular group of students and justification for the plans	0 1 2 3 4	0 1 2 3 4
182. Curricular materials and resources for biology (e.g., textbooks and other printed materials, computer software, laboratory materials, human expertise) appropriate for particular groups of students and particular topics	0 1 2 3 4	0 1 2 3 4
183. Skills of laboratory management	0 1 2 3 4	0 1 2 3 4
184. Media (e.g., film, television, video) appropriate for particular groups of students and particular topics in biology	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of IMPORTANCE for and LEVEL OF UNDERSTANDING needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

J. CONTENT-SPECIFIC PEDAGOGY (cont.)	IMPORTANCE	LEVEL OF UNDERSTANDING
185. Instructional technologies (e.g., computer, videodisc, interactive television) appropriate for particular groups of students and particular topics in biology	0 1 2 3 4	0 1 2 3 4
Instruction		
186. Knowledge, experience, and skills that students bring to various topics in biology	0 1 2 3 4	0 1 2 3 4
187. Knowledge, experience, and skills that students need for various topics in biology	0 1 2 3 4	0 1 2 3 4
188. Recognition of and accommodation to the prior conceptions, experience, and skills that students bring to various topics in biology	0 1 2 3 4	0 1 2 3 4
189. Ways of presenting/explaining biology (e.g., analogies, explanations, drawings, performance) that make the subject matter understandable and interesting to particular groups of students	0 1 2 3 4	0 1 2 3 4
190. Teaching strategies and activities as related to specific objectives (e.g., laboratory work, supervised practice, group work, lecture) in biology appropriate for particular groups of students and particular topics	0 1 2 3 4	0 1 2 3 4
191. Experiences for promoting student self-esteem and success in biology	0 1 2 3 4	0 1 2 3 4
Assessment		
192. Evaluation strategies (e.g., laboratory reports, portfolios, observations, interviews, oral discussions, essays, written tests, performances) to assess student performance in biology	0 1 2 3 4	0 1 2 3 4
193. Errors, patterns of errors, inaccuracies, and problems in student work that arise from misconceptions about topics in biology	0 1 2 3 4	0 1 2 3 4

Evaluate each knowledge area in terms of IMPORTANCE for and LEVEL OF UNDERSTANDING needed by newly licensed (certified) biology teachers if they are to perform their job in a competent manner.

IMPORTANCE		LEVEL OF UNDERSTANDING	
(0)	Of no importance	(0)	An understanding of the knowledge area is not needed
(1)	Of little importance	(1)	DEFINE the terms used in the knowledge area
(2)	Moderately important	(2)	COMPREHEND the essential properties of the knowledge area
(3)	Important	(3)	APPLY/UTILIZE the knowledge area to address problems or questions
(4)	Very important	(4)	ANALYZE the knowledge area into component parts and explain the interrelationships among the parts

J. CONTENT-SPECIFIC PEDAGOGY (cont.)	IMPORTANCE	LEVEL OF UNDERSTANDING
Professional Concerns		
194. Professional and scholarly literature (e.g., journals, reference works) appropriate for biology teachers and students	0 1 2 3 4	0 1 2 3 4
195. Professional and scholarly organizations for biology teachers and students	0 1 2 3 4	0 1 2 3 4
196. Responsibilities for continuing education in science education and in biology	0 1 2 3 4	0 1 2 3 4
197. Legal responsibilities and liabilities for teachers in biology	0 1 2 3 4	0 1 2 3 4
198. **Overall evaluation of the importance of Content-Specific Pedagogy**	0 1 2 3 4	

199. How well do the knowledge areas in section J cover the important aspects of Content-Specific Pedagogy?

1	2	3	4	5
Very Poorly	Poorly	Adequately	Well	Very Well

What important aspects, if any, are not covered?

PART II - RECOMMENDATIONS FOR TEST CONTENT

Listed below are ten broad topics that may be covered on the new licensing examination for biology. If the examination contained 100 questions, how many questions should be included from each topic? If you feel a category should not be included in the exam, put 0 in the space provided. Make sure your responses sum to 100.

TOPICS (out of 100)	NUMBER OF TEST QUESTIONS
200. BASIC PRINCIPLES OF SCIENCE	
201. MOLECULAR AND CELLULAR BIOLOGY	_____
202. CLASSICAL GENETICS	_____
203. EVOLUTION	_____
204. DIVERSITY OF LIFE	_____
205. PLANTS	_____
206. ANIMALS	_____
207. ECOLOGY	_____
208. ISSUES AND APPLICATIONS RELATING TO SCIENCE, TECHNOLOGY, AND SOCIETY	_____
209. CONTENT-SPECIFIC PEDAGOGY	_____
TOTAL	100

PART III - BACKGROUND INFORMATION

The information that you provide in this section is completely confidential and will be used for research purposes only. Please answer the questions by circling the number that most closely describes you or your professional activities. Unless otherwise indicated, please circle only one response for each question.

210. Where do you work?

1. Alabama
2. Alaska
3. Arizona
4. Arkansas
5. California
6. Colorado
7. Connecticut
8. Delaware
9. District of Columbia
10. Florida
11. Georgia
12. Hawaii
13. Idaho
14. Illinois
15. Indiana
16. Iowa
17. Kansas
18. Kentucky
19. Louisiana
20. Maine
21. Maryland
22. Massachusetts
23. Michigan
24. Minnesota
25. Mississippi
26. Missouri
27. Montana
28. Nebraska
29. Nevada
30. New Hampshire
31. New Jersey
32. New Mexico
33. New York
34. North Carolina
35. North Dakota
36. Ohio
37. Oklahoma
38. Oregon
39. Pennsylvania
40. Puerto Rico
41. Rhode Island
42. South Carolina
43. South Dakota
44. Tennessee
45. Texas
46. Utah
47. Vermont
48. Virginia
49. Washington
50. West Virginia
51. Wisconsin
52. Wyoming

211. What is your age?

1. Under 25
2. 25-34
3. 35-44
4. 45-54
5. 55-64
6. Over 64

212. What is your sex?

1. Female
2. Male

213. Which of the following best describes the area in which you work?

1. Urban
2. Suburban
3. Rural

214. How do you describe yourself?

1. Native American, American Indian, or Alaskan Native
2. Asian American, Asian, Native Hawaiian, or Pacific Islander
3. African American or Black
4. Mexican American or Chicano
5. Puerto Rican
6. Latin American, South American, Central American, or other Hispanic
7. White
8. Other

215. Which of the following best describes your highest educational attainment?

1. Less than a bachelor's
2. Bachelor's
3. Bachelor's + additional credits
4. Master's
5. Master's + additional credits
6. Doctorate

216. Which of the following best describes your current employment status?

1. Temporary substitute (assigned on a daily basis)
2. Permanent substitute (assigned on a longer term basis)
3. Regular teacher (not a substitute)
4. Principal or assistant principal
5. School administrator
6. Curriculum supervisor
7. State administrator
8. College faculty
9. Other (please specify)_____

217. How many years have you taught biology?

1. Never taught biology
2. Less than a year
3. 1 - 2 years
4. 3 - 5 years
5. 6 - 10 years
6. 11 - 15 years
7. 16 - 20 years
8. 21 or more years

218. What grade level(s) are you currently teaching? (Circle all that apply)

1. Preschool/Kindergarten
2. Grades 1-4
3. Grades 5-8
4. Grades 9-12
5. College
6. Do not teach
7. Other (please specify)_____

219. Which of the following describes your current teaching assignment? (Circle all that apply)?

1. General Biology
2. Honors or AP Biology
3. Anatomy and Physiology
4. Earth and Space Science
5. Ecology
6. General Science
7. Marine Science
8. Physical Science
9. Physics
10. Chemistry
11. College
12. Do not teach
13. Other (please specify)_____

220. Circle the following organizations to which you belong.

1. American Association for the Advancement of Science
2. American Biology Laboratory
3. American Federation of Teachers
4. National Association of Biology Teachers
5. National Association for Research in Science Teaching
6. National Science Supervisors Association
7. National Science Teachers Association
8. National Association for Science, Technology and Society
9. National Education Association
10. Other (please specify)_____

221. With which documents are you familiar? (Circle all that apply)

1. *Science for All Americans*, AAAS Project 2061
2. *Scope, Sequence, and Coordination*, NSTA
3. *State Science Guidelines* (framework, objectives, etc.)
4. Other (please specify)_____

THANK YOU FOR COMPLETING THIS INVENTORY.
PLEASE RETURN IT WITHIN 10 DAYS USING THE ENCLOSED ENVELOPE.

Appendix C

Survey Cover Letter

Follow-Up Post Card

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08541

609-921-9000
609-734-1090 (Fax)
CABLE-EDUCTESTSVC

DIVISION OF APPLIED
MEASUREMENT RESEARCH

Survey Cover Letter

October 1990

Dear Colleague:

I am writing to ask your cooperation in a project that should be of importance to teachers, college faculty, administrators, and other professionals in your field. Educational Testing Service (ETS) is in the process of developing a new generation of assessments for the purpose of licensing teachers. One type of assessment will be created to measure the prospective teacher's subject-matter or specialty-area knowledge and will likely be administered upon completion of the undergraduate teacher education program. One such assessment is a new version of the NTE Biology test. I am asking for your help as we develop this examination.

As part of the developmental process, ETS has worked closely with an advisory committee of classroom teachers, college faculty, and school administrators to identify potentially important knowledge and skill areas in Biology instruction. The enclosed inventory has been constructed as a way to obtain your judgments on the importance of these areas for the newly licensed (certified) Biology teacher. Your responses and those of other professionals to this inventory will guide the development of the new examination.

You will notice that the inventory asks for some background information about you; this is solely for purposes of describing respondents. **Your answers will be treated in strict confidence.**

A postage-paid envelope is enclosed for the return of your completed questionnaire. Thank you for your participation in this important project.

Sincerely,

Scott Wesley, Ph.D.
Associate Research Scientist

Enc (2)

Follow-Up Post Card

JOB ANALYSIS INVENTORY
FOR BIOLOGY TEACHERS

Dear Colleague:

An inventory was recently sent to you to obtain your opinions of what a newly licensed biology teacher should know and be able to do. If you have not already done so, please complete the inventory and return it in the postage-paid envelope to:

Educational Testing Service
Mail Stop 11-P
Princeton, NJ 08541

If you have already returned the inventory, please accept my thanks for your help in this important project.

