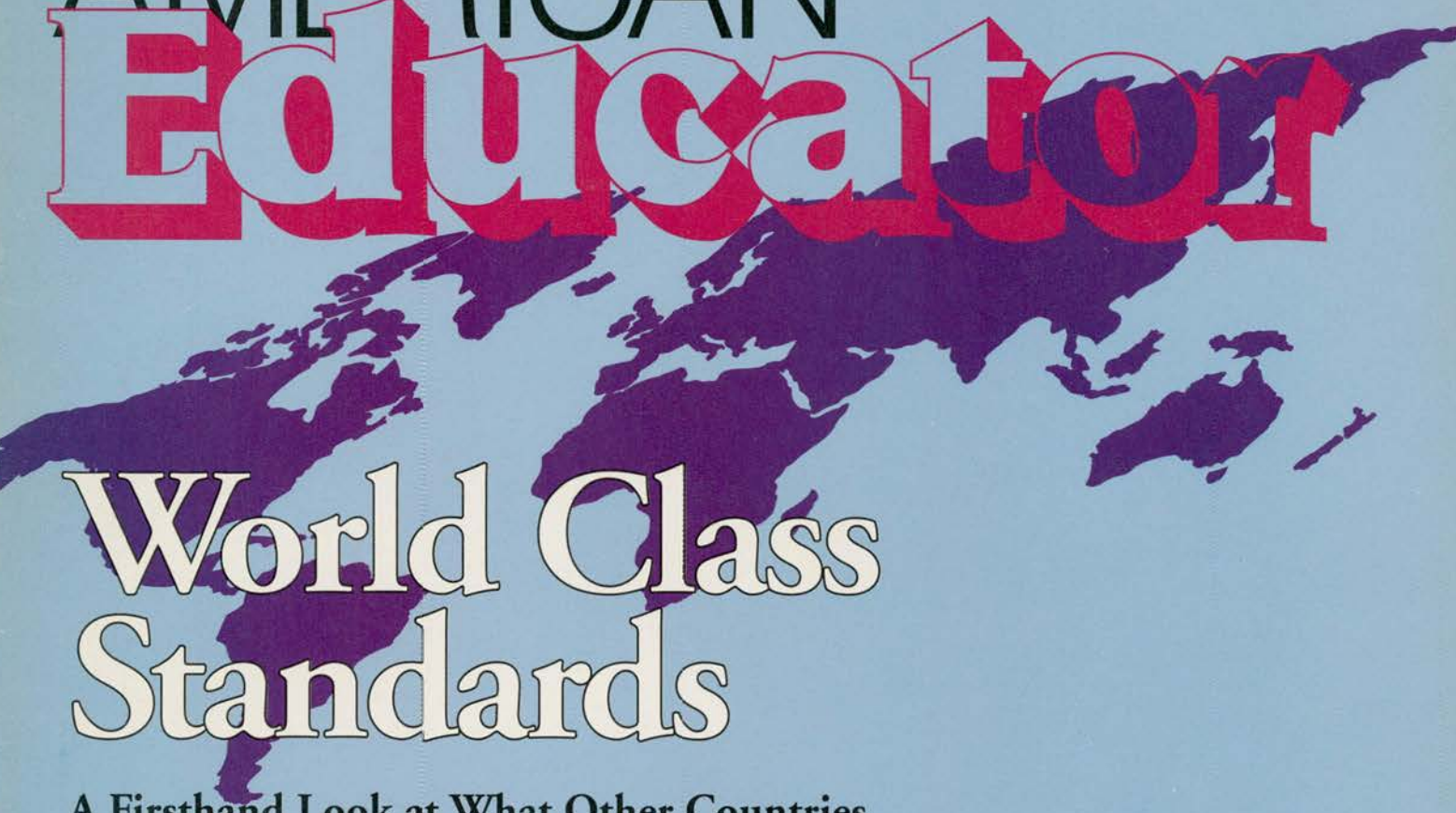
AMERICAN FEDERATION OF TEACHERS
SPRING 1994

AMERICAN Educator



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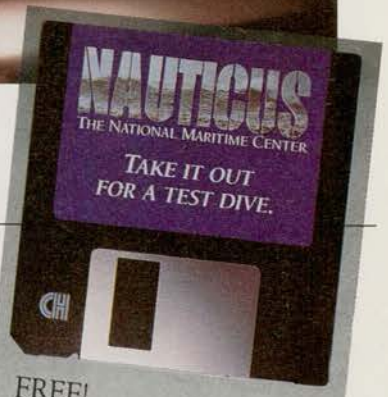

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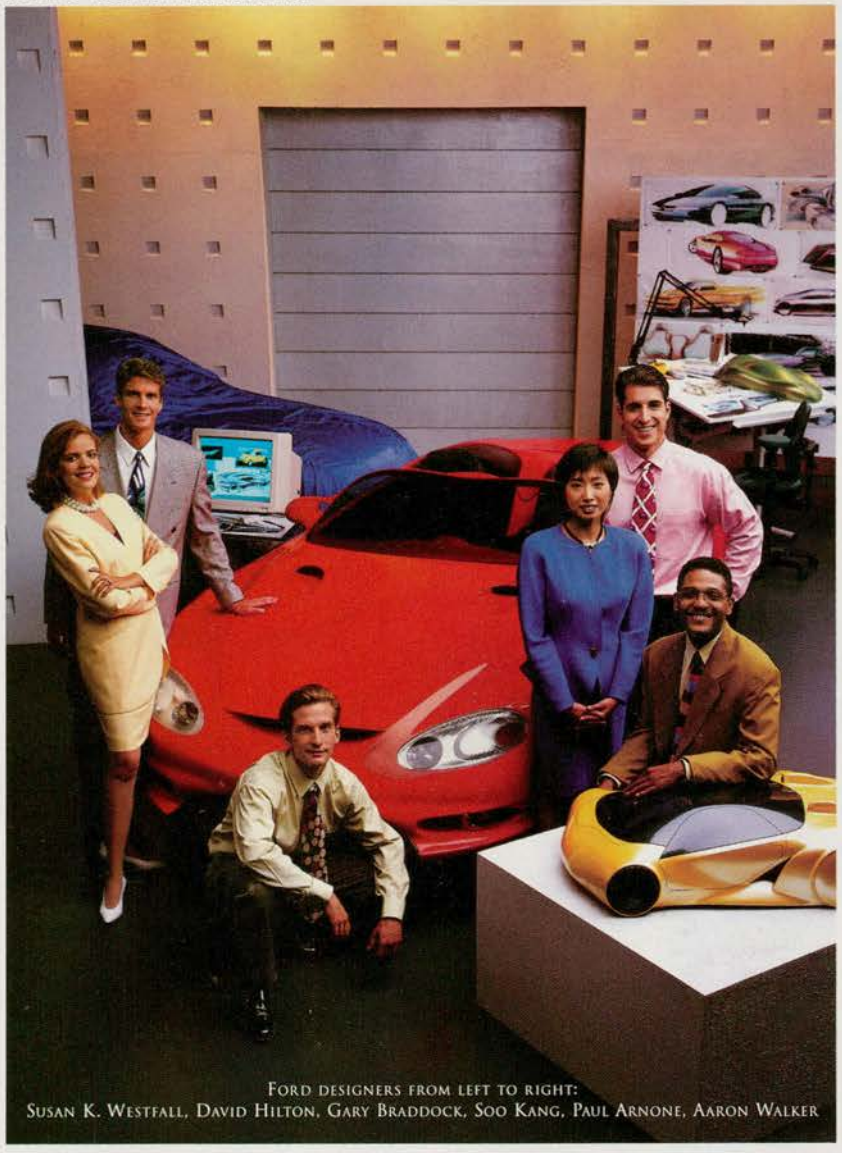

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SUSAN K. WESTFALL, DAVID HILTON, GARY BRADDOCK, SOO KANG, PAUL ARNONE, AARON WALKER

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The Professional Journal of the American Federation of Teachers
Volume 18, No. 1
Spring 1994

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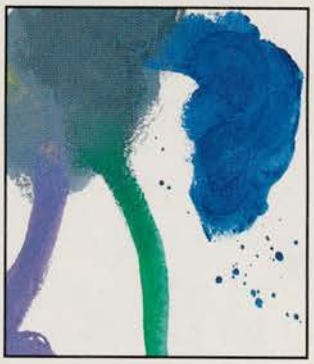

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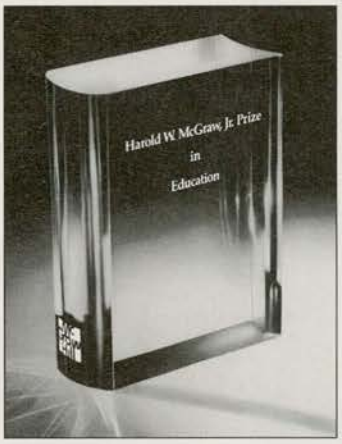
AMERICAN Educator

The Harold W. McGraw, Jr. Prize in Education

Three who make a difference: Announcing the 1993 winners of the McGraw Prize in Education.



The Harold W. McGraw, Jr. prize was established in 1988, in celebration of McGraw-Hill's 100th anniversary and in honor of our chairman emeritus.

Each year, up to three $25,000 prizes are awarded to people who have made a difference in education.

For 1993, the Board of Judges selected these three individuals for distinguished contributions to the advancement of education.

Sister Mary Brian Costello, R.S.M.

As Superintendent of Schools for the Archdiocese of Chicago, the largest private school system in the world, Sister Mary Brian Costello, R.S.M., gained national attention as a powerful voice for inner-city education.

Her concern for economically disadvantaged children led Sister Mary Brian to establish summer learning centers in the heart of the city's poorest areas to provide them with special educational opportunities. She also helped develop innovative learning programs for preschoolers as well as for exceptional children and those learning-disabled or handicapped by economic condition or circumstance.

Sister Mary Brian is currently serving as Chief of Staff for the Archdiocese, where, in keeping with her life-long commitment to education, she has provided leadership for Big Shoulders, the Archdiocese's ambitious program to assist and strengthen parochial schools of the inner city.

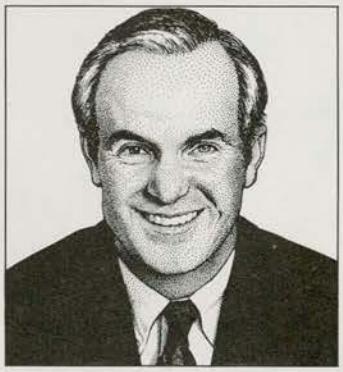
Sharon Darling

Adult illiteracy cripples many efforts to educate disadvantaged youngsters, fueling a seemingly endless cycle of undereducation, unemployment and poverty.

With a lifetime of work in the field of literacy, Sharon Darling developed a model that breaks the intergenerational grasp of illiteracy and poverty by bringing undereducated parents and children to school to learn together. Her imaginative approach has given thousands of families new confidence, hope and self-esteem.

To assist educators and policymakers in developing and funding family literacy efforts, Ms. Darling established the National Center for Family Literacy in Louisville, Kentucky. The Center has successfully spread her innovative ideas throughout the country, providing opportunities for parents to improve their own lives as well as the lives of their children.

Booth Gardner



Education is at the very center of Booth Gardner's agenda. As Governor of the State of Washington for eight years, he successfully introduced reforms which improved education throughout the state.

Stemming from his belief that all children can and should learn at higher levels, Governor Gardner helped develop an innovative system of results-based education programs that significantly raised academic achievement standards for all students, lowered dropout rates, provided greater flexibility for students to learn, elevated standards for educators and fully funded early childhood education.

At the national level, Governor Gardner shares his devotion to education reform with leaders from across the country, through the programs he developed in his home state and as former chairman of both the National Governors Association and the Education Commission of the States.

For more information, write to The Harold W. McGraw, Jr. Prize in Education, McGraw-Hill, Inc., 1221 Avenue of the Americas, New York, NY 10020.

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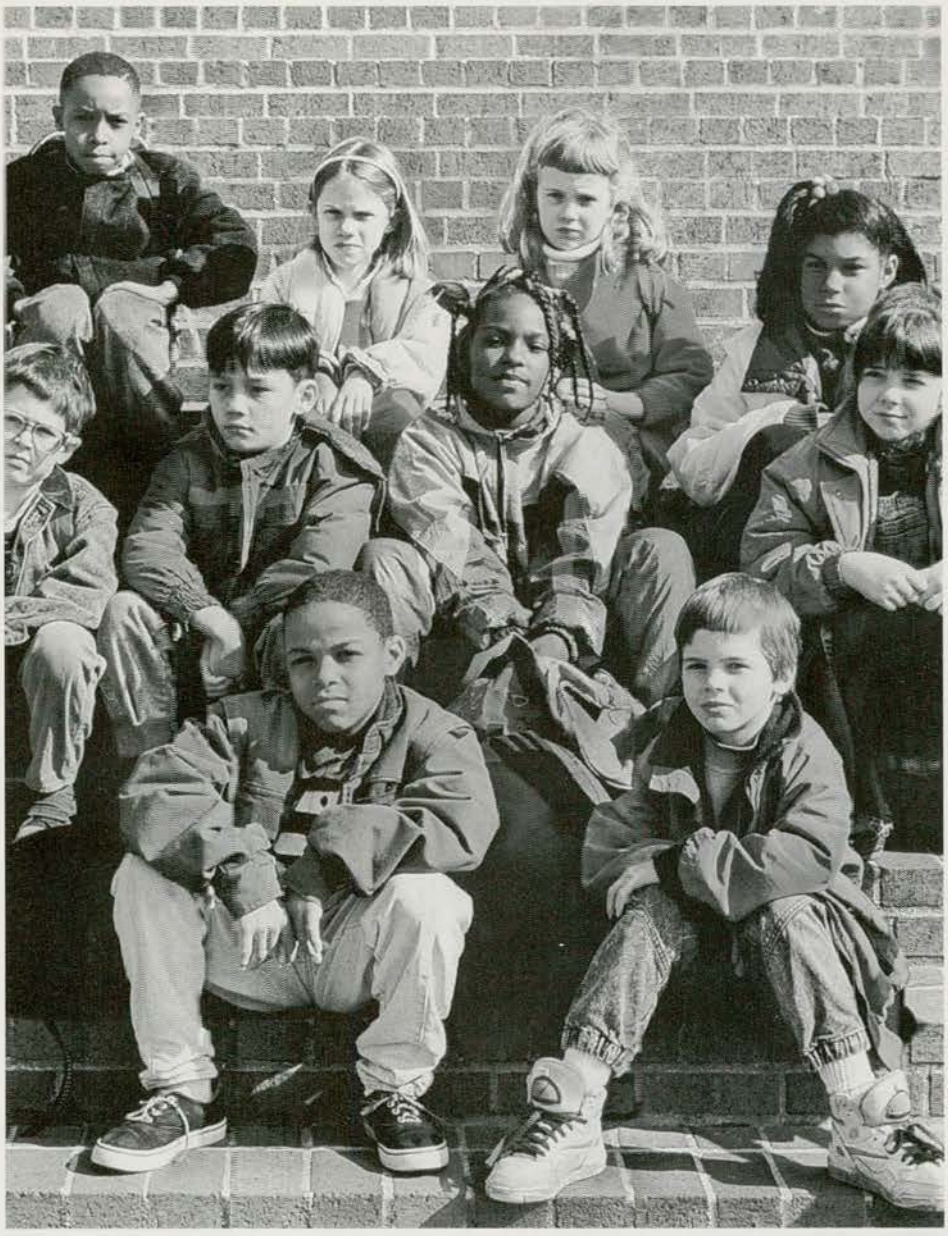

"Nearly one fourth of America's public school students say they have been **the victims of an act of violence** in or around school."

—*The MetLife Survey of the American Teacher 1993: Violence in America's Public Schools*

An epidemic of violence seems to be sweeping America's schools. Where gum-chewing and talking in class used to be serious problems, one now hears of students and teachers alike being robbed or shot or stabbed.

How big is the problem, really? How much of it is media hype? Where does it happen most? How does it affect education? What causes it? How can it be controlled?

To help examine these and other critical questions, MetLife commissioned the research firm of Louis Harris & Associates to interview over two thousand teachers, students and law enforcement officials on the subject of violence in America's schools.

The results of this survey are yours for the asking. We published them not to moralize or suggest remedies, but to provide you with a foundation of informed opinion upon which remedial action can be formulated.

The MetLife Survey of the American Teacher 1993: Violence in America's Public Schools is the most recent in a decade-long series of surveys sponsored by MetLife. You may obtain a summary of the findings, without cost, by writing to MetLife Teachers' Survey 1993, PO Box 807, Madison Square Station, New York, NY 10159-0807.

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Defining World Class Standards

A PUBLICATION SERIES OF THE AMERICAN FEDERATION OF TEACHERS

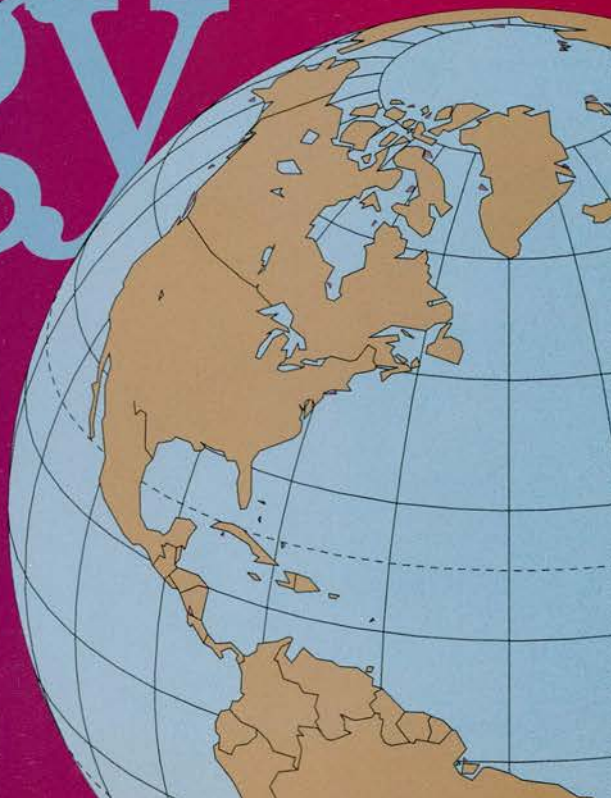
Excerpts from

What College-Bound Students Abroad Are Expected To Know About

Biology

Exams from England and Wales, France, Germany and Japan

Plus a comparative look at the United States



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AMERICAN FEDERATION OF TEACHERS

NATIONAL CENTER FOR IMPROVING SCIENCE EDUCATION

THERE IS a growing awareness in this country both that academic performance in our schools is not high enough and that we need to set "world class" standards for our students. The American Federation of Teachers has been a strong advocate for school reform based on rigorous academic standards for many years, and we are thrilled that the national conversation has taken off at such a fast pace. Yet, as we have observed and become involved in some of the standards-setting activities under way at the national, state and local levels, we have noticed an alarming inconsistency. Many people are using the term "world class standards," but there is a surprising dearth of resources available to show educators, policymakers, and others exactly what "world class" means.

This spring, the AFT launched a new publication series designed to fill that void. The *Defining World Class Standards* series will publish translated assessments, curriculum materials, and other foreign documents that may help illuminate what a world class standard is and bring substance to the current standards-setting discussions and activities. Over time, we hope to cover a variety of subject areas and grade levels, and we intend to focus on standards for both work-bound and college-bound students. The inaugural volume of the series focuses on standards for college-bound students in science, specifically biology.

What College-Bound Students Abroad Are Expected To Know About Biology, a joint publication of the AFT and the National Center for Improving Science Education (NCISE), contains examinations taken by college-bound students at the end of their secondary school careers in England and Wales, France, Germany, and Japan. These exams—the A-levels in England and Wales, the *baccalauréat* in France, the *Abitur* in Germany, and the university entrance exams in Japan—are among the most challenging tests given to students in these countries; and the tests (though not necessarily in biology) are required of all college-bound students. As an additional resource, the Advanced Placement (AP) biology exam is also included in the book along with a discussion of standards—or the lack thereof—for college-bound students in the United States. Unlike the foreign exams, the AP is not required of college-bound youngsters and is taken by only a small percentage of American students.