Sincerely,

Scott Wesley

Scott Wesley, Ph.D.
Associate Research Scientist

Appendix D

Demographic Distributions

	Number	Percent
Age		
Less than 25	4	1.2
25-34	35	10.4
35-44	105	31.1
45-54	125	37.0
55-64	65	19.2
65 and over	4	1.2
No Response	0	0.0
Gender		
Female	122	36.1
Male	216	63.9
No Response	0	0.0
Race/Ethnicity		
American Indian or Alaskan Native	8	2.4
Asian, Asian American, Hawaiian Native, or Pacific Islander	7	2.1
Black or African American	6	1.8
Hispanic	3	0.9
White	303	89.6
Other	4	1.2
No Response	7	2.1
Educational Degree		
Less than a Bachelor's	0	0.0
Bachelor's	5	1.5
Bachelor's + additional credits	54	16.0
Master's	12	3.6
Master's + additional credits	168	49.7
Doctorate	96	28.4
No Response	3	0.9

	Number	Percent
Area		
Urban	88	26.0
Suburban	145	42.9
Rural	101	29.9
No Response	4	1.2
Current Employment Status		
Temporary Substitute	3	0.9
Permanent Substitute	0	0.0
Regular Teacher	188	55.6
Principal of Assistant Principal	4	1.2
School Administrator	4	1.2
Curriculum Supervisor	11	3.3
State Administrator	0	0.0
College Faculty	99	29.3
Other	17	5.0
No Response	12	3.6
Teaching Experience		
Less than 1 year	6	1.8
1 - 2 years	9	2.7
3 - 5 years	28	8.3
6 - 10 years	32	9.5
11 - 15 years	58	17.2
16 - 20 years	57	16.9
21 or more years	141	41.7
Never taught Biology	4	1.2
No Response	3	0.9

	Number	Percent
Grade Levels Currently Teaching*		
Preschool/Kindergarten	1	0.3
Grades 1 - 4	2	0.6
Grades 5 - 8	27	8.0
Grades 9 - 12	198	58.6
College	126	37.3
Do not teach	13	3.8
Other	9	2.7
Geographic Region		
Northeast	75	22.2
Central	86	25.4
South	90	26.6
Far West	86	25.4
No Response	1	0.3
Current Teaching Assignment*		
General Biology	232	68.6
Honors or AP Biology	107	31.7
Anatomy and Physiology	85	25.1
Earth and Space Science	24	7.1
Ecology	57	16.9
General Science	30	8.9
Marine Science	13	3.8
Physical Science	28	8.3
Physics	12	3.6
Chemistry	41	12.1
College	90	26.6
Do not teach	12	3.6
Other	87	25.7

* Multiple responses were permitted. Hence, the totals will exceed 338 and 100%.

	Number	Percent
Professional Organizations*		
American Association for the Advancemeent of Science	56	16.6
American Biology Laboratory	9	2.7
American Federation of Teachers	15	4.4
National Association of Biology Teachers	261	77.2
National Association for Research in Science Teaching	10	3.0
National Science Supervisors Association	24	7.1
National Science Teachers Association	184	54.4
National Association for Science, Technology and Society	8	2.4
National Educational Association	119	35.2
Other	102	30.2
Familiarity With Documents*		
Science for All Americans	131	39.3
Scope, Sequence, and Coordination, NSTA	139	41.1
State Science Guidelines (framework, objectives, etc)	150	44.4
Other	29	8.6

* Multiple responses were permitted. Hence, the totals will exceed 338 and 100%.

Appendix E

Overall Importance and Level of Understanding Ratings

		Importance	Level of Understanding					
				Percent Responding				
		Mean	Mean	0	1	2	3	4
A. BASIC PRINCIPLES OF SCIENCE								
Scientific Methodology/Techniques/History								
1	Processes involved in scientific inquiry	3.64	3.43	0	0	10	36	54
2	Science process skills (e.g., observe, interpret, apply)	3.61	3.43	0	0	9	38	53
3	Evaluating and drawing conclusions from scientific studies	3.47	3.28	0	2	15	36	47
4	Application of scientific principles and theories	3.50	3.31	0	1	9	47	43
5	Role of concepts in integrating science	3.37	3.24	0	1	17	40	42
6	Identification of problems for scientific investigation	2.97	2.89	0	4	27	45	24
7	The role of models in scientific investigations	2.99	2.84	0	4	29	43	23
8	Commonly shared values of the scientific community	3.21	2.95	0	4	27	38	31
9	Important scientific findings, scientist(s)	2.54	2.34	1	11	50	29	9
10	History and philosophy of science	2.38	2.26	1	14	51	26	8
Mathematics, Measurement, and Data Manipulation								
11	The metric system	3.44	3.24	0	1	14	45	41
12	Scientific notation (exponential form)	2.73	2.70	2	7	28	48	16
13	Significant figures in measurement and calculation	2.65	2.60	1	9	30	48	12
14	Unit conversion/dimensional analysis	2.37	2.46	3	11	35	39	12
15	Experimental errors (e.g., sources, precision, accuracy)	2.69	2.61	2	8	32	43	15
16	Estimation/approximation	2.72	2.67	2	4	33	47	14

Percent Responding Legend

0 An understanding of the knowledge area is not needed
1 Requires the ability to define the terms used in the knowledge area
2 Requires the ability to comprehend the essential properties of the knowledge area
3 Requires the ability to apply\utilize the knowledge area to address problems or questions
4 Requires the ability to analyze the knowledge area into component parts and explain the interrelationships among the parts

Note: Mean importance ratings that are less than 2.50 are shaded.

		Importance	Level of Understanding					
				Percent Responding				
		Mean	Mean	0	1	2	3	4
17	Generation of laboratory and field data	3.17	3.13	0	3	17	43	37
18	Measures of central tendency and dispersion	2.38	2.42	3	13	33	40	11
19	Data manipulation and generation of tables, graphs, or charts	3.09	3.05	0	3	19	47	31
20	Interpretation of tables, graphs, or charts	3.47	3.38	0	1	9	42	48
Laboratory, Field Activities, and Safety								
21	Use of laboratory and field equipment	3.69	3.36	0	0	7	50	44
22	Preparation of specimens and materials	2.98	2.83	1	5	21	55	18
23	Legal responsibilities and liabilities	3.23	2.89	1	3	32	35	29
24	Safety procedures	3.75	3.32	0	1	12	41	46
25	Emergency procedures for laboratory accidents	3.73	3.33	0	1	11	45	44
26	Laboratory and field hazards	3.57	3.19	0	1	16	46	37
27	Storage and disposal of materials	3.42	3.06	0	2	20	47	31
28	Overall importance of Basic Principles of Science	3.54	--	--	--	--	--	--
B. MOLECULAR AND CELLULAR BIOLOGY								
Chemical Basis of Life								
30	Atoms, molecules, and bonding	3.22	2.99	0	1	28	44	28
31	Ions, pH, buffers, and water	3.06	2.86	0	2	31	44	22
32	Biologically important inorganic molecules (e.g., CO_2, NH_3)	3.14	2.90	0	3	27	47	23
33	Funcational groups in organic molecules (e.g., NH_2, COOH)	2.82	2.68	2	6	31	45	16
34	Carbohydrates, lipids, proteins, nucleic acids	3.46	3.20	0	0	17	46	37
35	Important compounds in energy transformations (e.g., ATP, NADP)	3.24	3.01	0	2	20	52	26
36	Couples reactions, free-energy changes, thermodynamics	2.49	2.42	2	10	43	37	8
37	Chemical reactions in fermentation, glycolysis, and respiration	2.94	2.83	0	5	30	42	23
38	Chemiosmosis in respiration	2.50	2.43	3	10	40	33	14
39	Light-dependent reactions in photosynthesis	2.92	2.80	1	2	35	41	22

Note: Mean importance ratings that are less than 2.50 are shaded.

		Importance	Level of Understanding					
				Percent Responding				
		Mean	Mean	0	1	2	3	4
40	Carbon fixation in photosynthesis	2.89	2.75	2	2	37	38	21
41	Chemiosmosis in photosynthesis	2.45	2.39	3	9	45	33	11
42	Interrelationships of anabolic and catabolic pathways	2.59	2.50	3	8	38	39	12
43	Structure of enzymes	2.66	2.57	1	7	39	40	13
44	Function of enzymes	3.27	3.07	0	2	17	53	28
45	Factors influencing enzyme activity (e.g., temperature, pH)	3.02	2.85	1	3	29	47	21
46	Regulation of enzyme function (e.g., feedback mechanisms)	2.69	2.58	1	6	39	39	14
Cell Structure and Function								
47	Membranes	3.42	3.16	0	1	20	41	38
48	Prokaryotic cells (subcellular components)	3.02	2.82	0	4	32	41	23
49	Eukaryotic cells (organelles and subcellular components)	3.35	3.08	0	2	22	40	35
50	Plant and animal cells	3.41	3.19	0	2	15	44	39
51	Fungal cells	2.53	2.42	2	14	38	35	12
52	Cell cycle including mitosis	3.55	3.35	0	1	12	39	49
53	Cytokinesis	3.10	2.90	1	5	25	42	27
54	Meiosis	3.57	3.39	0	0	11	39	50
Molecular Genetics								
55	Structure of DNA and RNA	3.57	3.33	0	0	16	35	49
56	Replication of DNA	3.53	3.28	0	1	17	36	46
57	Protein synthesiss (transcription, translation, processing)	3.45	3.22	0	2	19	36	43
58	Gene regulation (e.g., lac operon)	2.81	2.63	1	9	36	36	19
59	Transposable elements	2.34	2.26	5	12	43	32	8
60	Mutations	3.20	3.02	0	2	23	47	28
61	Oncogenes and cancer	2.63	2.45	0	11	41	38	9
62	Viruses and viroids	2.79	2.56	0	9	39	39	13

Note: Mean importance ratings that are less than 2.50 are shaded.

		Importance	Level of Understanding					
				Percent Responding				
		Mean	Mean	0	1	2	3	4
63	Microbial genetics	2.44	2.34	3	11	43	34	9
64	Recombinant DNA technology	2.90	2.70	1	7	34	39	20
65	Overall importance of Molecular and Cellular Biology	3.35	--	--	--	--	--	--
C.	**CLASSICAL GENETICS**							
67	Mendel's Law	3.41	3.32	0	2	12	38	48
68	Probability and prediction of inherited characteristics	3.32	3.24	0	1	13	46	40
69	Mechanisms and results of genetic linkage and recombination	3.01	2.89	0	3	29	45	23
70	Non-Mendelian inheritance	3.15	3.06	0	2	21	47	30
71	Causes of human genetic disorders (e.g., chromosonal aberration)	3.20	3.02	0	3	21	48	28
72	Environmental influences on expression of phenotype	3.04	2.89	0	5	24	49	22
73	Overall importance of Classical Genetics	3.32	--	--	--	--	--	--
D.	**EVOLUTION**							
75	Evidence supporting evolution (e.g., molecular, fossil record)	3.30	3.15	0	2	21	37	40
76	Evolutionary mechanisms (e.g., natural selection)	3.31	3.11	0	2	21	41	36
77	Population genetics (e.g., genetic drift, gene flow)	2.88	2.80	1	5	30	44	21
78	Adaptive radiation and speciation	2.92	2.78	0	4	32	45	19
79	Diversity of life forms and evolutionary basis for classification	3.13	2.96	0	2	29	41	29
80	Principles of phylogeny	2.69	2.57	1	7	42	36	15
81	Origin of life	2.91	2.77	1	5	31	42	21
82	Overall importance of Evolution	3.24	--	--	--	--	--	--

77

78

Note: Mean importance ratings that are less than 2.50 are shaded.

		Importance	Level of Understanding					
				Percent Responding				
		Mean	Mean	0	1	2	3	4
E. DIVERSITY OF LIFE								
Taxonomy								
84	Classification schemes	2.85	2.82	0	5	30	43	22
85	Defining characteristics between and within the five kingdoms	3.06	2.93	0	5	26	39	30
Characteristics and Representatives of Kingdoms								
86	Monerans	2.79	2.65	0	4	44	37	16
87	Protists	2.81	2.68	0	4	41	39	16
88	Fungi	2.76	2.64	0	4	44	37	16
89	Plants	3.06	2.88	0	2	32	42	24
90	Animals	3.11	2.93	0	2	31	40	27
91	Overall importance of Diversity of Life	3.05	--	--	--	--	--	--
F. PLANTS								
Evolution								
93	Adaptation to land	2.77	2.70	0	6	35	42	17
94	Major divisions (e.g., bryophytes, pteridophytes)	2.53	2.46	1	9	46	33	12
Anatomy								
95	Roots	2.80	2.73	0	5	35	43	17
96	Stems	2.81	2.73	0	5	35	44	17
97	Leaves	2.87	2.78	0	4	33	44	19
98	Reproductive structures	2.98	2.86	0	2	30	47	21
Physiology								
99	C3 and C4 photosynthesis	2.35	2.32	4	14	38	32	11
100	CAM (Crassulacean acid metabolism)	1.81	1.91	12	19	40	26	4
101	Control mechanisms (e.g., hormones, photoperiods, tropisms)	2.72	2.66	1	6	35	45	14
102	Water and nutrient transport	3.01	2.83	0	3	29	50	18

Note: Mean importance ratings that are less than 2.50 are shaded.

		Importance	Level of Understanding					
				Percent Responding				
		Mean	Mean	0	1	2	3	4
103	Water potential	2.57	2.50	2	7	41	37	12
104	Nutrition	2.84	2.70	0	5	35	45	15
105	Mycorrhizae	2.02	2.05	5	16	52	22	5
Reproduction								
106	Alternation of generations	2.73	2.65	0	7	38	37	18
107	Fertilization and zygote formation	3.03	2.87	0	3	32	40	25
108	Flowers, fruits, and seeds	3.10	2.93	0	2	30	43	26
109	Dispersal and germination	2.90	2.78	0	3	36	40	20
110	Vegetative propagation (asexual reproduction)	2.74	2.66	0	5	40	39	16
111	Development and differentiation	2.67	2.58	0	8	40	37	15
112	Overall importance of Plant	3.06	--	--	--	--	--	--
G. ANIMALS								
Evolution								
114	Classification based on phylogeny	2.76	2.68	0	8	34	39	18
115	Major phyla (e.g., platyhelminthes, annelida, chordata)	2.87	2.73	0	6	34	39	20
Life Functions and Associated Structures								
116	Digestion	3.10	3.00	0	2	26	44	29
117	Circulation	3.12	3.04	0	1	23	45	30
118	Respiration	3.13	3.04	0	1	24	44	30
119	Excretion	3.06	3.00	0	2	26	44	29
120	Nervous control	3.11	3.03	0	1	24	45	30
121	Contractile systems and movement (e.g., muscles)	3.00	2.93	0	2	28	44	25
122	Support	2.94	2.85	0	2	32	44	22
123	Integument	2.81	2.78	0	4	35	42	20

Note: Mean importance ratings that are less than 2.50 are shaded.

		Importance	Level of Understanding					
				Percent Responding				
		Mean	Mean	0	1	2	3	4
124	Immunity	3.13	3.02	0	2	23	46	29
125	Chemical control (e.g., hormones)	3.07	2.99	0	2	26	43	29
Reproduction and Development								
126	Gamete production	3.26	3.05	0	2	21	47	30
127	Fertilization	3.23	3.00	0	3	23	46	28
128	Parthenogenesis	2.28	2.30	2	13	47	28	10
129	Embryogenesis	2.69	2.62	0	9	36	39	16
130	Growth and differentiation (e.g., homeotic genes, induction)	2.58	2.53	2	11	35	38	15
131	Metamorphosis	2.61	2.57	0	9	38	41	12
132	Aging	2.58	2.52	1	9	39	38	13
Behavior								
133	Taxes	2.37	2.37	1	13	42	35	9
134	Instincts	2.47	2.44	1	11	42	37	9
135	Learned behaviors (e.g., imprinting, conditioning, insight)	2.54	2.50	0	10	39	39	11
136	Communication (e.g., pheromones, vision, sound)	2.62	2.59	1	8	37	42	13
137	Overall importance of Animals	3.24	--	--	--	--	--	--
H. ECOLOGY								
Populations								
139	Intraspecific	2.89	2.80	1	6	26	47	21
140	Density-dependent and density-independent factors	2.76	2.74	1	7	31	41	21
141	Population growth (e.g., biotic potential, environmental resistance)	3.22	3.11	0	4	18	39	38
142	Patterns of dispersion (e.g., random, clumped, uniform)	2.44	2.48	1	11	39	35	13

Note: Mean importance ratings that are less than 2.50 are shaded.

		Importance	Level of Understanding					
				Percent Responding				
		Mean	Mean	0	1	2	3	4
143	Life-histoory patterns (e.g., r and k strategies, mortality)	2.28	2.27	4	14	42	30	9
144	Social behavior (e.g., dominance, territoriality, hierarchy, altruism)	2.65	2.55	0	10	38	38	14
Communities								
145	Niche	3.05	2.95	0	3	27	41	28
146	Interspecific relationships (e.g., commensalism, mutualism)	3.19	3.09	0	2	22	42	35
147	Species diversity	3.09	2.98	0	2	24	48	26
148	Succession	3.12	3.00	0	3	24	42	31
Ecosystems								
149	Terrestrial biomes (e.g., rain forest, tundra, desert, grasslands)	2.93	2.80	0	5	30	43	22
150	Aquatic ecosystems	2.88	2.77	0	6	32	42	21
151	Energy flow (e.g., trophic levels, food webs, productivity)	3.35	3.23	0	1	18	39	42
152	Biogeochemical cycles (e.g., nitrogen, carbon, water)	3.12	3.04	0	3	24	39	34
153	Stability and disturbances (resistance to/recovery from change)	2.76	2.71	0	8	30	44	18
154	Interrelationships among ecosystems	3.08	3.00	0	3	22	46	29
155	Human impact (e.g., deforestation, pesticides, pollution)	3.68	3.50	0	0	9	31	60
156	Overall importance of Ecology	3.51	--	--	--	--	--	--
I.	**ISSUES AND APPLICATIONS RELATING TO SCIENCE, TECHNOLOGY, AND SOCIETY**							
158	Human population growth	3.38	3.26	0	3	14	37	46
159	Energy production and use (e.g., deforestation, acid rain)	3.49	3.33	0	2	9	41	48
160	Production/use of consumer products (e.g., ozone degradation)	3.36	3.21	0	3	16	38	43
161	Biological magnification of toxic materials in food chains	3.30	3.15	0	3	18	40	39
162	Resource management (e.g., wildlife, forests, soil, water, metals)	3.23	3.06	0	4	21	40	35
163	Relationship of resources, population patterns, and global politics	3.06	2.95	0	7	23	39	32
164	Ethics and biology (e.g., gene cloning, in vitro fertilization)	3.28	3.22	0	3	17	36	44
165	Effects of agricultural practices on the environment	3.11	2.99	0	4	24	41	31

Note: Mean importance ratings that are less than 2.50 are shaded.

		Importance	Level of Understanding					
				Percent Responding				
		Mean	Mean	0	1	2	3	4
166	Prediction and preparation for natural disasters	2.22	2.26	3	16	43	28	10
167	Current developments in biology and other sciences	3.18	2.87	0	5	30	37	28
168	Overall importance of Issues and Applications Relating to Science, Technology, and Society	3.43	--	--	--	--	--	--
J.	**CONTENT-SPECIFIC PEDAGOGY**							
Factors That Influence Learning and Instruction								
170	Complex factors that may specifically affect the teaching of biology	3.02	2.93	0	6	24	40	30
171	Complex factors that may affect students learning of biology	3.24	3.08	0	3	21	39	36
172	The impact of learning theories on the teaching of biology	2.59	2.55	3	14	28	34	21
Curriculum: Organization, Materials and Management								
173	Thernes and concepts central to the science of biology	3.37	3.20	0	2	17	38	42
174	Current goals in teaching biology	3.03	2.89	0	6	26	41	27
175	Purposes for learning biology	3.29	3.11	0	3	19	42	36
176	Purposes for teaching a particular topic in biology	3.16	2.99	0	2	26	41	30
177	Relationships among topics in biology	3.39	3.25	0	1	16	39	44
178	Relationships between biology and other disciplines	3.30	3.18	0	1	20	40	39
179	Scope and sequence of topics in biology curriculum	2.87	2.81	1	8	26	39	26
180	Spacing of biology instruction	2.72	2.62	3	9	33	33	22
181	Lesson plans in biology curriculum and justification for the plans	2.81	2.76	1	6	31	40	22
182	Curricular materials and resources for biology	3.23	3.03	1	4	19	44	33
183	Skills of laboratory management	3.42	3.28	0	1	15	39	45

Note: Mean importance ratings that are less than 2.50 are shaded.