The materials and information in this book and the series that will follow should serve as a valuable resource to anyone involved in setting or evaluating academic standards for students, whether at the national, state, local, or school level. All of us will be wiser, more informed participants in discussions about standards if we are aware of what is demanded elsewhere. But it is our hope that the *Defining World Class Standards* series will serve an even wider audience. We expect that educators will want to use the materials to compare their expectations for their students with those of their counterparts overseas. Parents might also be interested in making similar comparisons. Business leaders will want to know what other countries expect of high school graduates and how well prepared they are to enter the work force. Higher education faculty will be interested in the standards for college-bound students.

In the end, we hope this book and the series that will follow will be not only a resource but also a clarion call. Our goal is to generate broad awareness among educators and the general public that we are expecting too little of our students and that we need to work together to enact the kinds of reforms that will enable our schools to help all youngsters reach their maximum potential.

The following report is an abridged version of *What College-Bound Students Abroad Are Expected To Know About Biology.* This report is organized into five sections: an introduction, which discusses the rationale for both the *Defining World Class Standards* series and this volume; a section on each of the featured countries; and, finally, a comparative discussion of all five countries and their examination systems. We are only able to include here portions of the exams and surrounding information on three of the five countries featured in the book: England and Wales, France, and Germany. Please note, however, that the other two countries included in the full book—Japan and the United States—are mentioned in the comparative discussion in the last section of this report. For each of the three countries, we have included portions of the exams as well as sample answers, or in the case of England and Wales, excerpts from the official scoring guides used to grade the exams. Prior to each exam is a brief country profile, which provides important background information and describes the role the exam plays in that country's education system.

* * *

IN 1989, a historic meeting took place in Charlottesville, Virginia. The nation's governors and the president came together collectively to address the need for fundamental changes and improvements in our schools. The result was a commitment to a set of six national education goals that would propel our education system into the 21st century. Two of those goals indirectly called for the setting of rigorous, "world class" academic standards for our students, standards that would drive everything else we do in our schools.

Why the emphasis on making our education standards "world class"? The president and governors fully

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What College-Bound Students Abroad Are Expected To Know About Biology *was co-sponsored by the American Federation of Teachers and the National Center for Improving Science Education, and is the inaugural volume of the AFT's* Defining World Class Standards *series. The principal author was Matthew Gandal, who is a research associate in the AFT Educational Issues Department. The research assistant on the project was Charles Hokanson. Ted Britton coordinated the project for NCISE.*

Copies of the book are available for $10. Shipping and handling costs are included. Send prepaid orders to Biology Book, AFT Order Dept., 555 New Jersey Ave., N.W., Washington, DC 20001. Checks should be made payable to the AFT.

recognized the link between students' performance and success in school and the contributions students will ultimately make to their communities and the nation as a whole. In order for the United States to remain internationally competitive—and for American families to raise their standard of living—businesses must be able to hire youngsters with the knowledge and skills necessary to compete in today's global economy. And, increasingly, youth without these skills will find it difficult to get and keep jobs that pay decent wages. It is imperative, therefore, that our schools help students learn and achieve at levels comparable to those reached by students in our competitor nations. Unfortunately, international comparisons over the years have clearly shown that we are not bringing our students up to those levels.

There is another reason, as well, to look at and be informed by internationally competitive standards. If we don't, there is a danger that those of us who have been involved so long in the struggle to raise student achievement will become prisoners of the status quo, unable to imagine youngsters achieving at higher levels than we are accustomed to. In this sense, our own experience can be limiting. The current emphasis on world class standards is designed to free us from these limitations and biases, and encourage us to learn from the experiences of other countries. By looking at what students in other nations are capable of accomplishing, we may aim higher when judging the potential of our own youngsters.

Since the Charlottesville Summit, much attention has been paid to the challenge of setting world class standards. With the support of the Clinton administration (and the Bush administration before that), the U.S. Congress, the nation's governors, professional associations and the business community, some of the nation's most highly respected educators and scholars have begun to develop national standards for what students should be expected to learn in the core academic subjects. In addition, educators at the state, district, and school levels are simultaneously organizing their own efforts to set world class standards for students.

But what is a world class standard? Despite the frequent use of the term and the references to high achievement in other lands, there is, unfortunately, not much available to apprise us of what is actually expected of foreign students in particular subjects.

Focusing on Science

The poor academic performance of our students has been well documented over the years in subjects across the board, including science. According to the most recent report on science achievement from the National Assessment of Educational Progress—*The 1990 Science Report Card* (published in 1992)—most U.S. eighth and 12th graders know some basic scientific principles, but a low percentage possess in-depth scientific knowledge and reasoning skills. Fewer than half of 12th graders demonstrated the ability to interpret graphs and tables, evaluate and design experiments, or make use of detailed scientific information. The message was similar when the 1991 International Assessment of Educational Progress measured science achievement among 13-year-olds; the United States ranked 13th out of 15 nations.

At a time when the global economy is becoming more and more dependent on scientific research and technology, we simply cannot afford such low levels of science achievement in our schools.

What are students in other countries expected to know and be able to do in science? How do these expectations compare with our own? These are the sorts of questions that many educators, parents and policymakers are asking as they become involved in the national conversation about standards. And it was questions like these that motivated the AFT and NCISE to produce a book on science expectations overseas.

Why focus on biology? Because it is the most commonly studied science subject in American high schools. Whereas only limited numbers of high school students in this country are exposed to physics and chemistry (20 percent and 45 percent respectively), 95 percent of students take at least one biology course.

As is discussed in significant detail in the final section of this report, one of our most striking findings has to do not with whose exams are most difficult, but rather with how many students in these countries are taking and passing the exams each year. With the exception of the United States, every country brings a significant number of students—at least 25 percent and as much as 36 percent of the age cohort—up to the level of performance demanded in these exams. In contrast, only 4 percent of 18-year-olds in the United States take and pass one or more AP exams.

Another important finding is that these foreign exams must be passed by students who want to go on to study in colleges and universities. And since the exams are well-aligned with the school curriculum, students understand that working hard in school will pay off. This alignment of curricula, exams, and incentives does not exist in the United States. Indeed, the test most widely taken in the U.S. for college admissions purposes—the SAT—makes a point of not being linked to any curriculum. In fact, the SAT does not even have specific sections or questions in subjects such as science, history, geography, or literature.

We believe that the information in this book will become a valuable resource for standards-setters at the national, state, and local levels; for professional and lay people who will be reviewing these standards; and for teachers involved in course and curriculum development. We hope it will stir discussion not only among educators and policymakers, but also among parents, students, and business and community leaders about what we *do* and *should* expect from our students. In England and Wales, France, Germany, and Japan, where students, teachers and parents all know what is expected of the college-bound and what is at stake, a significant number of youngsters rise to the challenge and achieve high standards. We think that upon reading through this material you will agree with us that we are asking too little of too many of our students, and we are giving them very few incentives to work hard.

A Profile of the Education System in England and Wales

UNTIL RECENTLY, most of the administrative control of schools in England and Wales rested with elected local governments that set up school boards called Local Education Authorities (LEAs). As in the United States, this strong tradition of local autonomy meant that the national government played only a distant policy role. Sentiment about Britain's tradition of local control began to change in the mid- to late-1980s, however, due largely to the efforts of Prime Minister Margaret Thatcher. The Education Reform Act of 1988 stripped the LEAs of much of their power, giving those at the school level more responsibility for school management and giving schools the opportunity to opt out of the jurisdiction of the LEAs altogether. But as it decentralized school management, the reform act also brought more centralization to the curriculum, creating a national curriculum for students age 5 through 16, the years when schooling is compulsory, and introducing national assessments to gauge performance.

The predominant pattern in England and Wales is for children 5 to 11 years of age to attend primary schools and those 11 to 16 to attend secondary schools. At the end of compulsory education, students continuing their studies may remain in secondary school for an additional two years or enroll in vocational training schools. The national curriculum applies to all primary and secondary school children through the age of 16. The subjects covered include English (and Welsh in almost all schools in Wales), mathematics, science, history, geography, technology, music, art, physical education, and—for secondary school students—foreign languages. Up to 70 percent of teaching time is supposed to be spent on these subjects, and national assessments are applied at four key stages (ages 7, 11, 14, and 16).

At age 16, after five years of secondary education, students may choose either to enter the job market or to pursue further full-time or part-time academic and/or vocational studies. At this time, the vast majority of pupils take examinations for the General Certificate of Secondary Education (GCSE) in various subjects. Typically, students take GCSE exams in eight subjects, and those intending to go on to further academic studies are expected to earn grades of A, B, or C on an A-G scale in five or more subjects.

In 1991, 62 percent of 16-year-olds chose to continue in full-time academic or vocational education. Another 20 percent chose to engage in part-time study.

The A-level Examinations

After taking GCSE examinations, students continuing their academic schooling spend two years preparing for the advanced, or A-level, exams. While in the first five years of secondary schooling students receive a fairly well-rounded curriculum, including at least those subjects mandated in the national curriculum, those working toward their A-levels usually concentrate on just three subjects, spending approximately equal time on each. Students are free to choose which subjects they will study. While students have traditionally chosen all three subjects in the same area, such as math/science or the humanities, thereby providing a focus for further specialization at a university, there has been an increasing trend toward studying for A-level exams in more than one curriculum area. Even if students do choose to take all three A-level exams in the same area, schools generally require some additional study in an area outside students' selected specialization (for instance, a humanities course for math/science students or a general science course for humanities specialists).

At the end of the second year, typically at age 18, students take the A-level examinations in each subject they studied. Some colleges and universities require candidates to have taken and passed two, others three. And the better the grade on each exam, the better the candidate's chances of being accepted to the school and discipline of his or her choice. In 1992, 31 percent of the age cohort took A-level exams in at least one subject. Nearly 80 percent of those earned passing grades: Fifteen percent of the age cohort earned three or more A-level passes, 6 percent earned two passes, and 4 percent earned one passing grade. Sixteen percent of all A-level candidates chose biology as one of their subjects, and 78 percent of those who took the exam passed it.

In an effort to allow A-level students to study a wider range of subjects, advanced supplementary (AS) courses were introduced in 1987, and AS exams in 1989. AS-level courses require half the teaching time and cover half the subject matter of the A-level, though the standard of work is supposed to be comparable. The addition of the AS-level was designed to allow for a wider combination of courses across discipline areas; however, the new option has yet to be widely used by students. In 1992, students took only 53,000 AS subject examinations in contrast to more than 700,000 A-level exams.

How Are the A-level Exams Developed and Graded?

A-level exams are developed by seven different examination boards, one for Wales and six for England (there is also one for Northern Ireland). Each board is responsible for developing exams and the corresponding curricula in all A-level subjects. While there is no published set of standards or guidelines for the examining boards to follow, the boards do agree on a common core of content in certain subjects, and a recently established national body, the School Curriculum and Assessment Authority (SCAA), monitors the boards' work to ensure consistent and high standards. Appointed by the Secretary of State for Education, the SCAA has the power to approve or withhold recognition of a particular exam and curriculum. It also must approve all new exams and curricula or any significant changes to existing ones.

The examination boards were originally set up by universities or groups of universities to help in the admissions process. Although some still have strong ties to universities, they are now independent, nonprofit organizations whose main source of revenue comes from the fees they charge schools for using their exams and curricula. Over the years, some boards have come to serve certain regions more consistently, but they have no territorial claims to any particular locality or region. In order to attract students and schools, the boards must rely on the quality of their materials and their reputations. As recently as 1990, a board that could not attract enough candidates was forced to shut down.

The competitive nature of the examination business makes the role of the SCAA very important. Its seal of approval is essential, and this ultimately is what keeps the boards accountable to the public. Universities also have a considerable amount of influence on the boards, particularly in terms of their reputations, since they, more than anyone else, rely on the boards to give them accurate information about the performance of students.

Each year, the examination boards hire secondary school and university level educators on a part-time basis to develop the exams and the scoring guides used by the teachers who grade them. Separate panels are created for each subject area, and business representatives are included on the panels when appropriate. The exam questions must cover the content laid out in the syllabi previously approved by the SCAA. Any significant changes in the syllabi or the make-up of the exams must be resubmitted for approval.

Reprinted in this Report

What College-Bound Students Abroad Are Expected To Know About Biology contains the complete 1992 A-level Biology Exam from the University of London Examinations and Assessment Council. The exam is nine hours long and consists of five different papers or sections, some of which have up to three subsections. The exam is by far the longest in the book, twice as long as the German exam, the second longest. Reprinted here are two of the five exam papers, totaling two and one-half hours of the nine-hour exam period, and selected excerpts from the Scoring Guide used to grade the exams. (The symbol Ⓐ next to a question indicates that the Scoring Guide for that question is provided at the end of the questions section.) NOTE: Paper four gives students a choice among three options: Microorganisms and Biotechnology, Applied Plant Biology, and Applied Animal Biology. We have chosen to show the third option, though the others are comparable in length and format.

1992 Advanced Level Examination in Biology

from the University of London Examinations and Assessment Council

PAPER 2

Time allotted: One hour and 30 minutes
Answer ALL FIVE questions.

1. Describe the technique you would use to compare the biochemical oxygen demand (BOD) of two water samples using methylene blue. (*7 points*) A

2. Describe, with practical details, how you would compare the reducing sugar and non-reducing sugar content of a sample of beans. (*10 points*) A

3. You are provided with an extract of chlorophyll pigments in an organic solvent. Describe, with practical details, how you would separate the pigments in the extract using chromatography. (*5 points*) A

4. You are asked to investigate the difference in plant species diversity between two areas of grassland, one of which has been grazed by sheep and the other which has been left ungrazed.

   a. (i) State the method you would use to investigate the two areas of grassland. (*1 point*)

   (ii) Describe how you would carry out the method. (*5 points*)

   b. Suggest differences that you would expect to find between the two areas. (*2 points*)

5. Red blood cells (erythrocytes) transport oxygen from the alveolar surface to the respiring tissues. A group of students expressed the view that people living at high altitude should have higher red blood cell counts than people living at sea level.

   The students selected two independent samples of people. Sample A contained nine people who lived at sea level, and sample B contained nine people who lived up a mountain at an altitude of 2,000 m above sea level.

   Samples of blood were taken from each person and the cell counts were determined using counting chambers.

   a. The table below shows the red blood cell counts of the nine people in each of the two samples.

Sample	Number of red blood cells/ dm^{-3} x 10^{12}								
A (sea level)	5.0	5.1	4.9	5.3	5.4	5.0	4.8	5.1	5.5
B (high altitude)	4.9	5.3	5.7	5.5	5.6	5.4	5.3	5.6	5.4

   The data were analysed using a Mann-Whitney *U* test to test the null hypothesis that there is no difference in the red blood cell counts of the two populations at a 5% significance level.

   (i) The median value at high altitude (sample B) is 5.4. Find the median value for the sea level population (sample A), and comment on the difference between the two median values. (*2 points*)

   (ii) Arrange the data from the table in order and in a form suitable for analysis using a Mann-Whitney *U* test. (*2 points*)

   b. (i) For this investigation the critical value of *U* at the 5% significance level is 17. The values calculated for *U* are 16 and 65. Which value of *U* would you take to determine the significance of these results? (*1 point*)

   (ii) Do the results enable you to accept or reject the null hypothesis? Explain your answer. (*2 points*)

   c. If the study was extended to use larger samples (100 people), explain how you would select the people for each sample. (*3 points*)

PAPER 4
OPTION C: Applied Animal Biology

Time allotted: One hour
Answer ALL SEVEN questions.

1. A comparison was made of the size of trout of different ages in two lakes in North Wales. The average length of trout from a mountain lake, Llyn Mynydd, was compared with trout from Llyn Alaw, a reservoir in a lowland agricultural area. The results are shown in the table below.

Age in years	Average length of trout/cm	
	Mountain lake	Reservoir
1	5	12
2	10	25
3	20	38
4	21	42

a. (i) How could the age of the fish be determined? (*1 point*) A

(ii) Give *one* reason why length was used as a measure of growth rather than any other parameter. (*1 point*) A

b. (i) Comment on the similarities in the growth patterns shown by the two populations of trout. (*2 points*) A

(ii) What is the percentage difference in growth rates as shown by average length of the two populations during their third year? Show your work. (*2 points*) A

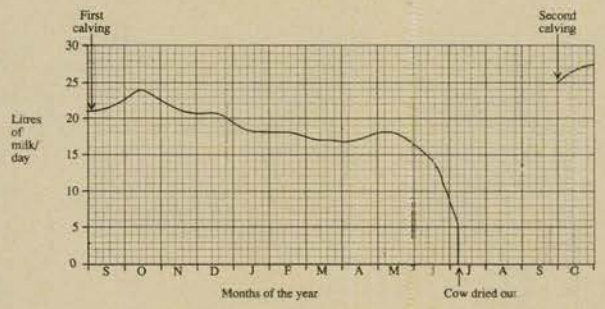
c. The difference in the growth rates of the two populations of trout has been attributed to the difference in nutrient availability in the mountain lake and in the reservoir.

Suggest how this difference could have arisen and why it would have had an effect on the average length of the trout. (*3 points*) A

d. Suggest *one* other factor which could differ in the two lakes and explain how this might affect the growth rates of the trout. (*2 points*) A

2. A cow does not produce milk without having a calf, and the aim of the farmer is to calve the cow once a year, at a time to suit the system of farming.

The graph below shows a cow's lactation over a year.



a. (i) How much milk was the cow giving per day at peak yield? (*1 point*)

(ii) Calculate the percentage increase in milk yield at the beginning of the second calving, compared with milk yield at the beginning of the first calving. (*1 point*)

(iii) In which month would the cow have been inseminated in order to produce the second calf in September? (*1 point*)

(iv) State one method by which drying-off is achieved. (*1 point*)

(v) Explain how drying-off benefits the cow. (*2 points*)

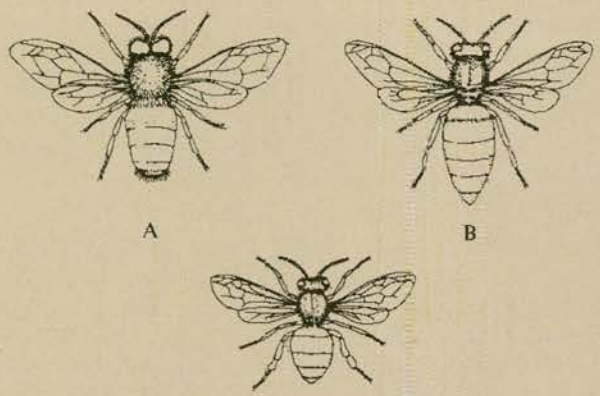
b. Colostrum (beastings) is produced by the cow for 3 to 4 days after calving.

(i) State *two* ways in which colostrum differs from ordinary milk. (*2 points*)

(ii) State *two* benefits to the calf of being given colostrum in the first few days of life. (*2 points*)

c. State *two* characteristics which a farmer would consider important in a good dairy cow. For each characteristic, give a reason to support your answer. (*4 points*)

3. The diagram below shows the three types of honey bee, labeled A, B and C.



A B

C

a. Identify A, B and C. (*3 points*) A

b. State three ways in which bees are of economic importance. (*3 points*) A

4. Describe how you would carry out an investigation to identify the food constituents of a chicken's egg. (*6 points*)

5. Describe the differences between the processes of pasteurisation and sterilisation of milk, indicating the effectiveness of each method. (*6 points*) A

6. a. Make a labeled diagram to illustrate the life cycle of an aphid. (*5 points*)

b. State two ways in which aphids are of economic significance. (*2 points*)

7. Discuss the advantages and disadvantages of the use of hormones to improve the growth of cattle for meat production. (*10 points*) A

Excerpts from the Scoring Guide for the 1992 A-level Biology Exam

Key ; indicates separate marking points
/ indicates alternative marking points
eq means allow any correct equivalent point
(acceptable alternatives are discussed at the Examiners' coordination meeting)

Paper 2

1. 250 cm^3 samples; bottles filled completely / all air excluded ; add 1 cm^3 or reasonable stated volume methylene blue / stated exact number of drops ; pipette well below surface ; replace stoppers immediately ; without introducing air ; incubate at 20 - 25°C ; in dark ; note time when colour disappears ; use of white background ; replication / split sample ; etc. ;
or
water sample ; + 10 cm^3 Fehling's B ; stated number drops methylene blue ; titrate with ferrous sulphate ; end point burette tip under water ;
7 points

2. known / weighed mass of sample ; stated volume of distilled water added to bean sample ; breaking / macerate / homogenise in blender / mortar and pestle ; filter / centrifuge ; add measured volume of filtrate ; to equal / stated volume of Benedict's (Fehling's) solution / clinitest tablet ; state how test is carried out / heat / boil (for up to 2 minutes) ; measure volume/weight of precipitate / compare with chart (clinitest) ; same volume of filtrate for non-reducing sugar / filter off precipitate ; details of acid hydrolysis ; neutralise ; repeat Benedict's test using same reagent volumes / repeat clinitest ; compare volume / weight / colour of precipitate with previous ; replication of whole experiment ;
10 points

3. mark the origin ; spot on the extract using a capillary tube pipette / glass rod / etc ; use of hair dryer to stop spreading / allow concentration of the spot ; repeat spotting ; solvent ; correct example e.g. petrol-ether + propanone (acetone) ; how paper is supported in solvent ; origin above solvent ; atmosphere saturated with solvent ; run until solvent front just below support ; mark solvent front ; place in dim light ;
5 points

Paper 4, Option C — Applied Animal Biology

1 a. (i) rings on scales / tagging and recapture
1 point

(ii) easy to do / fish kept out of water for minimum time / isometric growth so good correlation / not affected by recent meal / eq ;
1 point

b. (i) both show exponential phase / growth doubles each year ; both show reduced growth / least growth during fourth year ; *2 points*

(ii) mountain lake 10 cm for the year, reservoir 13 cm / 10^{-13} / difference in growth rate is 3 cm per year ; 3/10 x 100 = 30% / 3/13 x 100 = 23% ;
2 points

(c) reservoir has rich nutrient run off ; mountain lake surrounded by infertile land ; nutrients needed for growth of plant life ; trout part of food chain / eq ;
3 points

(d) pH ; could affect the availability of nutrients / growth of organism ;
or
temperature ; affects growth rates of food organisms / trout more active feeder at higher temperature ;
or
named pollutant ; toxic effect in relation to trout growth ;
or
light ; depth / volume light / could affect plant growth hence trout ;
or
oxygen ; related to metabolism of the trout ;
2 points

3. a. A = drone ; B = queen ; C = worker ; *3 points*

b. honey formation / production ; wax formation / production ; royal jelly ; queen / new colonies sold ; pollination ;
3 points

5. *pasteurisation*: high temperature / 72° ±3 / 62° ±3 stated ; for short time / time stated / related to temperature (15 sec / 30 min) ; improves keeping qualities of milk ; kills some microorganisms ;

sterilisation: high temperature / 130 - 140°C / 100 - 120°C ; time stated / related to temperature (UHT 2 sec / 15 - 40 mins) ; microorganisms killed ; more effective than pasteurisation / milk will keep longer ; vitamin content of both affected ; comment about taste ;
6 points

7. hormones concerned are anabolic / steroid hormones ; naturally occurring ones are progesterone / testosterone / androgen / eq ; some artificial ones / named e.g. ; implanted / tagging ears ; used with steers / bullocks ; castration of bulls removes the source of testosterone ; so growth would be slower ; treated cattle convert their food to meat more efficiently / ref weight gains / less food for same amount of muscle / large size "sooner" (time ref) ; leaner animal / carcass is produced ; danger / uncertainty of hormones getting into humans ; farmers have more control over meat production ; leaner meat / preferred by humans / better for them / less chance of coronary heart disease ; may interact with other chemicals in the animal / cattle body / side effects / abnormalities / eq ; cost implications elaborated / cost of chemicals ; cost of development / pretesting / trialling ; better profit related to meat sale ; ethics / moral objections ;
10 points

A Profile of the French Education System

EDUCATION IN France is a highly centralized institution. The Ministry of National Education has authority over the content of the curriculum and assessments in primary and secondary schools, leaving the local administrative responsibilities to 28 regional academies (26 in France, two overseas). Consequently, students in all regions of France follow a common core curriculum and are tested on the same knowledge and skills. The common core does, however, allow for some regional variation.

Schooling is compulsory in France between the ages of 6 and 16. Pre-elementary schooling is available to children 2 to 6 years old, and though not required, 35 percent of 2-year-olds, over 97 percent of 3-year-olds, and nearly 100 percent of 4-, 5-, and 6-year-olds attend. Students spend their first five years of compulsory education in primary school (*école primaire*) and the next four in secondary school (*collège*). From *école primaire* through *collège,* all students follow a national core curriculum that prescribes the number of hours per week to be spent on each subject. At the end of their last year of *collège,* students may earn a diploma, the *brevet de collège,* based on their *collège* grades and test scores in three subjects: French, mathematics, and history/geography.

At the completion of the *collège*, students continue in the second cycle of secondary school, the *lycée.* Those who do must decide whether they will enter a three-year stream leading to the *baccalauréat* diploma and higher education, or a two-year vocational/technical stream leading to the *Certificat d'Aptitude Professionelle* (CAP). Although compulsory education ends at age 16, over 85 percent of 17-year-olds and over 55 percent of 18-year-olds study full-time in *lycées.*

The Road to the French Baccalauréat

Students in general or specialized academic *lycées* work toward a special diploma called the *baccalauréat,* which is awarded based on their performance on a set of exams taken during the final or *terminale* year. Since its introduction in the Napoleonic era, the *baccalauréat* has been targeted at the highest-achieving French students, serving as their ticket to higher education and the most prestigious careers. It has earned a strong reputation in France and around the world and has even inspired others to pattern their programs after it, most notably the International Baccalaureate program.

Over the years, some have criticized the *baccalauréat* process for being elitist. The French government has tried to respond to these concerns by expanding the *baccalauréat* curriculum and opening it up to a greater number of students. Before 1950, there were only four different subject areas in which students could specialize during their final years in the *lycée* and only one kind of *baccalauréat* diploma. Only 5 percent of the age cohort typically earned the *baccalauréat* each year. In 1992, 51 percent of the age cohort passed the *baccalauréat.* And it is now offered in 38 subject areas and comes in three different types of diplomas: the general *baccalauréat,* offering a purely academic curriculum for college-bound students; and two vocational diplomas, the technical *baccalauréat,* for students planning to attend two-year vocational programs preparing them for the job market, and the professional *baccalauréat,* for students who will be directly entering the job market. In every case, however, students receive a well-rounded curriculum in terms of the core disciplines, and they are expected to demonstrate mastery—the degree of which may vary—in most of these subject areas.

During the first year of *lycée,* students follow a common curriculum with a strong emphasis on the core disciplines—foreign language, French, history and geography, mathematics, natural sciences, physics and chemistry, and sports—complemented by an array of elective course options. The first year is designed to give students a taste of each subject area and prepare them to make important academic and professional decisions in years two and three. The course load is quite heavy during the first year, and a significant number of students repeat the grade (15 percent in 1992).

Promotion from the first to the second year of *lycée* is not automat-

ic but depends on student achievement and elective course difficulty during the first year. Some students leave school at the end of the first year to enter the work force or begin apprenticeships; and, as mentioned earlier, others repeat the grade. In 1992, 80 percent of *lycée* students moved from the first to the second year.

At the end of the first year, students must choose the focus of their studies during their final two years of *lycée* and, consequently, decide which of the three types of *baccalauréat* diploma they will seek.

To earn their "general" or academic *baccalauréat,* there are eight subject area tracks (usually referred to by their corresponding letter assignments) in which students can focus: (A1) literature and mathematics; (A2) literature and languages; (A3) literature and art; (B) economics and social sciences; (C) mathematics, physics and chemistry; (D) biology, mathematics, physics and chemistry; (D') agriculture; and (E) mathematics and technology. The "C" track is regarded as the most demanding.

Beginning in 1995, the organization of the three types of *baccalauréat* exams will change due to 1993 *lycée* reforms. The general (academic) *baccalauréat* will be reduced to 3 main tracks, referred to by their initials: L (literary, consolidating the former "A" tracks); S (scientific, including the former "C," "D," and "E" tracks); and ES (economic and social sciences, the former "B" track).

The Baccalauréat Exam

At the end of the third and final (*terminale*) year of *lycée,* students take the *baccalauréat* exams in the subject areas required by their particular tracks. (The exception is French, which all students take at the end of year two.) The exams consist of both written and oral sections, with the written tests lasting up to four days and the total testing time averaging up to 25 hours. Students are tested in certain core subjects even if not directly related to their area of focus. While students in all tracks take the same exam in French literature, in almost all other subjects students take exams that differ by track. The scores from these exams are also weighted differently when the overall *baccalauréat* grade is determined. For example, the French exam will count more for those who have chosen literature as an area of concentration than for those who have chosen science.

A student's final *baccalauréat* score is determined by taking the average of the scores for all of the exams after applying the appropriate weights. The grading scale runs from 0-20, with a 20 being a near perfect score. A total score of 10 or above is considered passing, and only students who pass may receive a *baccalauréat* diploma.

The *baccalauréat* process has evolved considerably as a result of the government's desire to make it accessible to a larger, more diverse population. Although passing the *baccalauréat* still earns students the right to enter higher education and remains a requirement for university entrance, the most prestigious and selective universities (*grandes écoles*) and the more popular divisions in other universities (medicine, dentistry, and some science departments) require passage of another exam, the *concours.* This normally requires one or two additional years of intense preparation after the *baccalauréat.* Admission to *grandes écoles* is competitive, and even a strong performance on the *concours* may not ensure admittance. Over 30 percent of 19- to 21-year-olds attend universities, *grandes écoles,* or classes preparing them to enter *grandes écoles.*

How Is the Baccalauréat Exam Developed and Graded?

Although some administrative authority is given to the 28 academies, the Ministry of National Education plays the dominant role in developing and administering the *baccalauréat.* The Ministry determines the topics to be covered in each year's examinations as well as the dates and administrative procedures for the tests.

For purposes of developing the *baccalauréat* exams, the academies are grouped into four clusters, each of which develops its own set of exams. Each cluster is headed by a *recteur* (chief administrative officer) who appoints *lycée* and university subject specialists to serve on committees charged with developing the exam questions, all of which must adhere to Ministry guidelines and grading criteria. The committees are assisted by specialists from *inspectorates,* local arms of the Ministry that oversee the examination process for each cluster of academies. The *inspectorates* ensure that the Ministry retains final authority over the standards being upheld by the *baccalauréat* examinations.

Baccalauréat exams are graded regionally by teams of teachers organized by each cluster.

Reprinted in This Report

What College-Bound Students Abroad Are Expected To Know About Biology contains the entire 1992 *baccalauréat* exam in biology for Track C from the cluster including the academies of Paris, Amiens, Creteil, Lille, Rouen, and Versailles. The exam is three hours long, and students are asked to choose one of two sections to work on for the entire period. Reprinted here are one of the two sections from that exam and sample answers for all of the questions in that section. (Please note, these are not actual student answers from the exam, but rather those prepared by the Éditions Nathan Publishing Company, which reprinted the exam materials and sold them as part of a study guide for students.)

In 1992, 51 percent of the age cohort received an academic or vocational *baccalauréat* diploma. Forty-three percent of the cohort tried for an academic *baccalauréat,* and 36 percent earned one.

Forty-four percent of *baccalauréat* candidates were in tracks that required a biology exam, and 20 percent were in the track that required this particular biology exam. Eighty-five percent of students taking this exam received their *baccalauréat* diplomas.

1992 Baccalauréat Exam in Biology (Track C)

from Paris, Amiens, Creteil, Lille, Rouen, Versailles

Time allotted: 3 hours
Students choose either Section I or II

SECTION I

PART A: Organized Recall of Knowledge (10 points total)

Measurements taken from a cell culture during the interphase preceding mitosis have revealed the following:

—a doubling of the quantity of DNA in the nucleus; and

—an increase in the weight of cytoplasmic proteins.

Using carefully selected, concise and clearly annotated diagrams, illustrate the two processes involved in preparing for mitosis. Limit your answer to the stages that take place in the nucleus. Without detailing the mechanism of protein synthesis, explain how these two processes prepare the cells for preserving:

— their genetic information; and

— their protein mass from one generation to the next.

PART B: Interpretation of Documents (10 points total)

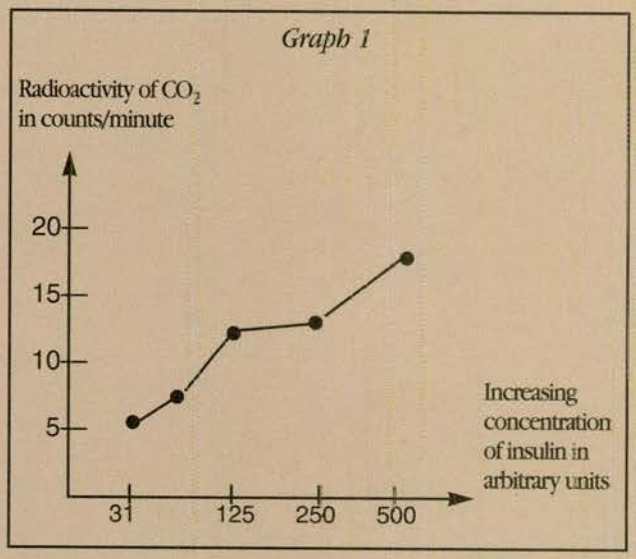
Effect of two hormones on their target cells.

We want to study the action of a hormone, insulin, on fat cells (Document 1) and the action of a gastric hormone, bombazine, on pancreatic acinar cells, which secrete pancreatic juices (Document 2).

Document 1

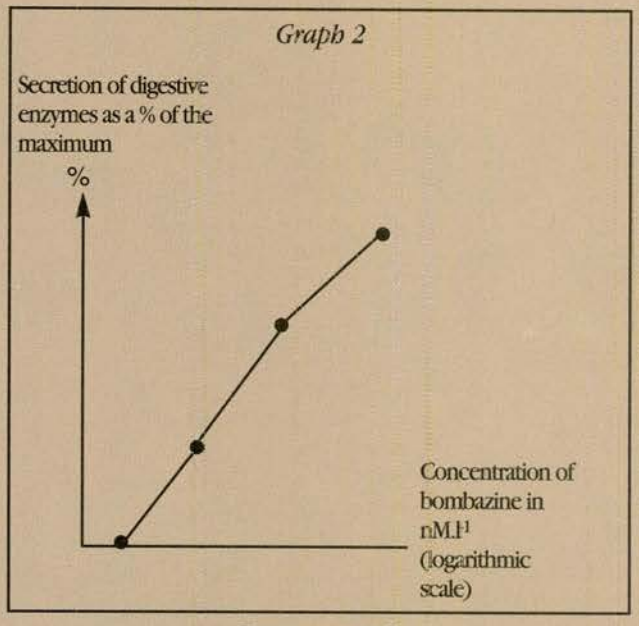
Experiment A

Fat cells from a rat are placed in a culture medium containing glucose marked with radioactive ^{14}C. The radioactivity of the CO_2 produced by the fat cells as a function of the concentration of insulin added to the culture medium is measured. (See Graph 1)



Experiment B

Insulin marked with a radioactive amino acid is injected intravenously in a mouse; we observe that the plasma membranes of the fat cells are radioactive.



Document 2

Experiment C

Pancreatic acinar cells are placed in a culture medium. The rate of secretion of digestive enzymes released by the cells in the medium is measured as a function of the concentration of bombazine added to the culture medium.

Graph 2 illustrates the results obtained.

Experiment D

In the presence of bombazine in a culture medium, an increase in the concentration of Ca^{2+} is observed in

the cytoplasm of the cells in the culture.

Experiment E

In the absence of bombazine in this culture medium, a release of digestive enzymes by exocytosis is observed when Ca^{2+} is injected into the cytoplasm of an acinar cell. (See Illustration 1)

Illustration 1

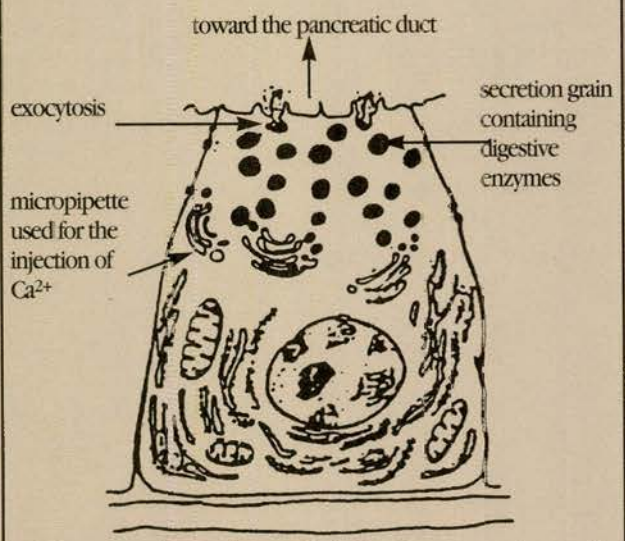


Diagram of an acinar cell in the pancreas observed under an electronic microscope

Question

1. Based on arguments drawn from Documents 1 and 2 show: *(2 points each)*
   a. the effects of insulin on fat cells and the effects of bombazine on acinar cells; and
   b. that these cells are target cells responding to a hormone message that you will define. (Your answer should include an explanation of what a hormone message is.)

Triggering the secretion of insulin.

Insulin is synthesized by the pancreas. Under normal physiological conditions, insulin secretion increases when the concentration of glucose in the blood rises.

Document 3

Experiment F

An islet of Langerhans isolated by microdissection is preserved under conditions ensuring that it will retain its physiological integrity. The penetration of calcium into the ß cells of an islet of Langerhans is measured at 5-minute intervals (Graph 3a), and the secretion of insulin by the same cells is measured every minute (Graph 3b), as a function of the concentration of extracellular glucose.

Experiment G

The injection of Ca^{2+} in the cytoplasm of the ß cells of the islets of Langerhans stimulates exocytosis of insulin, even in the absence of glucose.

Question

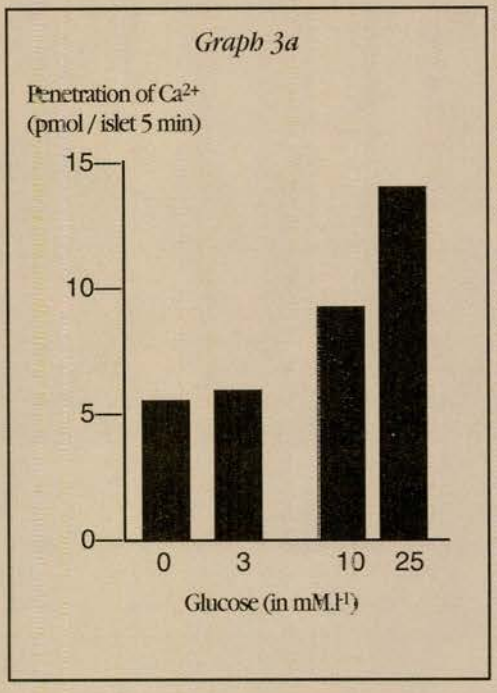
2. What information can you derive from a side-by-side comparison of all the data provided in Document 3 on triggering the secretion of insulin? *(1 point)*

Document 4

It has been shown that the membrane of the ß cells contains calcium ducts that are dependent on the transmembrane voltage; when these open, calcium penetrates the cell.