		Importance	Level of Understanding					
				Percent Responding				
		Mean	Mean	0	1	2	3	4
184	Media (e.g., film, television, video)	2.82	2.73	1	4	33	45	17
185	Instructional technologies	2.83	2.78	1	5	28	46	20
Instruction								
186	Knowledge, experience, and skills that students bring	2.88	2.77	0	6	31	42	21
187	Knowledge, experience, and skills that students need	3.17	2.97	0	4	23	45	28
188	Prior conceptions, experience, and skills that students bring	2.95	2.81	1	6	27	45	22
189	Ways of presenting/explaining biology	3.66	3.45	0	1	8	37	54
190	Teaching strategies and activities as related to specific objectives	3.56	3.39	0	1	9	39	50
191	Experiences for promoting self-esteem and success in biology	3.35	3.18	0	3	16	41	40
Assessment								
192	Evaluation strategies to assess student performance in biology	3.37	3.21	0	1	15	45	39
193	Errors, patterns of errors, inaccuracies in student work	2.95	2.82	0	6	27	42	23
Professional Concerns								
194	Professional and scholarly literature	2.95	2.75	1	6	29	48	17
195	Professional and scholarly organizations	2.88	2.67	1	6	34	43	16
196	Continuing education in science education and in biology	3.26	2.94	1	4	24	44	27
197	Legal responsibilities and liabilities for teachers in biology	3.18	2.90	0	5	27	40	28
198	Overall importance of Content-Specific Pedagogy	3.28	--	--	--	--	--	--

Note: Mean importance ratings that are less than 2.50 are shaded.

Appendix F

Importance Ratings by Employment Category

		Teachers (N=188)		College Faculty (N=99)	
		Mean	SD	Mean	SD
A.	**BASIC PRINCIPLES OF SCIENCE**				
Scientific Methodology/Techniques/History					
1	Processes involved in scientific inquiry	3.57	0.70	3.73	0.57
2	Science process skills (e.g., observe, interpret, apply)	3.52	0.72	3.68	0.59
3	Evaluating and drawing conclusions from scientific studies	3.37	0.80	3.54	0.68
4	Application of scientific principles and theories	3.42	0.67	3.57	0.59
5	Role of concepts in integrating science	3.28	0.70	3.47	0.65
6	Identification of problems for scientific investigation	2.88	0.88	3.04	0.85
7	The role of models in scientific investigations	3.03	0.79	2.84	0.91
8	Commonly shared values of the scientific community	3.17	0.87	3.22	0.85
9	Important scientific findings, scientist(s)	2.52	0.82	2.51	0.71
10	History and philosophy of science	2.36	0.82	2.42	0.78
Mathematics, Measurement, and Data Manipulation					
11	The metric system	3.36	0.76	3.58	0.71
12	Scientific notation (exponential form)	2.57	0.98	2.88	0.92
13	Significant figures in measurement and calculation	2.57	0.98	2.77	0.88
14	Unit conversion/dimensional analysis	2.29	1.05	2.46	0.85
15	Experimental errors (e.g., sources, precision, accuracy)	2.63	0.95	2.66	0.79
16	Estimation/approximation	2.60	0.95	2.84	0.73
17	Generation of laboratory and field data	3.14	0.85	3.20	0.69
18	Measures of central tendency and dispersion	2.13	0.95	2.77	0.84
19	Data manipulation and generation of tables, graphs, or charts	3.04	0.84	3.14	0.82
20	Interpretation of tables, graphs, or charts	3.41	0.69	3.60	0.57
Laboratory, Field Activities, and Safety					
21	Use of laboratory and field equipment	3.72	0.50	3.58	0.67
22	Preparation of specimens and materials	3.06	0.83	2.78	0.96
23	Legal responsibilities and liabilities	3.39	0.77	2.88	0.95
24	Safety procedures	3.81	0.43	3.60	0.64
25	Emergency procedures for laboratory accidents	3.76	0.51	3.62	0.64
26	Laboratory and field hazards	3.63	0.61	3.48	0.66
27	Storage and disposal of materials	3.47	0.72	3.27	0.77
28	Overall importance of Basic Principles of Science	3.49	0.56	3.59	0.53

Note: Mean ratings that are less than 2.50 are shaded.

		Teachers (N=188)		College Faculty (N=99)	
		Mean	SD	Mean	SD
B.	**MOLECULAR AND CELLULAR BIOLOGY**				
Chemical Basis of Life					
30	Atoms, molecules, and bonding	3.19	0.72	3.21	0.71
31	Ions, pH, buffers, and water	2.95	0.82	3.11	0.75
32	Biologically important inorganic molecules (e.g., CO_2, NH_3)	3.09	0.77	3.24	0.79
33	Functional groups in organic molecules (e.g., NH_2, COOH)	2.76	0.94	2.89	0.83
34	Carbohydrates, lipids, proteins, nucleic acids	3.44	0.65	3.49	0.65
35	Important compounds in energy transformations (e.g., ATP, NADP)	3.19	0.75	3.33	0.69
36	Coupled reactions, free-energy changes, thermodynamics	2.37	0.84	2.71	0.79
37	Chemical reactions in fermentation, glycolysis, and respiration	2.95	0.81	2.90	0.76
38	Chemiosmosis in respiration	2.52	0.94	2.41	0.93
39	Light-dependent reactions in photosynthesis	2.91	0.80	2.86	0.72
40	Carbon fixation in photosynthesis	2.88	0.85	2.88	0.71
41	Chemiosmosis in photosynthesis	2.42	0.95	2.44	0.92
42	Interrelationships of anabolic and catabolic pathways	2.48	0.92	2.77	0.85
43	Structure of enzymes	2.66	0.92	2.61	0.96
44	Function of enzymes	3.28	0.69	3.32	0.67
45	Factors influencing enzyme activity (e.g., temperature, pH)	2.94	0.86	3.13	0.68
46	Regulation of enzyme function (e.g., feedback mechanisms)	2.59	0.89	2.77	0.76
Cell Structure and Function					
47	Membranes	3.42	0.65	3.44	0.73
48	Prokaryotic cells (subcellular components)	3.01	0.84	3.00	0.91
49	Eukaryotic cells (organelles and subcellular components)	3.38	0.73	3.36	0.74
50	Plant and animal cells	3.51	0.61	3.29	0.82
51	Fungal cells	2.56	0.92	2.43	0.91
52	Cell cycle including mitosis	3.61	0.59	3.48	0.74
53	Cytokinesis	3.08	0.80	3.13	0.79
54	Meiosis	3.58	0.61	3.56	0.58
Molecular Genetics					
55	Structure of DNA and RNA	3.60	0.60	3.49	0.65
56	Replication of DNA	3.56	0.63	3.45	0.69
57	Protein synthesis (transcription, translation, processing)	3.45	0.71	3.45	0.69
58	Gene regulation (e.g., lac operon)	2.76	0.87	2.77	0.87
59	Transposable elements	2.32	0.95	2.19	0.87
60	Mutations	3.20	0.70	3.18	0.72
61	Oncogenes and cancer	2.62	0.85	2.53	0.76
62	Viruses and viroids	2.86	0.81	2.60	0.80

Note: Mean ratings that are less than 2.50 are shaded.

	Teachers (N=188)		College Faculty (N=99)	
	Mean	SD	Mean	SD
63 Microbial genetics	2.44	0.89	2.34	0.82
64 Recombinant DNA technology	2.90	0.87	2.86	0.76
65 Overall importance of Molecular and Cellular Biology	3.38	0.65	3.26	0.59
C. CLASSICAL GENETICS				
67 Mendel's Law	3.40	0.71	3.45	0.69
68 Probability and prediction of inherited characteristics	3.30	0.70	3.35	0.64
69 Mechanisms and results of genetic linkage and recombination	3.01	0.71	3.01	0.72
70 Non-Mendelian inheritance	3.16	0.76	3.13	0.72
71 Causes of human genetic disorders (e.g., chromosomal aberration)	3.26	0.68	3.07	0.79
72 Environmental influences on expression of phenotype	3.09	0.77	2.95	0.79
73 Overall importance of Classical Genetics	3.30	0.67	3.38	0.62
D. EVOLUTION				
75 Evidence supporting evolution (e.g., molecular, fossil record)	3.22	0.87	3.48	0.71
76 Evolutionary mechanisms (e.g., natural selection)	3.22	0.78	3.55	0.63
77 Population genetics (e.g., genetic drift, gene flow)	2.77	0.84	3.06	0.81
78 Adaptive radiation and speciation	2.86	0.84	3.05	0.68
79 Diversity of life forms and evolutionary basis for classification	3.10	0.79	3.21	0.73
80 Principles of phylogeny	2.65	0.90	2.79	0.82
81 Origin of life	2.87	0.91	2.98	0.87
82 Overall importance of Evolution	3.12	0.78	3.51	0.66
E. DIVERSITY OF LIFE				
Taxonomy				
84 Classification schemes	2.94	0.84	2.66	0.84
85 Defining characteristics between and within the five kingdoms	3.10	0.82	2.98	0.93
Characteristics and Representatives of Kingdoms				
86 Monerans (prokaryotes)	2.81	0.82	2.71	0.80
87 Protists	2.88	0.79	2.69	0.83
88 Fungi	2.82	0.80	2.65	0.80
89 Plants	3.13	0.76	2.97	0.76
90 Animals	3.19	0.77	2.99	0.76
91 Overall importance of Diversity of Life	3.10	0.73	2.97	0.78
F. PLANTS				
Evolution				
93 Adaptation to land	2.73	0.80	2.86	0.79
94 Major divisions (e.g., bryophytes, pteridophytes)	2.54	0.79	2.52	0.87

Note: Mean ratings that are less than 2.50 are shaded.