The difference in the transmembrane potential of ß cells is measured as a function of the concentration of extracellular glucose. (See Table 1)

Graph 3a



Graph 3b

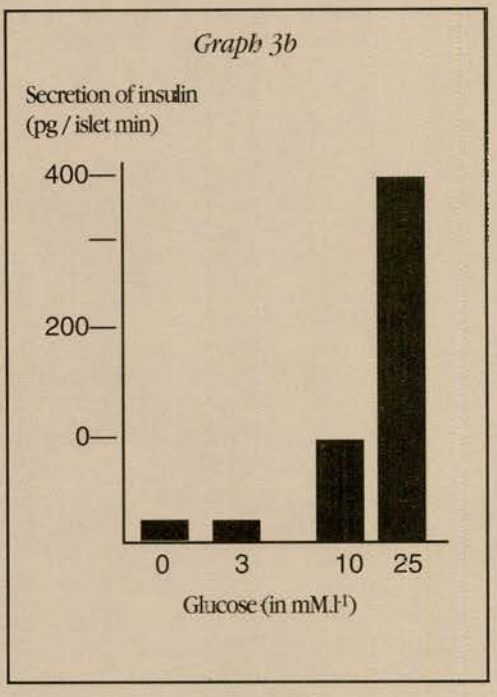


Table 1

Concentration of extracellular glucose in mM.[1]	0	3	7	10	25
Difference of transmembrane potential of the ß cell of the islets of Langerhans	-70mV	-70mV	-55mV	Series of slow depolarizations at a rate of up to - 18 mV	Series of fast depolarizations at a rate of up to - 18 mV

Threshold point at which the calcium ducts that are dependent on transmembrane voltage open.

Questions

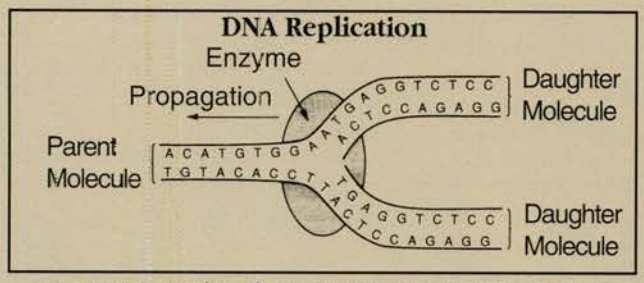
3. What new information does Document 4 provide? (*2 points*)

4. Use all your answers from Part B to draw a functional diagram showing the chronology of events leading to exocytosis of insulin. (*3 points*)

Answer for Section I, Part A

Doubling the Quantity of DNA

Deoxyribonucleic acid is a double-helix molecule: each of its two strands is a chain of nucleotides, units consisting of a phosphoric acid and a C5 sugar, to which an organic base is linked. The two strands are linked by the bases. There are four pairs of complementary species of bases. The pairs formed are A-T (adenine-thymine) and G-C (guanine-cytosine). This molecule is capable of reproducing itself, as shown in the diagram below, in which the DNA is represented only by its base sequences.



It is apparent that the two separated strands serve as a pattern and that the new bases are positioned across from a complementary base (semi-conservative replication). One molecule produces two. Several enzymes act as catalysts in this DNA synthesis.

The base sequence of the initial molecule is preserved in the two daughter molecules, which are replicas of the initial molecule. This continuity is assured because the bases are complementary. Because the sequence of the bases determines the genetic code, the daughter molecules inherit the information contained in the parent molecule.

Increase in Protein Mass

1. Location in the cell

The linking of amino acids to build a protein occurs in the cytoplasm. The sequence of the amino acids is determined by a gene, that is, a segment of a DNA molecule. However, the DNA does not leave the nucleus. All protein synthesis starts with copying the DNA code in the nucleus, or transcription.

2. Transcription: DNA → mRNA

RNA is a single-stranded nucleic acid with the same bases as DNA except for U, uracil, which replaces T.

After a DNA molecule opens, one of its two strands serves as a pattern for building an RNA molecule.

The location of each new base is determined by the complementarity of A-U G-C; therefore the code is preserved. Enzymes are involved in the transcription process.

This RNA is called messenger RNA, because it is exported into the cytoplasm, where it will represent the genetic code and guide the synthesis of a protein.

Preparation for Mitosis

1. Information

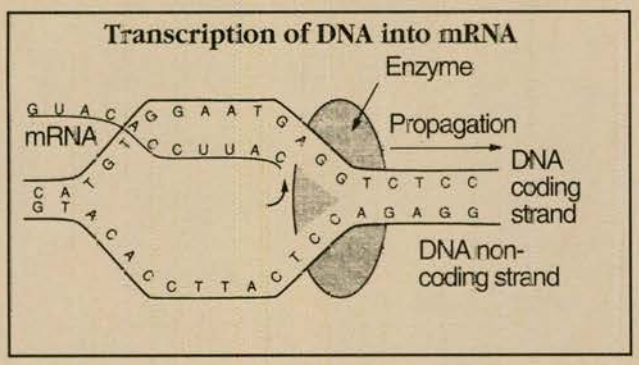
DNA is the main component of chromosomes. Its replication corresponds to the formation of double chromosomes formed by two chromatids. At the very beginning of mitosis, chromosomes have two chromatids, since replication occurs during interphase. The two chromatids of a chromosome contain the same genetic information. At the end of mitosis, they are distributed into the two daughter cells.

2. Protein mass

Protein synthesis enables the cell that is going to divide to have enough material for two cells. Each daughter cell quickly increases its protein mass, starting with the transcription of DNA into messenger RNA in its nucleus.

Conclusion

The interphase nucleus is active and prepares a cell for its next mitosis. The DNA is replicated in it. The transcription of DNA into messenger RNA triggers protein synthesis, which occurs in the cytoplasm. This ensures stability in structure and function from one



generation of cells to the next.

Answers for Section I, Part B

1. a.

■ Action of insulin on fat cells

Experiment A: By analyzing the graph, it is apparent that the insulin causes the fat cells to use the marked glucose for respiration (production of CO_2) and for synthesizing lipids (lipogenesis).

Conclusion: Therefore, a hormone changes the function of a target cell.

■ Action of bombazine on pancreatic acinar cells

Experiment C: By analyzing the document, it is apparent that, like in A, the bombazine stimulates the pancreatic cell and causes it to secrete its enzymes.

Same conclusion as in A: The hormone alters the function of a cell.

Experiment D: The presence of bombazine allows Ca^{2+} to penetrate the target cell.

Experiment E: This experiment shows that the penetration of Ca^{2+} causes enzymes to be released by exocytosis.

Conclusion: Hormone → penetration of Ca^{2+} → release of enzymes by exocytosis.

b.

Experiment B: The marked insulin has attached to the plasma membranes of the fat cells. Therefore, it has a special affinity for the membrane of the target cells, which denotes the presence of membrane receptors.

Conclusion: The target cells are characterized by their membrane receptors, which are capable of fixing the specific hormone corresponding to them.

■ Definition of the hormone message: this information is provided by the hormone molecule to the target cell: the message is carried throughout the body in the bloodstream and will be used only by competent cells having receptors to which the hormone will attach.

It is the association of hormone and receptor that will trigger changes in the membrane or cytoplasm needed for the target cell response.

2.

Experiment F:

■ The presence of glucose stimulates the penetration of Ca^{2+} into the β cells (Graph 3a).

■ The secretion of insulin increases with the concentration of glucose (Graph 3b).

Experiment G: The release of insulin is stimulated by the penetration of Ca^{2+} alone.

Conclusion: The increase in glycemia triggers the release of insulin by causing the calcium ions to penetrate the β cell.

This diagram is therefore similar to that of question 1.

hyperglycemia → penetration of Ca^{2+} → secretion of insulin (by exocytosis)

3. *Interpretation of Document 4:* By measuring the potential difference as a function of the concentration of extracellular glucose, the following is apparent:

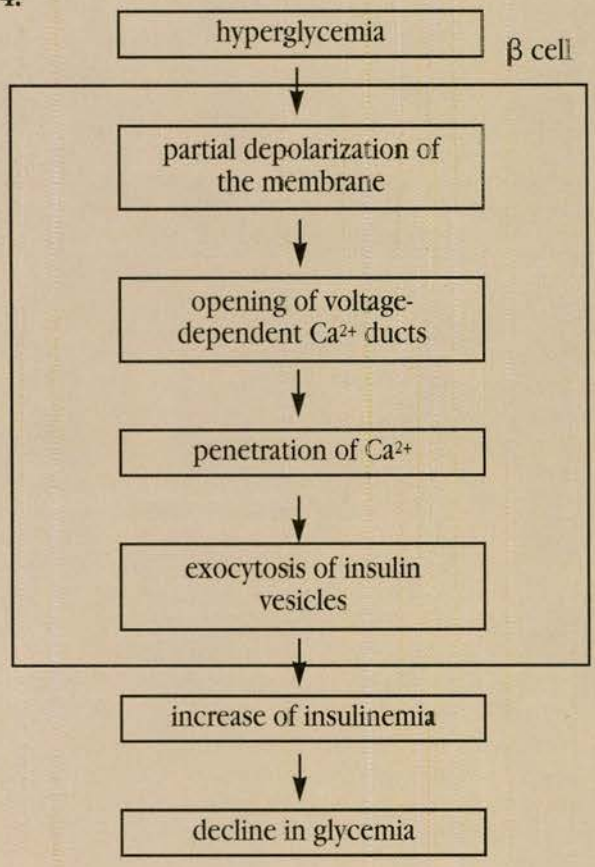
■ an increase in the glucose concentration causes depolarization, which is initially constant until it reaches a certain threshold;

■ from the concentration threshold, or from 7 to 10 mMl^{-1} inclusive, depolarization becomes rhythmic; and

■ beyond that threshold, the voltage-dependent calcium ducts begin to open.

Conclusion: The Ca^{2+} ducts open after partial depolarization of the membrane, which is related to hyperglycemia.

4.



A Profile of the German Education System

IN GERMANY, as in the United States, local control of education is an important tradition. Schooling is primarily the responsibility of each of the 16 German states, or *Länder,* with the national government playing a coordinating role. There is, however, a certain degree of uniformity across the *Länder,* with common policies achieved by consensus in the Standing Committee of the Ministers of Education (*Kultusministerkonferenz*), a body composed of the education ministers from each of the *Länder.*

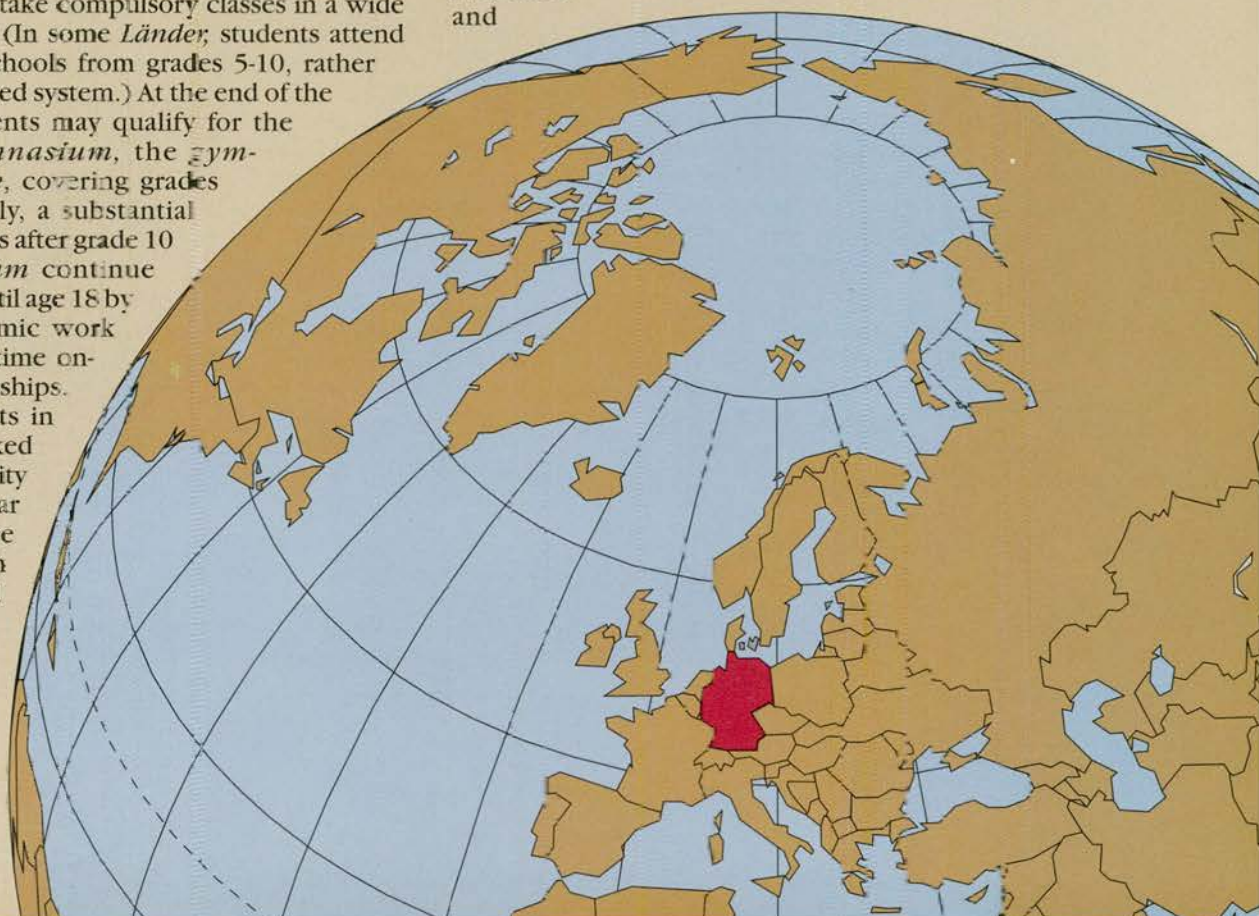
Compulsory schooling usually lasts nine or 10 years in Germany, beginning at age six. Children attend *grundschule,* or primary school, for four years (six years in two *Länder*), after which they move into one of three secondary tracks: (1) the *hauptschule,* the most basic level, lasting through the ninth year of schooling and preparing students to enter employment and receive additional training; (2) the *realschule,* a more advanced level that extends through the 10th year of schooling and prepares students primarily for middle-level, nonprofessional careers (while also allowing access to upper secondary education and university entrance); and (3) the *gymnasium,* the most academically rigorous secondary school path aimed at those students interested in attending a university. In grades 5-10 of the *gymnasium,* students take compulsory classes in a wide range of subjects. (In some *Länder,* students attend comprehensive schools from grades 5-10, rather than this three-tiered system.) At the end of the 10th grade, students may qualify for the upper-level *gymnasium,* the *gymnasiale oberstufe,* covering grades 11-13. Additionally, a substantial number of students after grade 10 of the *gymnasium* continue their education until age 18 by combining academic work with full- or part-time on-the-job apprenticeships.

Usually, students in Germany are tracked or grouped by ability after the fourth year of schooling (age 10). Exactly which secondary school path students take is determined by their performance in the *grundschule.* Recommendations are made by teachers (and other school personnel), and final decisions are made in consultation with parents, who ultimately decide. In 1990-91, approximately 33 percent of German students were in *hauptschule,* 28 percent in *realschule,* 31 percent in *gymnasium,* and 8 percent in comprehensive schools.

Grade-level retention does occur in secondary schools, but students in the *realschule* and *gymnasium* are not allowed to be held back more than twice. If such a situation arises, the student is transferred to a track below (i.e., from *gymnasium* to *realschule* or from *realschule* to *hauptschule*). Access to an upper-track school from one below is possible, but not very common. The most common upward move is when students who have completed the *realschule* move into the upper level *gymnasium* to prepare for university study. The transfer figures vary between *Länder* from 2 percent to 16 percent of students.

Standards for University Entrance: the Abitur

While there is no single set of national standards in Germany, there is a process for college qualification and an earned certificate called the *Abitur,* whose structure and



characteristics are quite consistent across the *Länder.*

During the 11th through 13th years of *gymnasium* (the upper level), students receive compulsory instruction in core subject areas with elective course options available as well. Each subject is taught at both a basic and an advanced level, the latter involving more rigorous content and more time for instruction. Students begin the process of working toward the *Abitur* at the beginning of the 12th year. Over those next two years, students must take a total of 28 courses, 22 at the basic level and six at the advanced level. Students must also choose four subjects in which they will eventually take the *Abitur* exam. At least one subject must be chosen from each of the following three fields of knowledge: (1) language, literature, and the arts; (2) social sciences; and (3) mathematics, sciences, and technology. At least two of the subjects chosen must be taken at the advanced course level.

Students usually take the *Abitur* exam at the end of their final *gymnasium* year. Three exams are written, and the fourth is oral. Exams in some subjects, such as art and music, may involve performance demonstrations. When a discrepancy exists between a student's course grades and exam scores, additional oral exams can be given.

The *Abitur* certificate is awarded based on a combination of students' grades over their final two years of coursework and their scores on the exams. Out of 840 total possible points, 540 are reflective of coursework (330 from the 22 basic courses, 210 from the six advanced), 300 of the exams. A total score of 280 is considered passing.

In 1991, 37 percent of the age cohort took the *Abitur.* More than 95 percent of these candidates passed. Typically, 85 percent of those who pass enroll in a university within two years (the remaining 15 percent are expected to enroll within a few more years).

At one time, passing the *Abitur* was enough to guarantee everyone a place in a university studying the subjects of his or her choice. Due in part to an increasing number of *gymnasia,* however, the number of students gaining an *Abitur* in Germany has increased beyond the capacity of the university system (from 1960 to 1986 the figure grew from 57,000 to 300,000). A passing mark on the Abitur still is required for university entrance, but it no longer guarantees students a choice of disciplines. Scores on the *Abitur* are now very important, and entrance into the more popular disciplines, such as medicine, is restricted by quota and often requires additional testing and interviews. In many cases, lengthy waiting lists exist.

How Is the Abitur Exam Developed and Graded?

The specific content of the *Abitur* exams and the syllabi for the courses leading up to the exams are determined by each individual *Land.* The education ministries in each of the *Länder* are responsible for defining the course content for each subject. But they must remain within a set of guidelines developed at the national level by the *Kultusministerkonferenz,* which determines issues such as eligibility to receive the *Abitur* and the number and distribution of subjects in which students must be examined. Though curricular differences exist across *Länder,* the national guidelines effectively maintain a high degree of uniformity.

In a great majority of *Länder,* teachers are responsible for developing the *Abitur* exams that will be given to their students. It is an accepted, indeed welcomed, responsibility of the job. At the beginning of each school year, teachers create a list of possible exam questions relating to their particular subjects and send them together as a school to the state education ministry (or to a regional "school inspectorate" in the larger *Länder).* Each question is evaluated based on a variety of criteria and either approved or returned to the teacher for improvement.

Teachers give the exams to their students, and they are also responsible for grading them in most *Länder.* In fact, part of their preservice training deals with creating and grading *Abitur* exams. Most *Länder* have a system in place for cross-checking teacher grading, but the system clearly requires a significant amount of trust to be vested in teachers.

In at least six *Länder*, the *Abitur* exams are created and graded at the state ministry level. Students in each of these *Länder* take the exact same exam in each subject. The exam reproduced in this volume is from Baden-Württemberg, one of these six *Länder.*

Reprinted in This Report

What College-Bound Students Abroad Are Expected To Know About Biology contains the entire 1992 Advanced level *Abitur* in Biology from Baden-Württemberg. Fifteen percent of *Abitur* candidates in Baden-Württemburg took this biology exam in 1992, and aproximately 96 percent passed. The exam is four and one-half hours long and consists of six sections. We have reprinted two of those sections here, along with sample answers for most questions in those sections. (The symbol Ⓐ next to a question indicates that a sample answer for that question is provided at the end of the questions section. As is the case with the *baccalauréat,* these are answers prepared by a publishing company that reprinted the exam materials and sold them to students as a study guide.)

Remember, *Abitur* candidates take four exams, and at least two of the four must be at the advanced level. In addition, to ensure that all students reach proficiency in a broad range of subjects, one of the four exams must be taken in each of the following three fields of knowledge: (1) language, literature, and the arts; (2) social sciences; (3) mathematics, sciences, and technology.

1992 Abitur Exam in Biology

from Baden-Württemberg

PART II: Immunobiology

Lyme disease (*Borreliosis*) is caused by a bacterial infection. The pathogenic organism (*Borrelia burgdorferi*) is transmitted by blood-sucking ticks. The following illustration shows the antibody concentration in the blood of a person after a first infection by *Borrelia burgdorferi.*

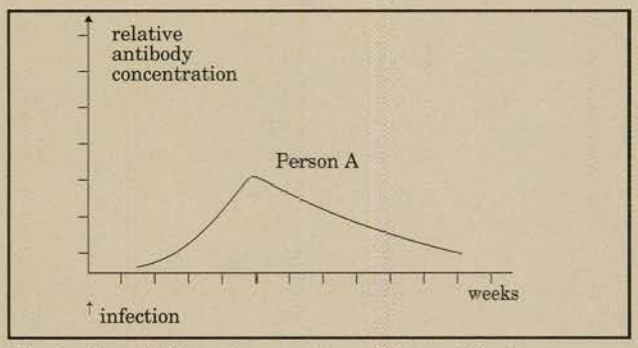


Illustration 1: Time progression of the antibody concentration after a first infection

1. Describe, with respect to the curve in Illustration 1, the development of antibodies after an infection. A

2. a. Describe the course of an immune reaction of another person (Person B) after a second infection and compare to that of Person A. A
   b. Redraw Illustration 1 on your answer sheet, and draw the curve for the antibody concentration to be expected for Person B. A

3. How could the antibody concentration in a patient's blood be determined? Describe a possible method. A

4. Make a schematic drawing of the structure of an antibody. Label the various parts. A

5. Another disease transmitted by ticks is early-summer meningoencephalitis (ESME). The cause is a virus. Active and passive immunization is possible against this disease.

   Explain the difference between active and passive immunization. In which case is the former used? In which case is the latter used? A

6. A severe case of *Borreliosis* can lead to nerve cell damage because of loss of myelin (demyelinization).
   a. Draw and label a motor nerve cell. (Size approximately one-half page)
   b. Explain which possible neurophysiological consequences may result from the demyelinization of a motor nerve cell. State your reasons.

PART III: GENETICS

Hereditary deafness can be caused either by anomalies in the inner ear (Family A) or by the degeneration of the auditory nerve (Family B). Deaf people have intimate social contacts among themselves and frequently marry. Illustration 1 shows the family trees of two families in which types of deafness appear.

1. a. Decide whether this handicap in Family A and Family B is dominant or recessive, and whether it will be inherited autosomally or gonosomally. Explain with the aid of Illustration 1. Give the genotypes of persons 1 through 6.

   b. Explain why person 7 and 8 are phenotypically healthy. Give their genotypes.

Questions 2-3

For about 20 years it has been possible, through amniocentesis (aspiration of amniotic fluid), to determine certain inherited ailments in the embryo. To do this, it is necessary to construct a karyogram.

2. a. What does a karyogram represent and what information can it give? A

   b. Why can't the deafness be diagnosed even with a karyogram? A

3. What inherited human ailments can be recognized with the help of a karyogram? Give three examples and state the corresponding changes in the karyogram. A

Questions 4-5

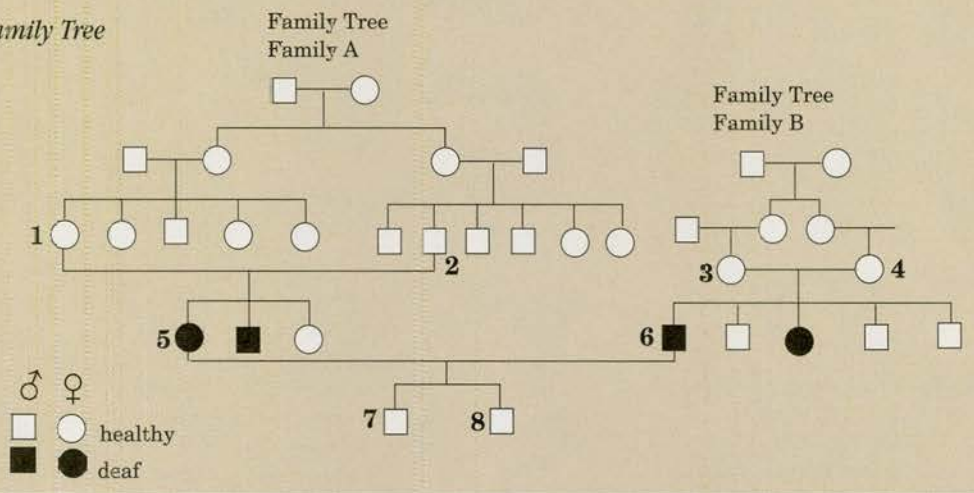
In 1908 HARDY and WEINBERG, independently of one another, formulated an important law of population genetics.

4. a. Explain what is meant by "population" in population genetics. A

b. Formulate the HARDY-WEINBERG law and explain what it states. Under what conditions is the HARDY-WEINBERG law valid? Ⓐ

5. A certain recessive hereditary trait appears in 16% of a population. How high is the percentage share of the carriers of the recessive allele? Ⓐ

Illustration 1: Family Tree



Sample Answers for the 1992 Abitur Examination in Biology

PART II: Immunobiology

1. In a bacterial infection, it is possible for either exotoxins produced by non-invasive bacteria or the bacteria themselves to enter the body. In either case, the immune response is activated by antibodies. In the first case, the immune system neutralizes the toxins produced by the bacteria with the help of antibodies. In the second case, the antibodies are aimed against the bacteria's surface molecules. The anti-phagocytic properties of the bacterial membrane are neutralized by the antibodies.

The increase of the relative antibody concentration and the consequent drop in the curve may be explained as follows:

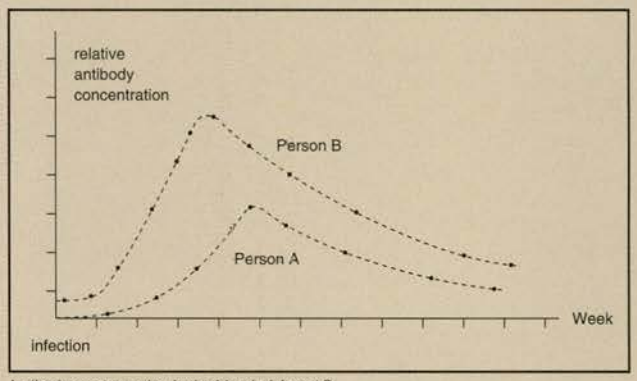
Week 1: After the infection, the number of antibodies is still normal. During this time the bacteria multiply (incubation phase). The recognition phase is in progress. The antigens encounter several T-lymphocytes, which are thereby activated and stimulated to divide. In this phase more T-helper cells are produced. These, in turn, cause the division of aforementioned B-lymphocytes which can form antibodies for the same antigen.

Week 2-5: During this time the differentiation phase takes place. The B-lymphocytes multiply extensively and are differentiated largely into plasma cells. Some of these become memory cells. The number of antibodies has now reached a maximum. Now begins the antigen-antibody reaction; the effector phase takes place.

From Week 5: The switch-off phase has begun. If no more antigen is present, no more antibodies are produced. The cessation of antibody production is effected by the T-suppressor cells. The reaction between antigens and antibodies causes the numbers of both to diminish.

2. a. After a second infection, the course of the immune reaction will be considerably faster in Person B than in Person A. The reason for this is that in Person B memory cells are still present from a similar, but earlier, infection. These are present for years (perhaps even for a lifetime) against a specific infection. If, during the course of a second infection, antibodies meet similar antigens, they are thereby activated and multiply quickly.

b.



Antibody concentration in the blood of A and B

3. To a defined volume of a patient's blood serum, an increasing amount of antigen is added. The result is an antigen-antibody reaction and, thus, a precipitation reaction. At very low levels of antibody mass, the test tubes remain in a refrigerator for a few days in order to obtain maximal precipitation. The precipi-

tates are then centrifuged off. Next, a method of quantitative determination is used. Since antibodies are proteins they could, for example, be hydrolytically split. The products of hydrolysis (amino acids) can be made to react with ninhydrin. The tinted liquid is examined photometrically. Similarly, this is done with a known amount of antigen as a reference substance.

4. The sketch should show the following structures: the constant and variable regions, the heavy and light chains, the point of contact of the antigens, and possibly the disulfide bridges.

5. Active immunization: Active immunization is based on the realization that human beings (as is the case among the higher vertebrates) who have recovered from certain illnesses are immune to them. Active immunization ensues through appropriate immunizing substances which are characterized by the fact that the infectious agent, while retaining fully its antigen structure, has been so modified that it is no longer capable of causing the corresponding disease. This may be done by using minimal doses of a preparation of the infectious agent or by modifying such a preparation chemically, by killing the pathogens, or by using living but weakened pathogens. Then the body has an immune reaction, forming antibodies. Since memory cells are formed at the same time, an active immunization acts preventively for a long time (often for years). This method is used when a certain illness has not yet been contracted (preventive immunization).

Passive immunization: Specific antibodies which are targeted at antigens which cause certain infectious diseases are administered. In contrast to active immunization, passive immunization is used only when contact with the antigen in question has already occurred (i.e., there is a high probability of its presence). By means of the administered antibodies, the organism is aided in its defense until enough of its own antibodies have been created. The antibodies themselves were obtained through actively immunizing a mammal (i.e., horse, cattle, sheep). Passive immunizations are effective for a few weeks only.

Part III: Genetics

2. **a.** In a karyogram the chromosomes of the metaphase stage are arranged according to their size and the position of the centromere. From a karyogram one obtains indications as to sex, as well as to those inherited ailments that have their cause in chromosome or genome mutations.

   b. In the case of deafness it is a matter of a gene mutation (point mutation). These types of mutation cannot be determined with the aid of a karyogram.

3. The following hereditary diseases could be recognized by means of a karyogram:

DOWNS syndrome:	2n + (Trisomy 21)
TURNER syndrome:	X0
KLINEFELTER syndrome:	XXY

4. **a.** A population means the totality of the individuals of a type of organism within a certain space and which, over several generations, is genetically connected. Therefore it encompasses same-species individuals of a region who may pair without restrictions.

   b. The HARDY-WEINBERG law states that in a so-called ideal population the relative frequency with which certain alleles are present in the gene pool remains unchanged over the generations. The allele frequencies can be calculated over as many generations as one likes. The prerequisite for these observations is an ideal population. In such a population, individuals pair at random. The individual genotypes are suited equally well to a constant environment and neither mutations nor selections appear. A genetic balance between the individual genotypes comes about, uninfluenced by how many individual alleles there were originally. If in such an ideal population a dominant allele A with a frequency p and corresponding recessive allele a with a frequency q appears, then, according to the law of population genetic balance, the individual genotypes AA, Aa and aa appear in the following relative frequency:

$$(p + q)^2 = p^2 + 2pq + q^2$$

or expressed differently since $p + q = 1$:

$$[p + (1-p)]^2 = p^2 + 2p(1-p) + (1-p)^2$$

5. There is the recessive allele: a and thus

$$a \cdot a = q^2$$

Let the dominant allele be A and thus $A \cdot A = p^2$

From the given pieces one obtains:

$$q^2 = 0.16 \text{ and } q = 0.4$$

Since $p + q = 1$, one obtains $p = 0.6$

Heterozygous carriers of a:

$$2pq = 2 \cdot 0.4 \cdot 0.6 = 0.48$$

For the carriers of the recessive gene one then obtains:

0.16 homozygote + 0.48 heterozygote= 0.64

Result: 64% of this population carry the recessive gene.

How Do These Countries Compare?

PERHAPS THE most striking finding from our research has nothing to do with which country's exams are hardest, but rather with how many youngsters take them.

Every country but the United States manages to bring a significant number of students up to the level of performance demanded by the exams in this volume. As illustrated in the accompanying graph, approximately one-third to one-half of the age cohort in England and Wales, France, Germany, and Japan take advanced subject-specific exams like the ones shown in this volume (though not necessarily in biology). In sharp contrast, only 7 percent of U.S. 18-year-olds take one or more AP exams.

Some like to downplay the high standards reached by students in other countries by labeling those systems as elitist. But this claim is difficult to justify in light of the numbers. As the graph shows, from one-quarter to over one-third of the age cohort in every country but the United States is able to meet the high standards reflected in these exams. Only the AP is reached by an elite number. (It is important to note, however, that the AP exams are offered in fewer than half of the high schools in the United States and—unlike the other examinations in this book—they are not required for university entrance.)

How do these countries prepare so many students to take these exams? Is there anything we in the United States can learn from these countries? Indeed, there are some basic ingredients in their education systems that differ from practices in the United States and that warrant further discussion.

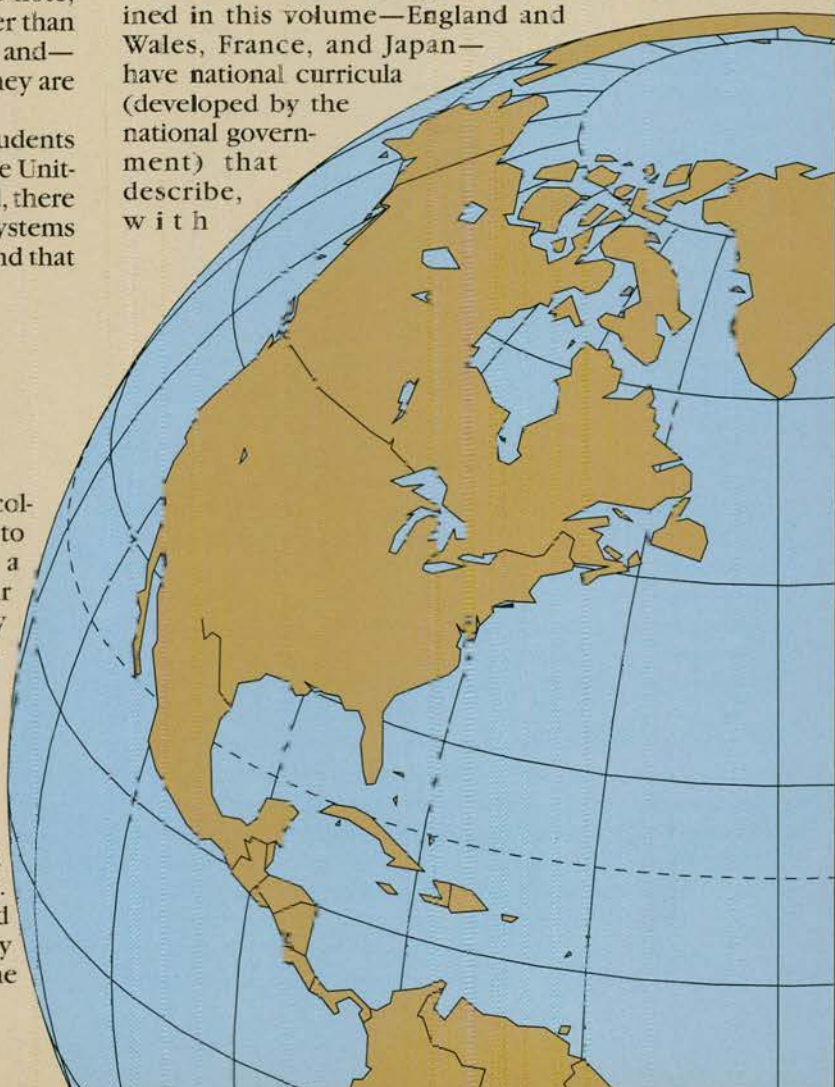
National Coordination of Curricula, Assessments, and Incentives

In each country except the United States, college-bound students know that if they want to study in a university they will have to pass a demanding set of exams. Furthermore, their course of study in secondary school is strongly tied to these exams. This reality serves as a powerful incentive for students to work hard and take school seriously. It also gives them, their parents, and their teachers something tangible to aim for.

In the United States, by contrast, a high school diploma is normally conferred based on taking a certain number of courses, not on reaching a particular standard of achievement. Although a few states, including New York and California, administer voluntary exams that may influence university admission and are tied to the curriculum covered in high school, there are no exams that all students nationwide must pass in order to be eligible for university study. Admission standards vary from institution to institution to the extent that some open-enrollment colleges and universities permit almost any student to attend. Unless students are among the few who plan on applying to highly selective institutions, there are no external incentives encouraging them to work hard and do well in difficult courses. This is markedly different from the incentives their European and Japanese counterparts face.

Central to each of these successful foreign systems is a clear relationship between the curricula and the exams. If schools are to prepare students to do well on a set of high-stakes exams, these exams must test what is covered in the curriculum. This is also essential to a meaningful incentive system for students. Students who see a link between what they are learning each day in school and the exams they will eventually need to take are likely to be motivated to concentrate on their schoolwork.

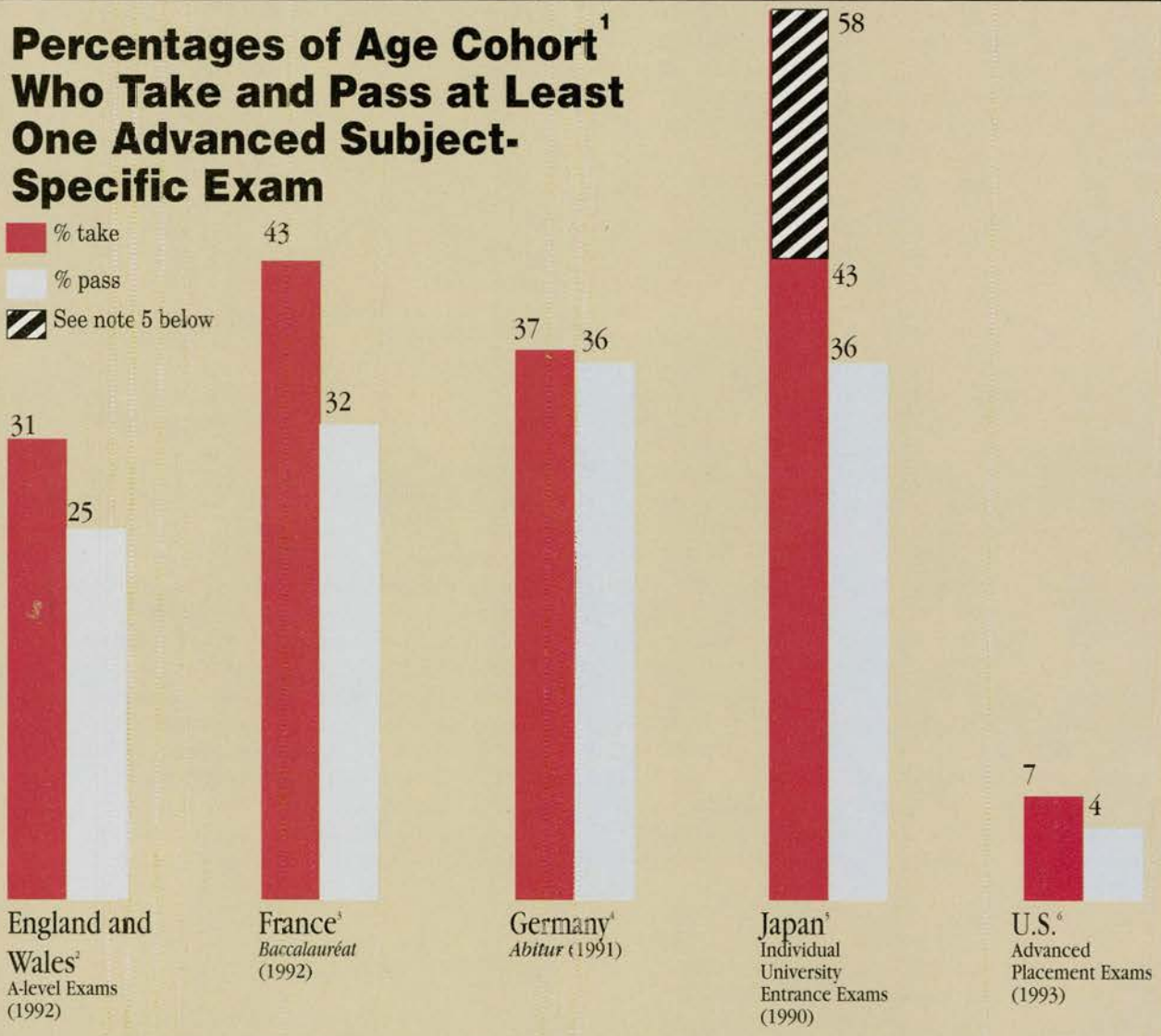
Three of the four foreign countries examined in this volume—England and Wales, France, and Japan—have national curricula (developed by the national government) that describe, with



varying degrees of specificity, the subject matter that students should be exposed to during their elementary and secondary years. In each of these countries, the key assessments taken by students throughout their educational careers—including the exams featured in this book—are tied to the curriculum.