		Teachers (N=188)		College Faculty (N=99)	
		Mean	SD	Mean	SD
Anatomy					
95	Roots	2.80	0.76	2.78	0.80
96	Stems	2.81	0.76	2.78	0.80
97	Leaves	2.87	0.75	2.83	0.79
98	Reproductive structures	2.99	0.71	2.94	0.74
Physiology					
99	C3 and C4 photosynthesis	2.38	0.99	2.26	0.93
100	CAM (Crassulacean acid metabolism)	1.83	1.01	1.73	0.86
101	Control Mechanisms (e.g., hormones, photoperiods, tropisms)	2.73	0.84	2.67	0.77
102	Water and nutrient transport	3.06	0.70	2.96	0.73
103	Water potential	2.63	0.93	2.46	0.81
104	Nutrition	2.86	0.81	2.74	0.74
105	Mycorrhizae	2.00	0.91	2.02	0.88
Reproduction					
106	Alternation of generations	2.67	0.92	2.86	0.92
107	Fertilization and zygote formation	3.00	0.82	3.07	0.78
108	Flowers, fruits, and seeds	3.11	0.75	3.09	0.75
109	Dispersal and germination	2.92	0.72	2.89	0.80
110	Vegetative propagation (asexual reproduction)	2.79	0.78	2.69	0.75
111	Development and differentiation	2.66	0.83	2.64	0.77
112	Overall importance of Plants	3.07	0.72	3.07	0.77
G. ANIMALS					
Evolution					
114	Classification based on phylogeny	2.83	0.81	2.71	0.90
115	Major phyla (e.g., platyhelminthes, annelida, chordata)	2.94	0.84	2.78	0.94
Life Functions and Associated Structures					
116	Digestion	3.16	0.70	2.95	0.73
117	Circulation	3.17	0.69	2.99	0.74
118	Respiration	3.19	0.69	2.98	0.71
119	Excretion	3.10	0.73	2.94	0.73
120	Nervous control	3.17	0.70	2.96	0.73
121	Contractile systems and movement (e.g., muscles)	3.05	0.73	2.87	0.76
122	Support	2.96	0.73	2.83	0.76
123	Integument	2.85	0.75	2.66	0.78
124	Immunity	3.19	0.73	2.97	0.73
125	Chemical control (e.g., hormones)	3.13	0.74	2.90	0.72

Note: Mean ratings that are less than 2.50 are shaded.

		Teachers (N=188)		College Faculty (N=99)	
		Mean	SD	Mean	SD
Reproduction and Development					
126	Gamete production	3.27	0.73	3.23	0.78
127	Fertilization	3.26	0.71	3.19	0.79
128	Parthenogenesis	2.30	0.88	2.22	0.80
129	Embryogenesis	2.68	0.85	2.70	0.81
130	Growth and differentiation (e.g., homeotic genes, induction)	2.57	0.91	2.58	0.85
131	Metamorphosis	2.67	0.75	2.55	0.85
132	Aging	2.55	0.85	2.63	0.83
Behavior					
133	Taxes	2.35	0.82	2.34	0.81
134	Instincts	2.49	0.75	2.40	0.82
135	Learned behaviors (e.g., imprinting, conditioning, insight)	2.58	0.77	2.46	0.81
136	Communication (e.g., pheromones, vision, sound)	2.64	0.80	2.59	0.87
137	Overall importance of Animals	3.24	0.66	3.22	0.71
H. ECOLOGY					
Populations					
139	Intraspecific competitions	2.88	0.87	2.89	0.71
140	Density-dependent and density-independent factors	2.78	0.87	2.71	0.82
141	Population growth (e.g., biotic potential, environmental resistance)	3.17	0.82	3.34	0.70
142	Patterns of dispersion (e.g., random, clumped, uniform)	2.49	0.87	2.31	0.89
143	Life-history patterns (e.g., r and k strategies, mortality)	2.28	0.98	2.31	0.92
144	Social behavior (e.g., dominance, territoriality, hierarchy, altruism)	2.65	0.85	2.59	0.82
Communities					
145	Niche	3.06	0.79	3.00	0.85
146	Interspecific relationships (e.g., commensalism, mutualism)	3.20	0.73	3.19	0.68
147	Species diversity	3.09	0.71	3.07	0.69
148	Succession	3.11	0.79	3.13	0.75
Ecosystems					
149	Terrestrial biomes (e.g., rain forests, tundra, desert, grasslands)	2.94	0.76	2.92	0.80
150	Aquatic ecosystems	2.90	0.76	2.79	0.75
151	Energy flow (e.g., trophic levels, food webs, productivity)	3.30	0.70	3.45	0.59
152	Biogeochemical cycles (e.g., nitrogen, carbon, water)	3.05	0.81	3.30	0.63
153	Stability and disturbances (resistance to/recovery from change)	2.76	0.82	2.76	0.87
154	Interrelationships among ecosystems	3.11	0.76	2.98	0.77
155	Human impact (e.g., deforestation, pesticides, pollution)	3.69	0.57	3.66	0.59
156	Overall importance of Ecology	3.49	0.64	3.55	0.56

Note: Mean ratings that are less than 2.50 are shaded.

		Teachers (N=188)		College Faculty (N=99)	
		Mean	SD	Mean	SD
I.	**ISSUES AND APPLICATIONS RELATING TO SCIENCE, TECHNOLOGY, AND SOCIETY**				
158	Human population growth	3.35	0.76	3.54	0.67
159	Energy production and use (e.g., deforestation, acid rain)	3.48	0.67	3.54	0.72
160	Production/use of consumer products (e.g., ozone degradation)	3.40	0.74	3.29	0.69
161	Biological magnification of toxic materials in food chains	3.34	0.76	3.25	0.80
162	Resource management (e.g., wildlife, forests, soil, water, metals)	3.26	0.78	3.20	0.81
163	Relationship of resources, population patterns, and global politics	3.11	0.82	3.06	0.88
164	Ethics and biology (e.g., gene cloning, in vitro fertilization)	3.35	0.78	3.16	0.78
165	Effects of agricultural practices on the environment	3.13	0.82	3.12	0.81
166	Prediction and preparation for natural disasters	2.27	0.93	2.13	0.88
167	Current developments in biology and other sciences	3.23	0.77	3.09	0.64
168	Overall importance of Issues and Applications Relating to Science, Technology, and Society	3.43	0.67	3.44	0.61
J.	**CONTENT-SPECIFIC PEDAGOGY**				
	Factors That Influence Learning and Instruction				
170	Complex factors that may specifically affect the teaching of biology	3.05	0.81	2.93	0.87
171	Complex factors that may affect students learning of biology	3.27	0.76	3.18	0.83
172	The impact of learning theories on the teaching of biology	2.57	1.00	2.58	1.03
	Curriculum: Organization, Materials and Management				
173	Themes and concepts central to the science of biology	3.31	0.74	3.48	0.66
174	Current goals in teaching biology	3.06	0.81	2.91	0.91
175	Purposes for learning biology	3.28	0.76	3.20	0.80
176	Purposes for teaching a particular topic in biology	3.17	0.73	3.04	0.80
177	Relationships among topics in biology	3.39	0.75	3.40	0.66
178	Relationships between biology and other disciplines	3.29	0.75	3.33	0.69
179	Scope and sequence of topics in biology curriculum	2.93	0.89	2.68	0.99
180	Spacing of biology instruction	2.74	1.08	2.67	1.00
181	Lesson plans in biology curriculum and justification for the plans	2.92	0.86	2.55	0.99
182	Curricular materials and resources for biology	3.28	0.77	3.17	0.85
183	Skills of laboratory management	3.50	0.66	3.25	0.81
184	Media (e.g., film, television, video)	2.81	0.83	2.81	0.84
185	Instructional technologies	2.83	0.83	2.78	0.90
	Instruction				
186	Knowledge, experience, and skills that students bring	2.87	0.85	2.90	0.90
187	Knowledge, experience, and skills that students need	3.19	0.79	3.13	0.80
188	Prior conceptions, experience, and skills that students bring	2.98	0.79	2.94	0.95
189	Ways of presenting/explaining biology	3.66	0.52	3.65	0.52

Note: Mean ratings that are less than 2.50 are shaded.

		Teachers (N=188)		College Faculty (N=99)	
		Mean	SD	Mean	SD
190	Teaching strategies and activities as related to specific objectives	3.61	0.57	3.43	0.66
191	Experiences for promoting self-esteem and success in biology	3.40	0.73	3.21	0.87
Assessment					
192	Evaluation strategies to assess student performance in biology	3.43	0.64	3.29	0.72
193	Errors, patterns of errors, inaccuracies in student work	2.91	0.84	3.04	0.89
Professional Concerns					
194	Professional and scholarly literature	2.87	0.87	3.07	0.71
195	Professional and scholarly organizations	2.85	0.90	2.93	0.78
196	Continuing education in science education and in biology	3.27	0.84	3.24	0.79
197	Legal responsibilities and liabilities for teachers in biology	3.31	0.80	2.94	0.92
198	Overall importance of Content-Specific Pedagogy	3.32	0.66	3.19	0.76

Note: Mean ratings that are less than 2.50 are shaded.