Although there is no national curriculum in Germany, and each *Land* (or state) exercises authority over education within its boundaries, the link between what is taught and what is tested is strong. In the case of the *Abitur,* it is the teachers themselves who are responsible for coming up with the questions for the exams in most *Länder.* However, in doing so they are expected to follow guidelines set at the state

Percentages of Age Cohort[1] Who Take and Pass at Least One Advanced Subject-Specific Exam



[1] The age cohort for England and Wales, France, and the United States is approximately 18-years-olds, the age at which most students in these countries complete secondary school. For Japan, the age cohort is approximately 18- to 21-year-olds (see Note 5 below). For Germany, the age cohort is all 18- to 21-year-olds; the range is due to more frequent grade retention and the fact that the *Abitur* is taken at the end of what would be a 13th grade in the other countries.

[2] A-level candidates generally take three subject-specific exams. Approximately 15 percent of the age cohort earned three or more passes, 6 percent earned two passes, and 4 percent earned one pass. (Source: Associated Examining Board)

[3] *Baccalauréat* candidates generally take subject-specific exams in six or more subjects, depending on the track chosen. Percentages shown represent the proportion of the age cohort who tried for and received one of the general (academic) *baccalauréats.* Overall, 51 percent of the age cohort earned either an academic or vocational *baccalauréat.* (Source: Embassy of France)

[4] *Abitur* candidates take four subject-specific exams, at least two of which must be at an especially advanced level. (Source: Embassy of the Federal Republic of Germany)

[5] Since Japanese students must take subject-specific exams in order to apply to universities, and pass these exams in order to gain admission, the figures in this chart represent the number of Japanese applying to and enrolling in universities in 1990. It is common for university applicants who fail the entrance exams to retake them in subsequent years. It is also common for some university applicants to delay applying to universities for the first time for one or more years. For these reasons, the age cohort used for Japan includes individuals over the age of 18. The reason for the range shown here is that approximately one-quarter of applicants in 1990 had graduated from high school in earlier years, but it is not clear how many of them had previously applied to college, and thus had taken the exams already. The 43 percent figure assumes that *all* applicants who had graduated in years prior to 1990 had previously applied to universities. The 58 percent figure assumes that *no* applicants who had graduated in years prior to 1990 had previously applied. We estimate the actual percentage of first-time applicants in 1990 to be between 45 percent and 50 percent of the age cohort. (Source: "The University Exams in Japan" by Tae Ryu)

[6] (Sources: Advanced Placement Program and U.S. Department of Education publications)

and national levels by various governmental bodies. This arrangement serves both to maintain some comparability of curricula and exams across the country and to ensure that exams of such importance are firmly rooted in the curriculum taught by the teacher. It is also testimony to the significant trust and responsibility vested in German teachers.

In contrast, the two exams that most commonly serve as a gateway to college in the United States, the SAT and ACT, are not based on the curriculum students study in school. The AP exams are based on AP curricula, but those courses only last for a limited time, usually one year. Also, the courses are not required as a prerequisite for taking the AP exams.

National Leadership and Local Autonomy

There are concerns in these foreign countries, as in the United States, about the extent to which national leadership with respect to educational standards and exams impinges upon local autonomy. Each country addresses the issue in a different way. But in every one of these countries, the national government plays some role in establishing or coordinating the establishment of a publicly known, rigorous standard of achievement. In three countries highlighted in this book—England and Wales, France, and Germany—before students can be admitted to universities, they are required to pass certain exams that ministerial authorities ensure are pegged to a comparable standard. Yet none of these countries has a single national test that all college-bound students must take.

In England and Wales, France, and Germany, students in various parts of each country take exams that different governmental or government-monitored organizations develop according to a national specification. Hence, for these countries, the "national" exam is actually a set of comparable exams used by different regions.

In Japan, each university exercises its autonomy by developing its own set of entrance exams, though the content of these exams reflects the national curriculum. Japan does have a set of national exams—the UECE, produced by university faculty on behalf of the Ministry of Education, Science and Culture—that college-bound students may take, but only a portion of the universities require students to take these exams. Only the universities' individual entrance exams are required of all students aspiring to higher education.

Narrowly Defined Versus Broad-Based Curricula for College-Bound Students

The caliber of these foreign exams and the corresponding pass rates may lead one to wonder whether students in these countries are becoming proficient in some subjects at the expense of others. Are students who spend their time studying for these biology exams neglecting other important subject areas?

In England and Wales, France, and Japan, the national curricula ensure that all students are exposed to challenging courses in core subject areas such as language/literature, math, science, and history. In Japan, the national curriculum applies to students all the way through high school. In England and Wales and in France, college-bound students begin to specialize and narrow their focus upon entering the upper level of secondary schooling. French students choose among 38 different *baccalauréat* tracks, each with its own set of courses and exams, usually numbering between seven and 10. Students in all tracks, however, take courses and exams in some or all of the core subjects previously mentioned. In England and Wales, those studying for their A-levels normally limit their studies to three subject areas in which they have chosen to be examined. Universities and departments within universities have varied criteria on the number and subjects of exams that must be passed by applicants.

In Germany, all *gymnasium* students are required to take certain core courses all the way through secondary school, including their final two years as they study for the *Abitur* exams. Students eventually choose four subjects in which to take the exams, but they are required to take at least one in each of three major curricular areas: language, literature, and the arts; social sciences; and math, science, and technology. Course grades as well as the exams are factored into each student's final *Abitur* score.

College-bound students in the United States are not required to take any advanced subject-specific exams. The most common requirement of college-bound students is that they have obtained a minimal number of course credits—or Carnegie units—though this is not necessarily a reliable indicator of their academic performance. Those who take AP exams may do so in any subject in which the exams are offered, but there are no government or university requirements in terms of subject areas or numbers of exams to be taken.

Which Country's Exams Are the Most Rigorous?

Comparing exams at this level is not an easy task. As part of a separate project being undertaken by the National Center for Improving Science Education, an international team of experts has been assembled to make comparisons of these and other exams. (The full report from that effort will be released in late 1994.)

While we cannot draw any final conclusions about which exams are the most rigorous, we can provide readers with a framework for making their own comparisons. A variety of factors contribute to the rigor of an exam. Some have to do with characteristics of the exams themselves, others with elements of the examination systems that affect either the exams or the students taking them. Following is a discussion of some of the more significant factors one should consider when making judgments about rigor.

■ **Exam Length**—The exams in this book differ significantly in length. The Tokyo University entrance

exam in biology is two and one-half hours long, whereas students in England and Wales are expected to spend up to nine hours on the A-level. A longer exam does not necessarily translate into a more rigorous exam, though it does require students to demonstrate their command over a substantially wider or deeper range of material. The more important issue, however, is how much material students are expected to work through—and at what level of complexity—during a given amount of time. For example, are Japanese students expected to cover more material at a more complex level in the two and one-half hours than their counterparts in England and Wales during the same amount of time? If so, that is more meaningful than the difference in length alone.

There is a further implication of exam length that is also worth considering, though it is not as relevant to the discussion of rigor. Many readers will be impressed when they learn that students in England and Wales are expected to spend nine hours on an exam, and rightly so. It is rare that we ask the same of students in this country. The fact is, longer exams, such as the A-level, require students to display higher levels of discipline and fortitude.

■ **Question Type**—There are a variety of different types of questions used in the five exams in this volume, including multiple choice, short answer, essay and even an example of a performance-based exercise. The European exams only employ open-ended questions. These require responses varying from short answers (words, phrases, a sentence or a few sentences) to extended essays (a paragraph or multiple paragraphs). The U.S. and Japanese tests are the only ones to use multiple choice questions. In fact, 60 percent of the AP biology score is compiled from multiple choice questions.

To what extent does question type reflect on rigor? There is no rule that says multiple choice questions are any easier to answer than open-ended items. However, a few important differences are worth pointing out. First, multiple choice questions give students the opportunity to guess the correct answer, whereas other types of questions provide less of an opportunity to do so. Second, there are certain limitations to what multiple choice questions can assess. Whereas open-ended questions can ask students to make and defend judgments, demonstrate scientific method, explain complicated logic in clear prose, and otherwise show how they arrived at their answers, multiple choice questions cannot. Third, though multiple choice questions can be crafted to assess higher order thinking, oftentimes they simply ask students to recall facts, definitions, equations, etc. from memory. (It should be pointed out, however, that the process of scoring open-ended items is more complicated and labor-intensive than it is for multiple choice.)

In contrast, the European exams make greater use of questions that require students to innovate, show their work, explain their answers, and back up their conclusions. For example, students taking these exams must be able to work through the often complicated steps necessary to solve the scientific problems posed, give explanations based on scientific principles, and plan or carry out scientific experiments. While the AP and Tokyo University entrance exams do require students to engage in these types of activities, they do so for a relatively small proportion of the exam. As mentioned earlier, both of these tests make use of multiple choice questions, the AP much more so than the Japanese exam. Of 24 questions on the Tokyo University exam, 10 are multiple choice questions. Of 124 questions on the AP exam, 120 are multiple choice, though the four open-ended questions represent 40 percent of the total grade.

■ **Breadth Versus Depth**—Educators are always debating this issue: Is it better to expose students to a large body of material or to limit the material and teach it in greater depth? The same is often asked of exams. There is no correct answer to this question, but it is instructive to think about how each country approaches the issue in these exams. While it is clearly true that an exam with greater depth and breadth is more rigorous than one with less of both, in most cases the issue is not so clear-cut. Of the exams in this book, for example, some emphasize depth more than breadth, others take the opposite approach, and some try to do both.

It is misleading to think about the depth and breadth of an exam, and impossible to accurately judge its rigor, without also looking at the curriculum students study in preparation. The exam is only part of a larger equation. Take France, for example. Even a quick read through these tests reveals a significant difference between the *baccalauréat* and the AP. While the French exam requires students to go into considerable detail on a small number of topics, the AP covers a substantially wider area in much less depth. Does this mean that the *baccalauréat* requires depth of knowledge but not breadth? Not necessarily. If the curriculum students study prior to taking the exam has breadth, then the students must know all of the subject matter in depth in order to do well on the exam, since they do not know which topics will be chosen. In this situation, neither depth nor breadth has been sacrificed, and it makes for a very rigorous test. On the other hand, if the French curriculum were narrowly defined but studied in depth, the *baccalauréat* would be considerably easier for students.

The England-Wales A-level in biology is an example of an exam that is able to emphasize both depth and breadth. Nine hours long, it covers quite a bit of ground, some of it in significant depth.

■ **Complexity of Knowledge**—One of the most important issues to confront when comparing exams, but also one of the most difficult, is how sophisticated or complex students' knowledge of a particular topic or concept must be. This is at the heart of what it means for one test to be more rigorous than another. One way to make such a comparison is to isolate questions of the same type and on the same topic, and determine which calls for more advanced knowledge. It is important to keep in mind the depth/breadth issue here, however, because some exams may cover more content but require a less thorough understanding of each issue. While we are unable to elaborate on the complexity of these exams in this book, NCISE's upcoming report will take up the issue in a more comprehensive manner.

■ **Grading Standards**—Comparing the complexity of the questions on these exams only deals with part of the issue. Just as important is how well students are expected to do on those questions. What is considered a good answer? How much is each question worth? Who grades the answers and using what scale? Are the scales for passing exams comparable? For example, is 60 percent considered a pass in one country but 70 percent a pass in another? The process of grading exams is different in each country, and in every case it is quite complicated. This book offers a glimpse at how the exams are graded, what is considered a strong answer, and what is needed to pass, but a more serious investigation is necessary in order to draw final conclusions.

■ **Preparation**—When considering how difficult these exams are for students, it is important to determine how well prepared students are to take them. As mentioned earlier, in order for an assessment to be a useful educational tool, it must be linked to the curriculum students study. It would then follow that the stronger the link between an exam and the curriculum, the better prepared the students will be to take it. (Of course this assumes, among other things, that educators do their part to effectively teach the curriculum.) If this is the case, it is important to ask certain questions: Do students in each country receive comparable instructional time in a tested subject area? To what extent is the secondary curriculum tailored to the subject areas of the exams? Do students in one country receive more instructional time in biology than students in another?

Other important questions to ask: To what degree can teachers and students in these countries anticipate exam topics, and thus study narrowly in preparation? To what extent can students learn how to do well on the exams through mastering certain methods, apart from the content knowledge?

A Broader Look at the Question of Rigor

What additional academic expectations do students face above and beyond the particular exams discussed in this book? After all, the ultimate question many readers will want to answer goes beyond comparing the particular exams and deals more broadly with the question of rigor. Put simply, how demanding are the expectations for college-bound students in these countries? Following are some of the issues worth considering:

■ **Scope of the Examination System**—Beyond the biology exams, how many other subjects are students tested on? How many of those subjects are outside the sciences? For example, do students who take these biology exams take other science exams such as physics or chemistry? Do they take exams in other subject areas, such as language/literature, mathematics, or history? Students in England and Wales who take the A-level in biology normally take exams in two other subjects of their choice, whereas French students taking the *baccalauréat* in biology must also take exams in French, history/geography, mathematics, philosophy, physics/chemistry, and a foreign language.

■ **How Much Does Each Exam Count?**—In every country but the United States, the exams in this book must be passed to gain admittance to a college or university. But there is a big difference between the value of a single exam in Germany and in England and Wales. A-level candidates take an average of three exams, and their scores on these exams are the main piece of information weighed by admissions offices in universities. In Germany, on the other hand, students' scores on their four *Abitur* exams make up only a fraction of their total *Abitur* grade. While this does not make one exam easier than another, it may put comparatively greater pressure on students to do well on the A-level.

■ **Expectations Beyond the Exams**—In the years leading up to the exams, do students have to study subject areas in which they will not be examined? Or is every course tied to a corresponding examination? In Germany, *Abitur* candidates must take 28 courses over a two-year period, but they are only tested in four of those areas. By contrast, in England and Wales, A-level candidates study almost exclusively the subjects they will be examined in.

* * *

These are just some of the factors readers should consider when comparing the exams discussed. It is by no means an exhaustive list. But it should serve as a helpful guide to anyone interested in contemplating what it means to have high standards for students. That is, after all, the purpose of the book from which this report is drawn and of the AFT's *Defining World Class Standards* series—to provide people in the United States with a firsthand look at what is expected of students in other countries so that we may become more informed judges of the standards we set for our own students. □

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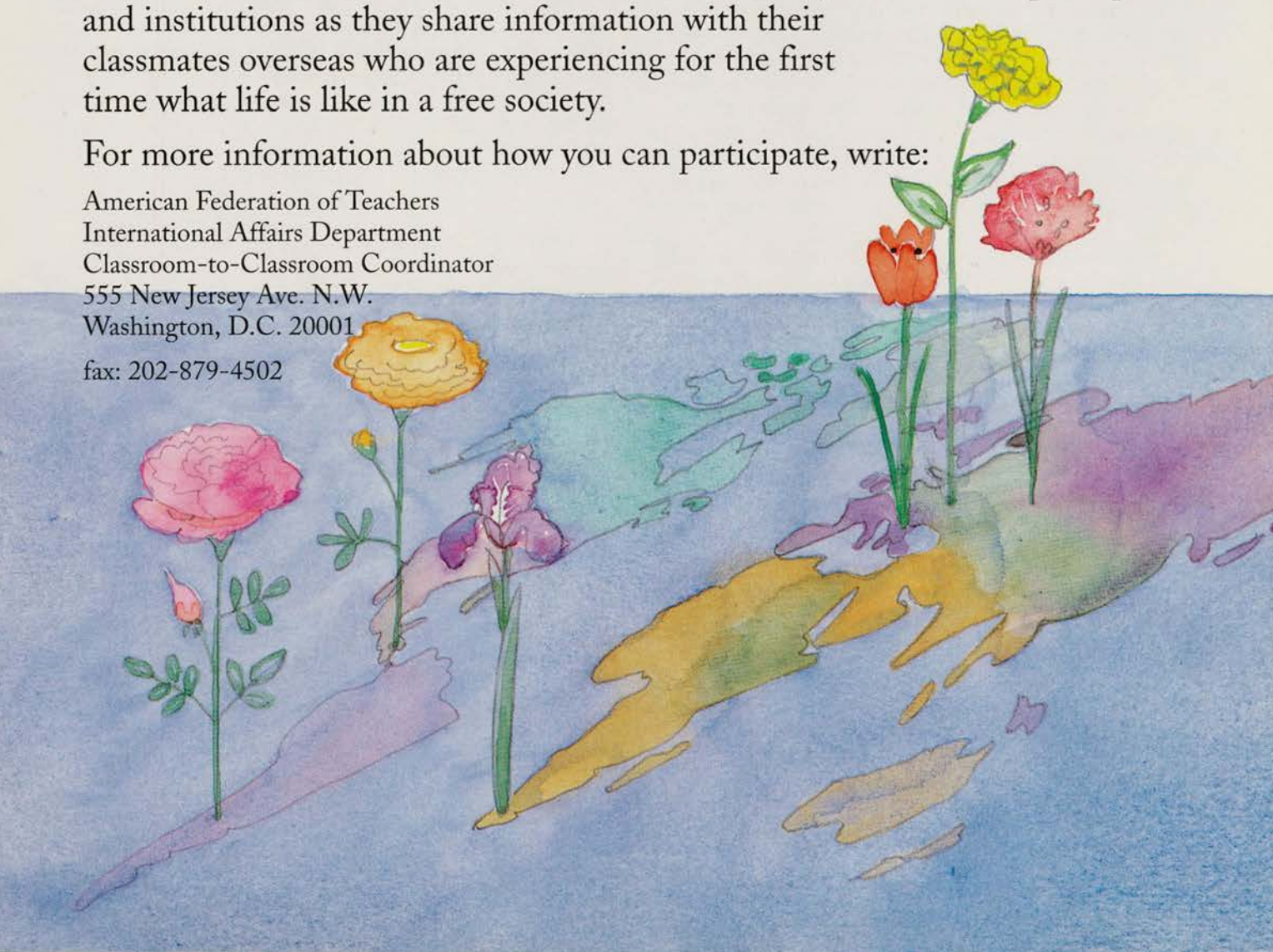


How To Teach Ancient History: A Multicultural Model

By Frank J. Yurco

TODAY'S SCHOOL teachers have trouble finding reliable and updated curriculum sources on ancient history, particularly as it relates to the Near East. In recent years, Afrocentrists have tried to fill in the gaps with their own revisionist views. They have met with a great deal of success, especially in urban schools, where many Afrocentric materials have received official sanction despite their historical distortions and misinterpretations.

Much of the problem lies in teacher education programs, which largely fail to expose student teachers to the most current information on ancient history and cultures. Most teachers graduate from college with very little knowledge of the ancient world, which, if studied at all, was probably surveyed rather than closely examined. This failing echoes in the woeful misunderstanding of history exhibited by many students entering college.[1] Inadequate teacher preparation only reinforces the misinformation spread by Hollywood films, pseudo-scientific popular magazines, and the sensationalist writings of certain non-scholarly authors.

Thus, an information gap exists between institutions of higher learning and K-12 teachers and students. The purveyors of Afrocentric ideas have exploited this gap to introduce their skewed ideas into the curriculum with materials like the Portland Baseline Afrocentric curriculum.[2]

To combat bad history, teachers should take advantage of the many museums and universities that offer educational outreach programs or provide enrichment courses to the public. Other resources are also available to teachers, including reliable translations of ancient texts as well as good histories and cultural studies of the Egyptians, Mesopotamians, Greeks, and Romans.[3] Several excellent popular journals also handle current archaeological research, such as the American Institute of Archaeology's *Archaeology*, the Biblical Archaeology Society's *Biblical Archaeology Review*, and the privately published *Kemet*. The American Institute of Archaeology offers membership to anybody interested, and it also has local branches across the country.

Another valuable resource is the academic alliance concept. Academic alliances are organized locally between colleges or universities and school teachers. They strive to create networks among professional scholars and K-12 teachers. In such programs teachers are invited to attend lectures by specialists and to approach and share ideas with scholars. Academic alliances have been formed in many places and cover many different subject areas. In Chicago, the Academic Alliance helped encourage and develop a project entitled *Extending the Great Conversation* (1989-1992), which involved 150 teachers from Chicago public schools in a 15-week program. Teachers studied the literature, history, and culture of ancient Egypt, ancient Mesopotamia, and ancient Greece with authorities in the field and learned that the whole Western literary tradition has its earliest roots in ancient Egypt

(Continued on page 36)

BETTMANN (3)

Clockwise from top: Detail from world map showing Africa (engraving, mid-17th century); Nubian soldier carrying a bow (2100 B.C.); female Egyptian druggists squeeze animal skin filled with medicinal herbs (undated); the pyramids of Egypt.

Frank J. Yurco is a professional Egyptologist affiliated with both the Field Museum of Natural History in Chicago and the University of Chicago. He is a school board member and vice president at St. Thomas the Apostle Elementary School in Chicago and was an instructor in the Extending the Great Conversation *project (1989-1992). This article is reprinted with permission from a collection of essays,* Alternatives to Afrocentrism, *published earlier this year by the Center for the New American Community, a project of the Manhattan Institute. The complete collection of twelve short essays, plus a list of recommended readings, may be purchased by sending a check or money order for $5, made out to the Manhattan Institute, to: The Center for the New American Community, 1745 N Street, N.W., Washington, DC 20036.*

. . . AND HOW NOT TO

A Critique of the Portland Baseline Essays

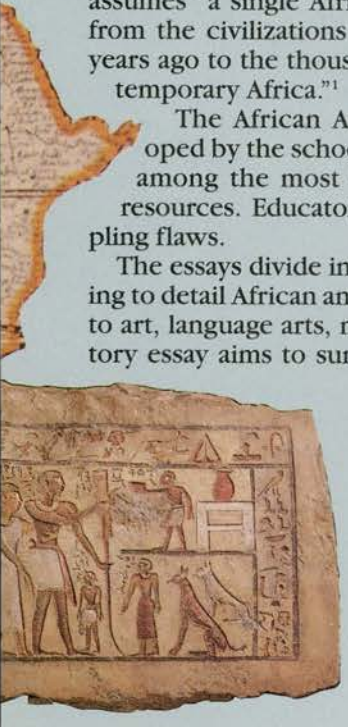
BY ERICH MARTEL

TEACHERS, PARENTS, and students are justified in wanting multi-cultural curricula that reflect the achievements of the world's diverse cultures. Older curricula often reflect a bias that denied or neglected the genuine contributions of Africa. But teachers who want reliable information on African and African-American history often don't know where to turn. Many have unfortunately looked to unreliable books and publications by Afrocentric writers.

The term "Afrocentrism" has engendered semantic confusion, meaning different things to different people. Some scholars, such as Russell Adams, chairman of the Afro-American Studies Department at Howard University, describe several types of Afrocentrism, ranging from a curricular emphasis on Afro-American culture and heritage, on the one hand, to undocumented assertions and pseudoscience, on the other. In this article, I use the term to connote undocumented assertions about the African past. This is the most commonly employed usage of the term in the general media and in academic critiques of Afrocentrism, such as those by Howard University classicist Frank Snowden, and Kwame Anthony Appiah of Harvard's Department of Afro-American Studies. Appiah describes an "Afrocentric paradigm," which holds that "Western scholarship . . . is hopelessly Eurocentric" having "concealed facts about the African origins of certain central elements of Western civilization" and which assumes "a single African culture, shared by everyone from the civilizations of the Upper Nile thousands of years ago to the thousand or so language zones of contemporary Africa."[1]

The African American Baseline Essays,[2] developed by the school system in Portland, Oregon, are among the most widespread Afrocentric teacher resources. Educators should be aware of their crippling flaws.

The essays divide into six separate sections, each trying to detail African and African-American contributions to art, language arts, math, music, and science; the history essay aims to survey political developments from ancient times to the recent past. These essays might as well be called "Egypt-centric," however, since so much of their content revolves around ancient Egypt. Openly disdainful of professional Egyptologists, most of the authors attempt major revisions of ancient Egyptian history. Although they claim to advance long ignored facts and to correct Eurocentric distortions of history, many of their claims and theories turn out to be little more than "Africanized" versions of discredited and discarded European ideas.



MUSEUM OF FINE ARTS, BOSTON

A 19th century conception of race binds the essays together. They try to portray all Africans across thousands of years and miles as part of a single "race" and culture simply on the basis of a few observable physical features, such as skin color and hair form. According to Philip Curtin, a professor of African history at Johns Hopkins University, "The fundamental problem is that [the social studies essay] puts forward racial theories that have been long ago abandoned by mainline scholars of Africa."[3]

Despite this, the essays' many inaccuracies have gained a foothold in a number of school districts. Two widely reported distortions are that ancient Egypt was a black nation and that the achievements of ancient Greece had African origins.

■ **"Ancient Egypt was a black nation" or Egypt was "The Land of the Blacks," claim the essays on art and music.**

"Black" and "white" are hard to define. Ancient Egyptian and Greek views of skin color were not the products of a legacy of racial discrimination, as they are in the modern United States. According to Frank J. Yurco, an Egyptologist at the Field Museum of Natural History in Chicago, these terms are simply a "chimera—cultural baggage from our own society that can only be imposed artificially on ancient Egyptian society."[4] Moreover, Yurco points to studies in physical anthropology and ancient Egyptian art that suggest the ancient Egyptians "were of varying complexions of color, from the light Mediterranean type (like Queen Nefertiti), to the light brown of Middle Egypt, to the darker brown of Upper Egypt, to the darkest shade around Aswan and the First Cataract region, where even

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This article is an expanded version of an essay that appeared in Alternatives to Afrocentrism, *published earlier this year by the Center for the New American Community, a project of the Manhattan Institute. Detailed critiques of the Portland Essays, upon which this article is based, are available by writing Erich Martel at Wilson H.S., Nebraska & Chesapeake Sts., N.W., Washington, DC 20016.*

today, the population shifts to Nubian."[5]

The phrase "Land of the Blacks" is a mistranslation of the ancient Egyptian word "KMT" (Kemet). It means "the black land," and refers to the black alluvial soil deposited by the Nile's yearly flooding, not the skin color of nearby residents. "KMT" contrasts the word "Deshret," or "the red land," which refers to the surrounding desert. The ancient Egyptians, who owed their lives to the Nile and the soil it made rich, often called themselves "the people of the black land."[6]

Linguistic, pictographic, and archaeological evidence point primarily to a Saharan origin of the ancient Egyptians from the west, not the south. This migration occurred following the gradual desiccation of the Sahara after 5500 B.C.E.[7]

Studies do show the early pre-dynastic (pre-3150 B.C.E.) population of southern ("Upper") Egypt having affinities with tropical Africans.[8] A recent study comparing pre-dynastic crania from northern ("Lower") Egypt with those from Europe and several regions in Africa concluded that "the attempt to force the Egyptians into either a 'black' or a 'white' category has no biological justification. . . . Egypt was basically Egyptian from the Neolithic right up to historic times."[9]

■ **"The African Origins of Greek development [were] an unquestioned reality of the Greeks," according to the art essay, or "Egypt gave birth to . . . Western civilization," claims the social studies essay.**

A central Afrocentrist tenet is the claim in the social studies essay that ancient Egypt was "the first great civilization" and that it was pivotal in the formation of Mesopotamia, ancient Greece, and ultimately Western civilization. In addition, several of the essays include bibliographical sources that propose the even more radical claim that other geographically distant civilizations, such as the Olmec of Mesoamerica, were heavily influenced by ancient Egypt.

Egypt and Mesopotamia shared contemporaneous beginnings in the late 4th Millenium. Contact and, consequently, two-way "borrowings" in the realms of culture and technology took place. Nonetheless, both trace their origins and development primarily to local factors. While Egypt (and Mesopotamia via the Phoenicians) did make important contributions to ancient Greece, indigenous Greek achievements were central to that process.[10] Scholars of pre-Columbian Mesoamerica see the origins of Olmec civilization and its artifacts in indigenous, not Egyptian, influences.[11]

OTHER PROBLEMS with the Portland essays run much deeper. Worldwide phenomena such as pentatonic scale in music, use of prophecy, body language, creation stories, rock art, as well as the earliest pottery, sculpture, and musical instruments are often described as if they originated in Africa. Features that might be considered unique to Africa, such as trickster stories, are not highlighted at all. According to George Washington University anthropologist Alison Brooks, a specialist in prehistoric African archaeology, dates and dynasties are confused. In addition, dates and periods overlap, contradict each other, and are not consistent among the six essays. In the social studies essay, for example, almost all the dates associated with human evolutionary stages are incorrect according to current evidence.[12]

The "Science and Technology" essay endorses pseudo-scientific notions, including "the extra-terrestrial origin of the Nile" and "water-laden micro-comets" as the source of the oceans. The author misinterprets a small bird effigy in the Cairo Museum as a model of a glider and writes that ancient Egyptians developed full-sized gliders 4,000 years ago and "used their early planes for travel expeditions and recreation." He attributes mystical powers to the pyramids and misinterprets artifacts in trying to show that the ancient Egyptians experimented with antennae and electricity. He also makes the startling claim that "for the ancient Egyptians as well as contemporary Africans worldwide, there is no distinction and thus no separation between science and religion."

Bernard Ortiz de Montellano, a professor of anthropology at Wayne State University in Detroit, comments that "the 'science' that the essay describes is pseudo science—a farrago of unsubstantiated and outrageous claims, arguments for the existence of the paranormal, and advocacy of the supernatural as an integral part of science."[13] Writing in the *Phi Delta Kappan*, Irving Klotz, professor emeritus of chemistry at Northwestern University, notes that "[t]he most devastating effect of the spread of this kind of material taught in the Portland Baseline Essays will be the inculcation in a generation of young people of an uncritical, superficial attitude toward science."[14]

Even the portion of the essay devoted to African-American scientists contains easily avoided inaccuracies. The essay states that "Thomas Jefferson appointed Benjamin Banneker to survey the site for the capital, Washington, D.C.," and that Banneker "wrote a proposal for the establishment of a United States Department of Peace." Had the author consulted *The Life of Benjamin Banneker* by Silvio Bedini, which is considered the definitive biography, he would have discovered no evidence for these claims. Jefferson appointed Andrew Ellicott to conduct the survey; Ellicott made Banneker his assistant for roughly three months in 1791. Benjamin Rush authored the "Department of Peace" proposal; the confusion arose among earlier biographers because the proposal appeared in Banneker's 1793 almanac.[15]

Another telling inaccuracy lies in repeating the widely circulated rumor that Dr. Charles Drew, who pioneered blood plasma storage, died after an auto accident because "not one of several nearby white hospitals would provide the blood transfusions he so desperately needed." In the 1982 *Dictionary of American Negro Biography,* however, historian Rayford Logan writes, "Conflicting versions to the contrary, Drew received prompt medical attention."[16] *The Washington Post* recently reported that Charlene Drew Jarvis, the daughter of Dr. Charles Drew, is actively trying to "destroy the myth" about the mistreatment of her famous father because she "discovered in her work on the local board of the American Red Cross that some African Americans cite the story of discrimination against her father" as one of the reasons for not donating blood or organs.[17]

At best, the essays' errors demonstrate a severe amount of sloppiness; at worst, they reveal an ideologically driven willingness to prefer the claims of non-specialists over the documented research of trained professionals. The most flagrant example of this is the author

of the science essay. Although credited as a "research scientist" at Argonne National Laboratories, he is described by the Director of Public Information at Argonne as an industrial hygiene technician with a high school diploma.[18]

The Portland Baseline Essays do contain some accurate information. The math essay's coverage of ancient Egypt includes a good deal of reliable information. The art, language arts, and music essays, despite many errors in their coverage of ancient Egypt, appear to treat their African-American sections accurately. Nevertheless, the essays as a whole are seriously flawed. Teachers who look to the Portland essays to infuse African historical content into their classes face an impossible task: how to sift reliable information from the specious.

HENRY LOUIS Gates, Jr., chair of Afro-American Studies at Harvard, points out the dangers this kind of Afrocentrism poses to the field of Afro-American studies: "For our field to survive, we need to encourage a true proliferation of rigorous methodologies, rather than seek ideological conformity. African American studies should be the home of free inquiry into the very complexity of being of African descent in the world, rather than a place where critical inquiry is drowned out by ethnic fundamentalism."[19]

If they are to gain acceptance, revisionist interpretations of history must be based upon impeccable and thorough research. The historiography of American history is replete with examples of inaccuracies and outright myths that were shattered by scholarly revisionist research. Such outstanding scholars as W.E.B. DuBois, Carter G. Woodson, John Hope Franklin, C. Vann Woodward, and Kenneth Stampp were among the many who played crucial roles in opening up textbooks and curricula to the African-American experience. Because of solid grounding, their research withstood criticism and could not be ignored. By contrast, the Afrocentrist historical revisions, such as those contained in the African-American Baseline Essays, are outside this rigorous tradition of scholarship. Most of the consultants and authors of the Portland essays are not professional scholars of ancient Egyptian or African history. Frank Snowden, professor emeritus of classics at Howard University and author of *Blacks in Antiquity* and *Before Color Prejudice: The Ancient View of Blacks*, has analyzed many of the Afrocentric writings on ancient history upon which the essays' Afrocentric claims are based. These writings are listed in the essays' bibliographies. Snowden states:

> "Though Afrocentrists may be competent in their own specialties, many of their statements about blacks in the ancient world demonstrate clearly that they have not approached the ancient evidence with the relevant scholarly apparatus. Many shortcomings have resulted: unfamiliarity with and a failure to use primary sources; a reliance on the undocumented opinions of fellow Afrocentrists (always the same few); a tendency to make general statements on the basis of a few lines from a single author or from a few texts without considering the total picture of blacks in antiquity; the use of language charged with political rhetoric; and a tendency to read a 'white conspiracy' into scholarly interpretations of the ancient evidence.
>
> ". . . Many students already have been misled and confused by the inaccuracies and omissions [of Afrocentrism] . . . but the damage to future generations is incalculable if this trend continues."[20]

The real solution is for teachers to stay informed of developments in their fields of study. They should read professional journals, attend conferences, and establish links to local universities and museums. They should consult the growing number of serious scholars of the African past and of the more recent African-American experience. They should argue among themselves in faculty lounges. They should remain open to new ideas, but always skeptical of dramatic and revisionist claims. While modern views of the past constantly change as new data emerge and new interpretations come forth, all of us should employ caution when confronted by claims purporting to reveal a "real truth" that sweeps away well-documented information about the past. □

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ANCIENT HISTORY

(Continued from page 32)

and ancient Mesopotamia. The program also introduced the teachers to Chicago's two major museums with exhibits and collections from Egypt and Mesopotamia—the Oriental Institute Museum at the University of Chicago and the Field Museum of Natural History. Teachers learned how the museum exhibits can be used as enrichment sources for their lessons, and about the varied outreach and education programs of these museums.

Not only were the teachers excited by the new approaches to ancient history, but their students responded remarkably. Reading directly about the experiences of ancient peoples provided a distinct thrill for the students. By using newer and more reliable texts, rather than more traditional but also outdated materials, the teachers were able to relate experiences that held direct relevance for situations that the students faced daily. Even on a kindergarten level, such an approach excited and stimulated the students, especially because some of the ancient texts are stories and myths.[4]

The ancient peoples of Egypt and Mesopotamia wrote not only kinglists and historical materials, but also literary texts, myths, stories, poetry, economic and legal texts, and even letters. Such materials bring these ancient peoples to life as no standard school text can ever do. In the ancient societies, the career of scribe offered a means for advancement in society. The scribal schools thus produced literature extolling education and encouraged students to excel. These school texts are powerful motivators also for today's students. The words of the ancient scribal masters still ring true today: Education is the road to advancement.

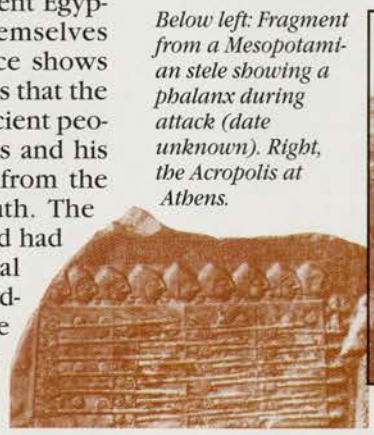
The ancient sources, directly read and translated, also illustrate that these ancient societies experienced no racial prejudice. Ancient Egypt, contrary to Afrocentric claims, was a multicolored society, with light to dark skinned peoples, and all shades in between.[5] The ancient Egyptians ascribed physical and language distinctions among humans to their creator deity, Re-Atum, and his effort to distinguish the peoples.[6] Yet in their view all humans were created equally by the creator deity, and he spread his blessings on all humans, including non-Egyptians like the Syrians and Nubians,[7] who lived to the north and south of ancient Egypt. Other texts illustrate the rudiments of social justice and equality, especially concerning the rights of women.[8] Such readings enhance the lessons of democracy and of social justice today.

The ancient Egyptians' lack of color prejudice should serve as another salutary lesson for us all today. It also contradicts the Afrocentric view that the ancient Egyptians called themselves and considered themselves "black."[9] Anthropological and artistic evidence shows that they did not.[10] Likewise, Afrocentric claims that the Egyptians were described as black by other ancient peoples are misrepresentations of fact. Herodotus and his contemporaries distinguished the Egyptians from the Kushites, their Nubian neighbors to the south. The Kushites were the blackest in complexion, and had the wooliest hair, according to the classical sources, as Snowden has emphasized repeatedly.[11] The Egyptians were not as dark as the Kushites, though they did vary from light to dark brown, even as they do today, as one travels southward in Egypt.[12]

The ancient Mesopotamians were also ethnically mixed. From the earliest times Sumerians mingled with Semitic migrants from Arabia.[13] Later Indo-European peoples migrated from southern Russian areas into the Near East and intermingled with the Babylonian population in what is called the Kassite Era. The Hittites, too, were Indo-European.[14] Thus the whole population of Mesopotamia was multiethnic. Later in the First Millennium B.C., even more Indo-European peoples, such as the Persians and Medes, moved into the Near East. With the conquest of the Persian Empire by Alexander the Great, the Greeks (another Indo-European population) entered Egypt and Babylonia. At that time, Hellenic ethnic chauvinism appears in Egypt under the Ptolemaic Dynasty.[15] Nonetheless, the Kushite-Meroitic peoples living south of Egypt in the Sudan were viewed very positively both by the Greeks and by the Old Testament.[16] In part, this stemmed from Kushite rule in Egypt, 712-663 B.C., when the Kushites resisted Assyrian domination and helped Hezekiah in 701 B.C.[17] It also stemmed from the fact that of all the Near Eastern powers, only the Kushites had remained independent of the Persian Empire.