Appendix G

Importance Ratings by Demographic Subgroups

	Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
	Female	Male	POC	White	NE	C	S	FW	≤5	>5
A. BASIC PRINCIPLES OF SCIENCE										
Scientific Methodology/Techniques/History										
1 Processes involved in scientific inquiry	3.67	3.63	3.58	3.64	3.77	3.64	3.46	3.71	3.53	3.58
2 Science process skills (e.g., observe, interpret, apply)	3.61	3.61	3.74	3.59	3.65	3.59	3.51	3.71	3.63	3.51
3 Evaluating and drawing conclusions from scientific studies	3.46	3.47	3.41	3.46	3.63	3.51	3.37	3.41	3.13	3.43
4 Application of scientific principles and theories	3.50	3.50	3.33	3.52	3.61	3.51	3.40	3.50	3.41	3.43
5 Role of concepts in integrating science	3.46	3.32	3.26	3.38	3.52	3.31	3.27	3.41	3.34	3.27
6 Identification of problems for scientific investigation	3.05	2.93	2.89	2.97	3.08	2.94	2.90	3.00	2.88	2.89
7 The role of models in scientific investigations	2.98	3.00	3.00	2.99	3.15	2.87	2.86	3.10	3.13	3.01
8 Commonly shared values of the scientific community	3.18	3.23	3.04	3.22	3.24	3.16	3.20	3.25	3.34	3.14
9 Important scientific findings, scientist(s)	2.54	2.53	2.52	2.54	2.65	2.63	2.45	2.42	2.56	2.51
10 History and philosophy of science	2.38	2.38	2.37	2.38	2.35	2.46	2.37	2.33	2.38	2.36
Mathematics, Measurement, and Data Manipulation										
11 The metric system	3.43	3.45	3.48	3.45	3.44	3.35	3.47	3.51	3.53	3.32
12 Scientific notation (exponential form)	2.69	2.74	2.93	2.71	2.81	2.58	2.64	2.87	2.88	2.52
13 Significant figures in measurement and calculation	2.69	2.63	2.70	2.64	2.64	2.56	2.64	2.75	2.78	2.52
14 Unit conversion/dimensional analysis	2.37	2.36	2.46	2.36	2.27	2.33	2.40	2.45	2.58	2.23
15 Experimental errors (e.g., sources, precision, accuracy)	2.70	2.68	2.54	2.70	2.73	2.70	2.60	2.73	2.74	2.62
16 Estimation/approximation	2.72	2.72	2.43	2.74	2.81	2.62	2.59	2.88	2.58	2.60
17 Generation of laboratory and field data	3.19	3.15	3.11	3.16	3.30	3.01	3.09	3.29	3.19	3.13
18 Measures of central tendency and dispersion	2.28	2.43	2.21	2.39	2.36	2.23	2.41	2.51	2.06	2.16
19 Data manipulation and generation of tables, graphs, or charts	3.16	3.05	3.04	3.08	3.30	2.88	3.15	3.06	2.94	3.05
20 Interpretation of tables, graphs, or charts	3.53	3.44	3.39	3.48	3.62	3.33	3.50	3.47	3.13	3.46

Note: Female (N=122); Male (N=216); POC=People of Color (N=28); White (N=303); NE=Northeast (N=75); C=Central (N=86); S=Southern (N=90); FW=Far West (N=86); ≤5=5 years teaching experience or less--teachers only (N=32); >5=More than 5 years teaching experience--teachers only (N=155). Mean ratings that are less than 2.50 are shaded.

	Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
	Female	Male	POC	White	NE	C	S	FW	≤5	>5
Laboratory, Field Activities, and Safety										
21 Use of laboratory and field equipment	3.81	3.62	3.71	3.69	3.80	3.65	3.66	3.66	3.81	3.70
22 Preparation of specimens and materials	3.09	2.91	3.07	2.97	3.00	2.90	2.95	3.06	3.26	3.03
23 Legal responsibilities and liabilities	3.31	3.19	3.44	3.21	3.23	3.28	3.22	3.19	3.33	3.41
24 Safety procedures	3.80	3.72	3.79	3.75	3.76	3.71	3.82	3.70	3.81	3.81
25 Emergency procedures for laboratory accidents	3.76	3.71	3.68	3.73	3.77	3.65	3.73	3.76	3.81	3.75
26 Laboratory and field hazards	3.64	3.54	3.64	3.57	3.60	3.55	3.67	3.47	3.71	3.61
27 Storage and disposal of materials	3.51	3.37	3.37	3.42	3.29	3.43	3.46	3.47	3.55	3.45
28 Overall importance of Basic Principles of Science	3.60	3.51	3.56	3.54	3.54	3.49	3.53	3.61	3.58	3.47
B. MOLECULAR AND CELLULAR BIOLOGY										
Chemical Basis of Life										
30 Atoms, molecules, and bonding	3.25	3.20	3.22	3.22	3.16	3.21	3.29	3.21	2.97	3.24
31 Ions, pH, buffers, and water	3.09	3.04	3.18	3.04	3.16	3.03	3.06	3.00	2.74	3.01
32 Biologically important inorganic molecules (e.g., CO2, NH3)	3.18	3.12	3.32	3.13	3.23	3.06	3.16	3.15	3.06	3.10
33 Functional groups in organic molecules (e.g., NH2, COOH)	2.80	2.83	3.04	2.80	2.93	2.80	2.84	2.72	2.55	2.82
34 Carbohydrates, lipids, proteins, nucleic acids	3.49	3.44	3.46	3.46	3.55	3.38	3.48	3.44	3.35	3.47
35 Important compounds in energy transformations (e.g., ATP, NADP)	3.33	3.20	3.14	3.25	3.34	3.28	3.18	3.20	3.19	3.21
36 Coupled reactions, free-energy changes, thermodynamics	2.50	2.48	2.82	2.46	2.46	2.52	2.47	2.51	2.52	2.34
37 Chemical reactions in fermentation, glycolysis, and respiration	2.95	2.93	3.07	2.92	2.99	2.88	3.03	2.86	2.90	2.97
38 Chemiosmosis in respiration	2.53	2.49	2.75	2.47	2.41	2.55	2.55	2.52	2.58	2.51
39 Light-dependent reactions in photosynthesis	2.94	2.91	3.00	2.91	2.91	2.88	3.02	2.88	2.97	2.91
40 Carbon fixation in photosynthesis	2.91	2.89	3.00	2.88	2.89	2.85	2.99	2.87	2.90	2.88
41 Chemiosmosis in photosynthesis	2.46	2.44	2.67	2.42	2.44	2.46	2.50	2.41	2.59	2.39
42 Interrelationships of anabolic and catabolic pathways	2.60	2.58	2.70	2.57	2.48	2.54	2.73	2.58	2.50	2.48
43 Structure of enzymes	2.76	2.60	2.74	2.65	2.88	2.56	2.67	2.56	2.47	2.70

Note: Female (N=122); Male (N=216); POC=People of Color (N=28); White (N=303); NE=Northeast (N=75); C=Central (N=86); S=Southern (N=90); FW=Far West (N=86); ≤5=5 years teaching experience or less--teachers only (N=32); >5=More than 5 years teaching experience--teachers only (N=155). Mean ratings that are less than 2.50 are shaded.

	Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
	Female	Male	POC	White	NE	C	S	FW	≤5	>5
44 Function of enzymes	3.29	3.26	3.22	3.29	3.41	3.24	3.31	3.18	3.16	3.31
45 Factors influencing enzyme activity (e.g., temperature, pH)	3.03	3.01	3.00	3.02	3.25	2.93	3.06	2.87	2.84	2.97
46 Regulation of enzyme function (e.g., feedback mechanisms)	2.68	2.69	2.93	2.66	2.83	2.60	2.73	2.62	2.59	2.60
Cell Structure and Function										
47 Membranes	3.53	3.36	3.33	3.43	3.53	3.34	3.52	3.28	3.50	3.41
48 Prokaryotic cells (subcellular components)	3.10	2.98	3.22	3.00	3.01	2.94	3.13	2.99	2.94	3.04
49 Eukaryotic cells (organelles and subcellular components)	3.43	3.30	3.44	3.34	3.43	3.19	3.46	3.33	3.28	3.42
50 Plant and animal cells	3.56	3.32	3.48	3.40	3.51	3.28	3.51	3.34	3.53	3.51
51 Fungal cells	2.65	2.46	2.85	2.50	2.45	2.44	2.70	2.52	2.91	2.50
52 Cell cycle including mitosis	3.66	3.49	3.59	3.56	3.61	3.49	3.63	3.47	3.66	3.60
53 Cytokinesis	3.11	3.10	3.26	3.08	3.04	3.06	3.17	3.13	2.94	3.12
54 Meiosis	3.63	3.53	3.56	3.57	3.57	3.53	3.62	3.55	3.50	3.60
Molecular Genetics										
55 Structure of DNA and RNA	3.59	3.56	3.52	3.58	3.72	3.47	3.61	3.51	3.41	3.64
56 Replication of DNA	3.53	3.53	3.52	3.54	3.71	3.47	3.57	3.41	3.38	3.60
57 Protein synthesis (transcription, translation, processing)	3.47	3.44	3.37	3.47	3.57	3.34	3.52	3.40	3.16	3.52
58 Gene regulation (e.g., lac operon)	2.75	2.85	2.96	2.79	2.93	2.76	2.86	2.72	2.66	2.79
59 Transposable elements	2.24	2.40	2.52	2.32	2.37	2.30	2.39	2.31	2.25	2.34
60 Mutations	3.16	3.22	3.15	3.21	3.27	3.22	3.18	3.15	2.94	3.26
61 Oncogenes and cancer	2.55	2.68	3.00	2.59	2.57	2.65	2.69	2.62	2.68	2.61
62 Viruses and viroids	2.84	2.75	2.92	2.76	2.80	2.64	2.93	2.77	2.84	2.86
63 Microbial genetics	2.36	2.49	2.73	2.41	2.45	2.38	2.56	2.38	2.29	2.47
64 Recombinant DNA technology	2.92	2.90	2.88	2.91	3.03	2.84	2.97	2.81	2.48	2.99
65 Overall importance of Molecular and Cellular Biology	3.36	3.34	3.46	3.35	3.41	3.25	3.41	3.35	3.19	3.44

Note: Female (N=122); Male (N=216); POC=People of Color (N=28); White (N=303); NE=Northeast (N=75); C=Central (N=86); S=Southern (N=90); FW=Far West (N=86); ≤5=5 years teaching experience or less--teachers only (N=32); >5=More than 5 years teaching experience--teachers only (N=155). Mean ratings that are less than 2.50 are shaded.

	Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
	Female	Male	POC	White	NE	C	S	FW	≤5	>5
C. CLASSICAL GENETICS										
67 Mendel's Law	3.40	3.41	3.29	3.42	3.52	3.30	3.44	3.39	3.38	3.41
68 Probability and prediction of inherited characteristics	3.35	3.31	3.18	3.33	3.40	3.30	3.34	3.26	3.13	3.34
69 Mechanisms and results of genetic linkage and recombination	3.02	3.00	2.96	3.01	3.19	2.98	2.99	2.92	2.81	3.05
70 Non-Mendelian inheritance	3.22	3.12	2.96	3.17	3.27	3.12	3.14	3.12	3.03	3.18
71 Causes of human genetic disorders (e.g., chromosomal aberration)	3.34	3.13	3.21	3.20	3.25	3.17	3.19	3.21	3.16	3.28
72 Environmental influences on expression of phenotype	3.15	2.99	3.14	3.03	3.15	3.02	3.03	3.00	3.03	3.10
73 Overall importance of Classical Genetics	3.40	3.28	3.26	3.33	3.38	3.32	3.37	3.25	3.19	3.33
D. EVOLUTION										
75 Evidence supporting evolution (e.g., molecular, fossil record)	3.34	3.28	3.29	3.30	3.53	3.22	3.21	3.28	3.22	3.22
76 Evolutionary mechanisms (e.g., natural selection)	3.29	3.33	3.32	3.31	3.43	3.24	3.29	3.32	3.09	3.25
77 Population genetics (e.g., genetic drift, gene flow)	2.83	2.91	2.93	2.86	2.88	2.85	2.90	2.90	2.91	2.75
78 Adaptive radiation and speciation	2.85	2.96	2.93	2.91	2.92	2.85	2.98	2.95	2.66	2.90
79 Diversity of life forms and evolutionary basis for classification	3.19	3.09	3.18	3.11	3.28	3.05	3.07	3.14	3.13	3.09
80 Principles of phylogeny	2.68	2.70	2.71	2.67	2.83	2.63	2.53	2.80	2.68	2.65
81 Origin of life	2.96	2.89	3.04	2.88	3.07	2.83	2.84	2.94	2.84	2.88
82 Overall importance of Evolution	3.22	3.25	3.26	3.23	3.39	3.18	3.17	3.25	3.00	3.14
E. DIVERSITY OF LIFE										
Taxonomy										
84 Classification schemes	2.86	2.85	3.04	2.83	3.00	2.67	2.84	2.93	3.00	2.92
85 Defining characteristics between and within the five kingdoms	3.09	3.04	3.18	3.04	3.15	2.92	3.02	3.18	3.38	3.04
Characteristics and Representatives of Kingdoms										
86 Monerans (prokaryotes)	2.92	2.71	2.96	2.76	2.88	2.63	2.83	2.81	2.94	2.78
87 Protists	2.95	2.74	3.00	2.79	2.89	2.68	2.86	2.85	3.00	2.86
88 Fungi	2.89	2.69	3.00	2.73	2.81	2.62	2.81	2.82	3.00	2.78

Note: Female (N=122); Male (N=216); POC=People of Color (N=28); White (N=303); NE=Northeast (N=75); C=Central (N=86); S=Southern (N=90); FW=Far West (N=86); ≤5=5 years teaching experience or less--teachers only (N=32); >5=More than 5 years teaching experience--teachers only (N=155). Mean ratings that are less than 2.50 are shaded.

		Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
		Female	Male	POC	White	NE	C	S	FW	≤5	>5
89	Plants	3.18	3.00	3.29	3.03	3.05	2.91	3.13	3.16	3.47	3.05
90	Animals	3.22	3.04	3.29	3.08	3.11	2.95	3.19	3.19	3.63	3.10
91	Overall Importance of Diversity of Life	3.18	2.98	3.36	3.02	3.03	2.91	3.11	3.18	3.34	3.04
F.	**PLANTS**										
Evolution											
93	Adaptation to land	2.78	2.76	3.04	2.74	2.78	2.71	2.76	2.82	2.71	2.73
94	Major divisions (e.g., bryophytes, pteridophytes)	2.48	2.56	2.89	2.48	2.39	2.58	2.58	2.56	2.65	2.52
Anatomy											
95	Roots	2.83	2.79	2.74	2.80	2.85	2.74	2.81	2.83	2.97	2.76
96	Stems	2.84	2.79	2.74	2.81	2.85	2.74	2.81	2.84	3.03	2.76
97	Leaves	2.88	2.87	2.85	2.87	2.93	2.80	2.89	2.88	3.10	2.82
98	Reproductive structures	3.01	2.97	2.96	2.98	3.06	2.88	3.01	3.00	3.23	2.94
Physiology											
99	C3 and C4 photosynthesis	2.28	2.39	2.48	2.33	2.33	2.29	2.38	2.40	2.55	2.35
100	CAM (Crassulacean acid metabolism)	1.82	1.81	2.15	1.78	1.73	1.80	1.86	1.86	2.00	1.81
101	Control Mechanisms (e.g., hormones, photoperiods, tropisms)	2.69	2.74	2.81	2.70	2.83	2.60	2.71	2.76	2.94	2.70
102	Water and nutrient transport	3.03	3.00	3.00	3.00	3.00	2.98	3.01	3.06	3.16	3.05
103	Water potential	2.58	2.57	2.52	2.56	2.51	2.40	2.70	2.66	2.87	2.59
104	Nutrition	2.88	2.82	2.93	2.82	2.86	2.81	2.92	2.77	3.06	2.83
105	Mycorrhizae	2.01	2.03	2.15	2.00	1.89	2.06	2.01	2.12	2.39	1.93
Reproduction											
106	Alternation of generations	2.69	2.75	2.74	2.72	2.69	2.51	2.92	2.79	2.84	2.64
107	Fertilization and zygote formation	3.01	3.05	3.11	3.02	3.10	2.89	3.15	3.01	3.19	2.97
108	Flowers, fruits, and seeds	3.08	3.11	3.00	3.10	3.08	3.00	3.17	3.14	3.23	3.09
109	Dispersal and germination	2.96	2.87	2.81	2.89	2.88	2.82	2.98	2.94	3.10	2.88

Note: Female (N=122); Male (N=216); POC=People of Color (N=28); White (N=303); NE=Northeast (N=75); C=Central (N=86); S=Southern (N=90); FW=Far West (N=86); ≤5=5 years teaching experience or less--teachers only (N=32); >5=More than 5 years teaching experience--teachers only (N=155). Mean ratings that are less than 2.50 are shaded.

	Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
	Female	Male	POC	White	NE	C	S	FW	≤5	>5
110 Vegetative propagation (asexual reproduction)	2.83	2.69	2.70	2.73	2.70	2.69	2.78	2.80	2.87	2.77
111 Development and differentiation	2.64	2.68	2.81	2.64	2.68	2.54	2.80	2.66	2.87	2.62
112 Overall importance of Plants	3.06	3.06	3.19	3.04	3.01	3.03	3.11	3.09	3.17	3.05
G. ANIMALS										
Evolution										
114 Classification based on phylogeny	2.80	2.74	2.78	2.75	2.81	2.62	2.75	2.88	2.94	2.81
115 Major phyla (e.g., platyhelminthes, annelida, chordata)	2.88	2.87	3.07	2.84	2.96	2.71	2.90	2.93	3.03	2.93
Life Functions and Associated Structures										
116 Digestion	3.13	3.08	3.18	3.08	3.15	3.01	3.13	3.12	3.32	3.12
117 Circulation	3.15	3.11	3.18	3.11	3.19	3.03	3.15	3.13	3.35	3.13
118 Respiration	3.17	3.11	3.14	3.12	3.20	3.06	3.14	3.13	3.35	3.15
119 Excretion	3.13	3.02	3.04	3.05	3.13	2.95	3.07	3.10	3.19	3.08
120 Nervous control	3.18	3.07	3.14	3.09	3.21	3.06	3.08	3.10	3.32	3.14
121 Contractile systems and movement (e.g., muscles)	3.03	2.98	3.04	2.98	3.01	2.94	3.02	3.01	3.23	3.01
122 Support	2.93	2.94	2.89	2.93	2.91	2.90	2.95	2.99	3.13	2.93
123 Integument	2.83	2.80	2.82	2.79	2.81	2.76	2.84	2.83	2.97	2.83
124 Immunity	3.18	3.10	3.15	3.12	3.22	3.03	3.13	3.14	3.13	3.21
125 Chemical control (e.g., hormones)	3.13	3.03	3.07	3.06	3.18	2.97	3.08	3.06	3.13	3.13
Reproduction and Development										
126 Gamete production	3.28	3.25	3.14	3.26	3.35	3.17	3.26	3.27	3.35	3.27
127 Fertilization	3.27	3.21	3.11	3.24	3.35	3.10	3.25	3.25	3.42	3.25
128 Parthenogenesis	2.19	2.33	2.44	2.25	2.26	2.23	2.25	2.39	2.58	2.26
129 Embryogenesis	2.60	2.73	2.75	2.67	2.78	2.59	2.72	2.67	2.77	2.67
130 Growth and differentiation (e.g., homeotic genes, induction)	2.42	2.67	2.79	2.56	2.66	2.51	2.59	2.58	2.74	2.54

110

111

Note: Female (N=122); Male (N=216); POC=People of Color (N=28); White (N=303); NE=Northeast (N=75); C=Central (N=86); S=Southern (N=90); FW=Far West (N=86); ≤5=5 years teaching experience or less--teachers only (N=32); >5=More than 5 years teaching experience--teachers only (N=155). Mean ratings that are less than 2.50 are shaded.

		Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
		Female	Male	POC	White	NE	C	S	FW	≤5	>5
131	Metamorphosis	2.48	2.68	2.61	2.60	2.59	2.54	2.67	2.64	2.87	2.63
132	Aging	2.50	2.63	2.75	2.56	2.53	2.56	2.63	2.60	2.81	2.51
Behavior											
133	Taxes	2.30	2.41	2.44	2.35	2.34	2.34	2.35	2.44	2.50	2.32
134	Instincts	2.41	2.51	2.63	2.44	2.45	2.43	2.46	2.55	2.67	2.45
135	Learned behaviors (e.g., imprinting, conditioning, insight)	2.50	2.56	2.78	2.50	2.51	2.49	2.59	2.57	2.70	2.55
136	Communication (e.g., pheromones, vision, sound)	2.64	2.62	2.86	2.59	2.71	2.58	2.58	2.64	2.74	2.63
137	Overall importance of Animals	3.24	3.23	3.11	3.24	3.26	3.16	3.27	3.25	3.42	3.21
H. ECOLOGY											
Populations											
139	Intraspecific competitions	2.89	2.89	2.96	2.88	2.89	2.77	2.90	3.00	3.06	2.85
140	Density-dependent and density-independent factors	2.73	2.78	2.82	2.75	2.71	2.60	2.77	2.95	2.97	2.76
141	Population growth (e.g., biotic potential, environmental resistance)	3.15	3.25	3.07	3.23	3.25	3.12	3.20	3.30	3.26	3.16
142	Patterns of dispersion (e.g., random, clumped, uniform)	2.45	2.44	2.54	2.43	2.33	2.34	2.44	2.66	2.81	2.43
143	Life-history patterns (e.g., r and k strategies, mortality)	2.24	2.31	2.29	2.27	2.16	2.24	2.26	2.45	2.68	2.21
144	Social behavior (e.g., dominance, territoriality, hierarchy, altruism)	2.67	2.63	2.86	2.62	2.51	2.59	2.74	2.72	2.87	2.61
Communities											
145	Niche	2.98	3.08	2.89	3.06	3.01	2.94	3.06	3.18	3.16	3.06
146	Interspecific relationships (e.g., commensalism, mutualism)	3.17	3.19	3.07	3.19	3.22	3.07	3.20	3.26	3.13	3.24
147	Species diversity	3.09	3.08	2.93	3.10	3.21	3.00	3.04	3.12	3.16	3.08
148	Succession	3.07	3.15	2.93	3.13	3.19	3.06	3.14	3.11	3.22	3.09
Ecosystems											
149	Terrestrial biomes (e.g., rain forests, tundra, desert, grasslands)	2.90	2.95	2.89	2.93	2.86	2.95	2.93	2.96	3.03	2.93
150	Aquatic ecosystems	2.89	2.87	2.93	2.86	2.85	2.93	2.84	2.88	2.94	2.89
151	Energy flow (e.g., trophic levels, food webs, productivity)	3.34	3.36	3.29	3.35	3.39	3.31	3.26	3.46	3.34	3.29

Note: Female (N=122); Male (N=216); POC=People of Color (N=28); White (N=303); NE=Northeast (N=75); C=Central (N=86); S=Southern (N=90); FW=Far West (N=86); ≤5=5 years teaching experience or less--teachers only (N=32); >5=More than 5 years teaching experience--teachers only (N=155). Mean ratings that are less than 2.50 are shaded.

		Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
		Female	Male	POC	White	NE	C	S	FW	≤5	>5
152	Biogeochemical cycles (e.g., nitrogen, carbon, water)	3.12	3.13	3.07	3.12	3.15	3.08	3.08	3.19	3.03	3.07
153	Stability and disturbances (resistance to/recovery from change)	2.83	2.72	2.82	2.75	2.66	2.78	2.72	2.86	3.00	2.72
154	Interrelationships among ecosystems	3.21	3.01	3.29	3.06	3.03	3.02	3.06	3.22	3.22	3.09
155	Human impact (e.g., deforestation, pesticides, pollution)	3.74	3.64	3.68	3.68	3.64	3.71	3.60	3.76	3.72	3.69
156	Overall importance of Ecology	3.51	3.50	3.41	3.52	3.51	3.49	3.44	3.60	3.53	3.48
I.	**ISSUES AND APPLICATIONS RELATING TO SCIENCE, TECHNOLOGY, AND SOCIETY**										
158	Human population growth	3.39	3.38	3.18	3.39	3.41	3.44	3.33	3.35	3.31	3.36
159	Energy production and use (e.g., deforestation, acid rain)	3.55	3.46	3.36	3.50	3.53	3.52	3.40	3.54	3.59	3.46
160	Production/use of consumer products (e.g., ozone degradation)	3.48	3.29	3.32	3.36	3.36	3.44	3.27	3.38	3.56	3.37
161	Biological magnification of toxic materials in food chains	3.40	3.24	3.21	3.30	3.28	3.39	3.19	3.34	3.41	3.33
162	Resource management (e.g., wildlife, forests, soil, water, metals)	3.33	3.18	3.04	3.25	3.12	3.31	3.20	3.28	3.38	3.24
163	Relationship of resources, population patterns, and global politics	3.16	3.00	3.04	3.06	2.89	3.08	3.07	3.18	3.22	3.08
164	Ethics and biology (e.g., gene cloning, in vitro fertilization)	3.32	3.25	3.32	3.27	3.35	3.31	3.24	3.22	3.25	3.39
165	Effects of agricultural practices on the environment	3.10	3.12	3.29	3.10	3.00	3.20	3.13	3.11	3.28	3.10
166	Prediction and preparation for natural disasters	2.30	2.18	2.71	2.16	2.03	2.20	2.36	2.27	2.50	2.22
167	Current developments in biology and other sciences	3.21	3.16	3.11	3.18	3.30	3.14	3.21	3.10	3.03	3.27
168	Overall importance of Issues and Applications Relating to Science, Technology, and Society	3.48	3.40	3.46	3.42	3.43	3.44	3.37	3.48	3.39	3.43
J.	**CONTENT-SPECIFIC PEDAGOGY**										
	Factors That Influence Learning and Instruction										
170	Complex factors that may specifically affect the teaching of biology	3.02	3.02	3.11	3.00	3.07	3.10	3.02	2.89	2.94	3.08
171	Complex factors that may affect students learning of biology	3.33	3.20	3.32	3.23	3.34	3.31	3.13	3.22	3.19	3.29
172	The impact of learning theories on the teaching of biology	2.49	2.65	2.75	2.57	2.66	2.57	2.53	2.62	2.41	2.62

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	Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
	Female	Male	POC	White	NE	C	S	FW	≤5	>5
Curriculum: Organization, Materials and Management										
173 Themes and concepts central to the science of biology	3.31	3.41	3.36	3.37	3.63	3.37	3.22	3.32	3.31	3.31
174 Current goals in teaching biology	3.04	3.03	3.18	3.01	3.01	3.04	2.98	3.12	3.22	3.03
175 Purposes for learning biology	3.28	3.29	3.32	3.28	3.28	3.21	3.28	3.39	3.50	3.23
176 Purposes for teaching a particular topic in biology	3.15	3.16	3.18	3.15	3.21	3.06	3.11	3.25	3.41	3.11
177 Relationships among topics in biology	3.46	3.35	3.61	3.37	3.51	3.28	3.29	3.51	3.74	3.31
178 Relationships between biology and other disciplines	3.29	3.30	3.52	3.28	3.25	3.29	3.29	3.35	3.63	3.21
179 Scope and sequence of topics in biology curriculum	2.89	2.85	3.39	2.81	3.00	2.84	2.77	2.89	2.88	2.95
180 Spacing of biology instruction	2.80	2.69	3.29	2.67	2.70	2.64	2.77	2.77	2.75	2.74
181 Lesson plans in biology curriculum and justification for the plans	2.80	2.82	3.29	2.76	2.97	2.80	2.70	2.80	2.84	2.94
182 Curricular materials and resources for biology	3.19	3.25	3.58	3.19	3.24	3.18	3.26	3.27	3.29	3.29
183 Skills of laboratory management	3.44	3.42	3.46	3.42	3.54	3.33	3.41	3.42	3.53	3.50
184 Media (e.g., film, television, video)	2.75	2.85	2.89	2.81	2.76	2.78	2.91	2.82	2.81	2.81
185 Instructional technologies	2.68	2.91	2.85	2.83	2.73	2.94	2.75	2.88	2.97	2.81
Instruction										
186 Knowledge, experience, and skills that students bring	2.91	2.87	2.81	2.88	2.96	2.88	2.78	2.94	3.16	2.82
187 Knowledge, experience, and skills that students need	3.16	3.17	3.08	3.17	3.31	3.11	3.10	3.18	3.31	3.18
188 Prior conceptions, experience, and skills that students bring	2.98	2.93	3.00	2.94	3.06	2.96	2.74	3.06	3.19	2.95
189 Ways of presenting/explaining biology	3.66	3.66	3.78	3.65	3.67	3.64	3.64	3.71	3.69	3.66
190 Teaching strategies and activities as related to specific objectives	3.57	3.56	3.67	3.55	3.60	3.55	3.47	3.64	3.69	3.59
191 Experiences for promoting self-esteem and success in biology	3.44	3.30	3.44	3.33	3.29	3.36	3.18	3.55	3.63	3.35
Assessment										
192 Evaluation strategies to assess student performance in biology	3.41	3.35	3.52	3.36	3.40	3.28	3.34	3.47	3.47	3.42
193 Errors, patterns of errors, inaccuracies in student work	2.97	2.94	3.30	2.92	2.86	2.94	2.94	3.05	3.09	2.88

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		Gender		Race/Ethnicity		Geographic Region				Teaching Experience	
		Female	Male	POC	White	NE	C	S	FW	≤5	>5
Professional Concerns											
194	Professional and scholarly literature	2.91	2.96	2.93	2.94	2.89	2.94	3.02	2.92	2.75	2.91
195	Professional and scholarly organizations	2.80	2.93	2.74	2.89	2.79	2.99	2.89	2.85	2.63	2.91
196	Continuing education in science education and in biology	3.20	3.30	3.22	3.26	3.29	3.37	3.15	3.26	3.19	3.30
197	Legal responsibilities and liabilities for teachers in biology	3.16	3.19	3.12	3.18	3.21	3.26	3.16	3.11	3.16	3.35
198	Overall importance of Content-Specific Pedagogy	3.20	3.32	3.24	3.28	3.21	3.32	3.30	3.29	3.16	3.37

Note: Female (N=122); Male (N=216); POC=People of Color (N=28); White (N=303); NE=Northeast (N=75); C=Central (N=86); S=Southern (N=90); FW=Far West (N=86); ≤5=5 years teaching experience or less--teachers only (N=32); >5=More than 5 years teaching experience--teachers only (N=155). Mean ratings that are less than 2.50 are shaded.

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