The ancient Near Eastern world also reached out to farther parts of Asia and Africa, and encountered other world civilizations. A South Indian sailor who was shipwrecked in the Red Sea in 118 B.C., for example, demonstrated to the Ptolemaic Egyptian navy the techniques of sailing directly to India by making proper use of the Indian Ocean's monsoon winds.[18] A rich trans-oceanic trade soon developed, linking India and the Mediterranean. The Romans took control of this route after occupying Egypt in 30 B.C., and they extended the route eastward as far as Southeast Asia and China. The Muslims later expanded it to the East Indies, and Swahili traders opened another route southward along the East African coast.[19] Madagascar, though, had earlier been settled by ocean-crossing East Indians, eloquent testimony to their navigation and seagoing skills.[20] All these experiences made the Mediterranean world even more multicultural. Only the Americas, Australia, and Antarctica remained unknown to them.[21] Thus, the study of ancient history reveals a multicultural world—much like the world we inhabit today. Seen in this light, the lack of racial prejudice among the ancient peoples should serve as an especially strong legacy to us.

By studying these cultures through direct translations and other materials, we can learn firsthand about the ancient world's chief legacies. From Egypt came the 365



Below left: Fragment from a Mesopotamian stele showing a phalanx during attack (date unknown). Right, the Acropolis at Athens.

BETTMANN (2)

and one-quarter day calendar that we still use, as well as its subdivision into 12 months and 24-hour days.[22] The Egyptians also gave us a sophisticated use of geometry, as well as number usage and calculation based upon the power of 10, anticipating the metric system.[23] Egyptian papyrus and writing led to the development of books and helped develop a literary tradition.[24]

From Mesopotamia came the sexagesimal system, a number system based upon the power of 60 that is still used in our clocks and time-keeping. The earliest known algebraic equations also come from Mesopotamia.[25] Many early civilizations also developed astronomy. In Egypt, observation of the star Sirius was tied to the Nile flooding. The South Indians, East Indians, and Pacific peoples developed star-based navigation, as well as oceanic current and wave pattern analysis, cloud and bird flight pattern analysis—all used in their highly sophisticated and successful trans-oceanic navigation and sailing.[26]

The proper study of ancient history should highlight the brilliant achievements of these many, diverse peoples. Western civilization owes a considerable cultural debt jointly to Egypt in Africa and to Mesopotamia, and indirectly to the wider world that those ancient cultures contacted and learned from. This is the true legacy of the ancient civilizations, and not the monocultural and African-centered view that the Afrocentrists present. Africa does indeed have a strong impact on this legacy, through Egyptian and Kushite contributions, but the legacy also comes from other, non-African cultures.

In conclusion, the direct study of ancient texts and the use of academically sound and scholarly historical sources offer us not only a fascinating glimpse of wonderful ancient civilizations, but also some valuable models in multicultural, ethnic, and racial toleration. Our entire ancient heritage is multicultural right from the start, with deep roots in both Africa and Asia. Today's teachers and students can surely profit from this history. □

End Notes

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SCHOOLS WHERE KIDS ARE KNOWN

BY GERALD GRANT

IN TOO many schools, children are lonely in the crowd. Except for a few star athletes or those lucky enough to form a bond with a teacher in what Eleanor Farrar called the "specialty shops" of top-track classes or studio arts or band, most students shuffle from class to class unknown and unchallenged. Gifts go unnoticed; opportunities are lost. The vast middle of the student body experiences school as coexistence rather than community. Such children are more likely to join a counterculture of drugs or violence. One can earn some "rep" that way, and outlaws stick together and protect one another.

About half of all students in the urban United States attend schools with an *average* enrollment of nearly 1,200. Although elementary schools are more inviting, it is not uncommon to find high schools of two or three thousand students, where it's impossible to know all the children. In large cities, children may enter these schools through turnstiles or metal detectors and turn down drab cinderblock hallways where they hear voices droning over public address systems but few of them are greeted by name. Rates of absenteeism and classroom disorder are higher in big and impersonal schools. A study of 744 comprehensive high schools revealed that dropout rates in schools of more than 2,000 pupils were twice that of schools with fewer than 667 students.

We need more visions to counter these trends—more images of schools where children are known. And that is what this essay is about: schools as places of nurture and places of joy; settings where intimacy is no stranger and where mutual discovery is commonplace. There's no great science or theory here. It is, rather, an album of recollections sifted from hundreds of schools I have visited as well as a few I have discovered vicariously. I have no grand design to offer. My motivation is wonder, though it embodies a hope for imitation and piecemeal change.

I remember how as a young researcher doing a study of the schools in the Archdiocese of New York that the extraordinary character of schools in the most depressing circumstances was impressed upon me. I was poring over computer printouts that showed the expected achievement of each school when compared with the usual "inputs" of the social class backgrounds of the children enrolled. An elementary school in the South Bronx leapt off the page. The children there were among the poorest of the poor, and the predicted scores had them two years below grade level. But the actual scores showed the opposite: They were nearly two years above grade level in all subjects. I got in a cab and went out to St. Augustine's. As we approached the school, we passed through neighborhoods that looked like pictures of Dresden at the end of World War II. Whole blocks were wiped away. What could explain the success of this school?

I entered the school just as the free reading period had ended. First-graders were putting books and audio tapes and, yes, even comic books back on shelves. The rule was that during free reading period for about twenty-five

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minutes each morning, children could read virtually anything they wished. Fifth-graders were leaving the room after having read stories to the youngsters. There were also tapes available for children to listen to stories being read while they turned the pages. The school operated on an extraordinary buddy system—they didn't use the fancier "peer tutoring" label—in which every child in the first three grades was paired with a buddy from the upper three grades. These buddies came in not only for reading period but at other times during the day and often met their younger charges at home in the morning to make sure they got to school on time and with the proper books and materials in tow. Children were known in the school; they were linked together, and they did not fail.

By citing such examples, I do not intend to gloss over society's responsibility to improve conditions for children born into economic tragedy. I agree with Harold Howe that schools cannot do it alone. Fixing schools alone is an inadequate remedy. We must give children a better chance from birth, and we must create better schools. Peer tutoring is one way to make them better. Someone should do a study some day on why such a good idea as peer tutoring has taken so long to spread throughout American education and why it is still underutilized.

But I promised inspiration, not laments. So let me relay to you a wonderful experiment in a San Francisco Bay Area school that Shirley Brice Heath of Stanford University told me about. It is an example of intelligent use of technology as well as an ingenious experiment in peer tutoring at several levels. Sixth-graders tutored second-graders. Before each tutoring lesson the older students discussed with their classmates what they were going to try to teach that day. They wrote an account of this discussion in their own journals. Then they went down to tutor the second graders. When they returned, they evaluated what they had done and discussed next steps and recorded that. Meanwhile, some college students in a nearby teacher training program were watching via TV monitors as the tutoring sessions proceeded. Each student teacher in training focused on one of the sixth-grade tutors. After watching the progress of the tutoring sessions for several weeks, the college students entered the sixth-grade classroom to coach the sixth graders about how to become better teachers.

Things need not be so ingenious in order to be effective. As headmaster of the Deerfield School in Deerfield, Massachusetts, many years ago, Frank Boyden installed his desk in the main hall. And there he worked and transacted business. Students passing in the hall would often stop at his desk. He knew every boy by name.

Dennis Littky, the principal of the public high school in Winchester, New Hampshire, simply told his guidance counselors that he wanted to sit in with them when each child planned his or her academic schedule. I watched him one morning while he gently quizzed and challenged half a dozen students in turn. He let them make choices but he made sure they had good reasons for them. Teachers knew he sat in; they knew he knew each kid; and they knew that kids told him about which teachers were challenging them and which ones weren't. Littky also made sure the children were known in the community. As part of both academic planning and career guidance he insisted that every child have several shadowing experiences—spending a day with an architect, carpenter, or the city manager in nearby Keene. Littky kept a journal in which he recorded small triumphs as well as large defeats in the life of a high school principal. He published these and distributed them to his faculty, who often read his insights about interesting students—Littky found them all interesting.

Like Littky, Deborah Meier is part of Ted Sizer's Coalition of Essential Schools. She's the founder and principal of Central Park East Secondary School in Harlem. Her students have made trips to Winchester and spent a few nights in the homes of Littky's parents, and the Harlem families reciprocated when the boys and girls from Winchester visited New York. On these trips Deborah Meier's teachers often accompany their advisory groups. Each teacher has an advisory group of 15 students. Five teachers with seventy-five students comprise a House at Central Park East. They meet as a House twice a day. Each teacher checks in with the students in her or his advisory group. They know whose mother has lost her welfare check or whether an uncle is dying of AIDS, as well as who's having problems with a particularly difficult assignment. Everyone is on a first-name basis in the hallways and when a student's name comes up in casual conversations several teachers within earshot will usually chime in with detailed comments about that student's work or current life situation. In their role with advisory groups, Central Park East teachers function like metapalets in Israeli schools, with a holistic concern for each child's development. Public schools in Rochester N.Y., are trying to move in this direction with uneven success in the development of their home-based guidance program. In some middle schools there, home-based guidance teachers meet at least 30 minutes a day with their students. Each home-based guidance class contains students from sixth, seventh and eighth grades, so that a student can stay with the same teacher for three years of middle school.

WHILE STUDENTS and teachers have more time to come to know one another in such settings, and this is a good thing in itself, some schools have taken a more radical step to make students known in fullness and depth. Patricia Carini at the Prospect School in North Bennington, Vermont, invented a child study method in which she would assemble all kinds of materials and work that a particular child had produced as well as test scores, teacher's comments, and other inventories concerning that child. Then, all the teachers in the school would spend several hours trying to make sense of these materials and sharing their insights about this child and the meaning of the documents before them. The child study method, as it came to be known, could not be done in such depth for every child, but the lessons learned in their discussions taught teachers to be more skeptical about the paper identities of students. Teachers also learned to pursue a wider variety of evidence in an effort to get to know and to evaluate each child. At the Brearley School in New York City all the teachers who deal with a particular student meet twice a year to pool their insights about that student. Because every child must be reviewed, the pace is much quicker than at Prospect. Here are some notes made after sitting in on one such review:

The art teacher gave her a 92. She said, "Sandra is

Each student sits around the table with the tutors, who discuss the student as if he or she were not present.

very unusual. She does beautiful detail work and knows what she is doing. She's naive but has a lot of style. Her personality really disturbs me. She gets so negative if you give her a suggestion, and then afterward I find she doesn't want me to come near her work, which is limiting for her if I can't help her out. It limits her possibilities. Sometimes this almost borders on rudeness. She has a rare talent but somehow she just puts you off." Then others nod in agreement and the biology teacher said, "Yes, that's true. She's very defensive and really shy. She does respond well to humor, and if you can kid her about her work, she loosens up a bit."

As I have written elsewhere, I was impressed with how carefully the Brearley teachers prepared for these reviews, making written comments about every child. They knew an amazing amount of detail about each, in class and out. Teachers did not always agree in their remarks. In fact, they felt free to express their disagreement, to admit their preferences and biases. It was taken for granted that only when the teachers were honest in their reactions to a child would they be able to learn much from the discussion. They were interested in the emotional and mental development of the child and in a wide range of qualities and virtues, including honesty and courage. And their judgments applied to both the individual and the community: The student was expected to meet the standards of the community, but the community was also responsible for meeting the needs of the child. A troubled girl was described as an anguished complainer who was growing increasingly self-absorbed and isolated. A teacher responded: "Let's break this thing if we can. Why is she so miserable? We really need to talk to her. We need to get her to believe that she's a serious, capable, worthwhile person."

At St. John's College in Annapolis, Maryland, they give this process an unusual name and an unusual twist. It's called the don rag. The dons, or tutors as they are more properly called at St. John's, meet at the end of the year to discuss the students they have taught in common. Each student sits around the table with the tutors, who discuss the student as if he or she were not present. Some comments may be harsh, but more often are spirit-raising and nearly always bracing. After 15 or 20 minutes of such talk, the student is invited to join the conversation. The student is discouraged from making any point-by-point rebuttals but rather is expected to reflect with some seriousness about what has been said and what responsibility he or she should take for setting a new course or altering bad habits.

These schools are making issues of character public. They are aware that the community bears a responsibility for shaping the character of its members. Schools are not solely responsible for the character of their pupils, but they are foolish to deny that they have a hand in it. The best faculty are engaged in the inspection of souls, though they may shrink from such language except perhaps in art classes or in the locker room at halftime. When one is engaged in creating something, whether it be a beautiful pot or a winning team, one can't avoid addressing the virtues. One of the most moving inspection of souls that I ever witnessed was carried out by the students themselves at the Meeting School in Rindge, New Hampshire. At the beginning of senior year a student committee is appointed for each student in the graduating class. The responsibility of this committee is to write a statement, called The Minute, for its student. The Minute is intended to sum up the character of the pupil and is kept secret until read at the graduation ceremony when the subject stands silently to hear the verdict of his or her peers. The committee members must unanimously agree that these are the most truthful and important things to be said about this person, and they go to great effort to do a portrait with warts and all. Many of them have a haiku-like quality. Few of them are ever forgotten.

At the Meeting School as well as the other Quaker schools I have visited, such as the George School outside Philadelphia, assessments of this kind are grounded in observations about one's behavior on the playing field as well as in the classroom and, perhaps even more importantly, in data about how well you do your job. Because at these schools students have some responsibility for running and maintaining the school. At George the Student Association for Greater Empathy or SAGE, as it is more commonly known, is a peer counseling organization where students may go as a kind of sanctuary even if they have smoked dope or had a couple of drinks. But the conditions for staying are that they enter counseling and cease violating the prohibition against drug and alcohol use. The students also work to maintain the grounds and the buildings—as is common in Japanese schools and places like the Putney School in Putney, Vermont, where the students help to run the farm that puts food on their own tables.

THESE ARE real-world exhibitions of one's talents and skills. They are necessary to the functioning of the place and cannot be avoided. But the recent revival of academic exhibitions—a 19th-century term—is also a good thing. The Coalition of Essential Schools at Brown University has rightly been given a great deal of credit for stimulating this movement in elementary and secondary schools. However, an extraordinary group of nuns at Alverno College in Milwaukee, Wisconsin, was a decade ahead of Ted Sizer's Coalition. What is particularly noteworthy about the Alverno inventions is that they are not only public exhibitions of what one has learned or can do but that the students themselves play a part in the assessing. For example, the first week on campus stu-

dents are asked to give a three-minute talk of their own choosing in front of a video camera. While everyone hopes the student will give a good talk, that is not the primary objective. Rather it is for the student to sit and assess her video presentation against a 10-point checklist denoting whether she made eye contact, good transitions from point to point, varied her voice level and expression. One passes this assessment by showing one can be self-critical—that your ratings agree with another objective observer's. At later stages in communication assessments, students take roles as members of a state Democratic committee that is about to select someone to be named by the governor to replace a United States senator who has just died. Students take roles as union leaders, county chairpersons, representatives of civil rights groups, and the like. Students who have previously passed this exercise, along with representatives from the Milwaukee community, sit in an outer circle to observe and assess how effective the students are in making an argument, listening, and responding to others at the mock session.

Exhibitions are authentic because they are live performances before real audiences who are learning about us and making judgments about us. We are becoming known. At the College of Human Services in New York City, Audry Cohen added another dimension to such exhibitions. She required all students—in the early years, most of them were Hispanic and Black women on welfare who had dropped out of high school—to take internships in social agencies. The aim was not only to learn a job but to analyze the agency and plan an intervention that could bring about some improvement in its functioning or quality of service. Students had to move from the easy work of complaint and fault finding to the demanding task of figuring out how to make effective changes, even if on a small scale. The students learn much about themselves as they reflect on the skills needed to bring about actual change as well as in analyzing their failures. And, the faculty attend carefully to these developments because the college's reputation is at stake as well.

The possibility of failure also characterizes the Outward Bound experience. It is encouraging to see the Outward Bound philosophy spreading to a number of programs in urban school districts. We need more such radical experiences where students and faculty face challenges together and where knowing or not knowing something can make a big and immediate difference, as when the failure to accurately read a map can result in missing your supper. It takes faculty out of lecturing roles into coaching and observing and providing feedback when it is needed. Teachers must know the limits and capacities of their students so as to fit appropriate challenges to them.

THERE'S MUCH talk today of new roles for teachers—as mentors, school-site managers, and policymakers of various stripes. But one of the unanticipated outcomes of a course I taught at a school in upstate New York that I called Hamilton High was to put students in new roles. The course on urban anthropology required students to analyze life in their own tribe, so to speak. They were trained in anthropological and sociological methods and then encouraged to develop projects describing life in their own school. Many of them cooked up projects on such topics as What's a Good Teacher? or What Does the Principal Do? or What's the History of This or That in the School? It required them to do not only observations but interviews. We encouraged the students to arrange interviews with teachers and staff in quiet and comfortable settings outside school, if possible. Some of them traveled to teachers' homes or met them for a cup of coffee after school. We advised the students to begin their interviews by collecting biographical information about the interviewee. It put them in a different role relationship with their teachers, whom they discovered at home caring for children or repairing a porch swing. Likewise the faculty connected for an hour or so in a one-to-one relationship with the student that often helped them to get to know that student in a different way. Eliot Wigginton's Foxfire experiment had similar outcomes as students began to collect data from informants in their own rural Georgia community.

These are schools where you can't get lost.

Let us not close this album without reference to vigilance and care of a more traditional sort. Olive DeVinney was a matriarchal principal at Brighton Elementary School in Syracuse, N.Y., who stood behind a second-floor window with a metal-tipped pointer in her right hand. The whole schoolyard erupted in disbelief on the day when she rapped that window so hard the glass fell out. Usually just a light tap was enough to bring a boy to attention in the farthest corner of the school yard. I thought of her many years later when I talked to the principal of Cardozo High School in Washington, D.C. James Williams had taken over as principal in the mid-1980s when drug use was spreading and only a few parents showed up at PTA meetings. He made students known to the parents and the community by finding myriad ways to honor and hold up those students. At Williams' PTA meetings the student choir sang, the band played, and food was served. He gave out literally hundreds of awards to students for all kinds of accomplishments. Soon more than 500 parents were regularly coming to these meetings. But in the most literal sense he also made the bad actors visible. He set up a telescope on the roof of the school so that he could survey the grounds during all recesses and lunch periods. Those who dealt drugs or tried to shake a student down soon found they couldn't get away with it at Cardozo.

THESE SNAPSHOTS of life in schools where kids are known were not taken in any scientific survey. This album is a result of free association. But as I reflect on why these schools may have come to mind, five themes emerge:

1. *Size.* Most of these schools are small or have found ways to make the student feel part of a community in which he or she is known. There are only 300-odd students at Winchester High School and not many more at Central Park East. Brearley goes from K to 12 but has only about 500 students and the Prospect School many less than that. St. John's College decided to build a second campus in Santa Fe, New Mexico, when enrollment in Annapolis pushed toward 400, believing that mass education is a contradiction in terms. While these schools started out small, they also went another step as did Deborah Meier at Central Park East in creating more intimate settings with 15-member advisory groups. "You cannot teach well if you do not know your students well," she wrote. "That means size and scale are critical. Even prisons, or army units, are not as huge, impersonal, and anonymous as many schools for young children, not to mention the average American high school." These are schools where you can't get lost, where violations of norms are noticed, and hurts are felt throughout the community. Names are known and used and faces are remembered. Courtesies are observed and those who are absent are missed.

2. *New roles and relationships.* Not only teachers but students and principals are in new roles and relationships. In these schools children have a chance to be teachers and teachers to be learners. There is more one-on-one and less batch-processing. Students are interns who work in the community or are collecting water from local streams in order to present measures of pollution to the town meeting. Principals are engaged in course-planning sessions with students, and teachers have a strong voice in running the school.

3. *Challenge.* These are schools where students are pushed, engaged, challenged, and held accountable. And when you are challenged by higher expectations or tougher standards, you learn more about yourself and you reveal more of yourself to others. Teachers and peers get to know students who are challenged in survival exercises and pushed to perform before real audiences where failure or humiliation is possible. Students are engaged in projects of meaning of their own devising. They are often accountable for the very functioning of the school: getting the soup on the table or keeping things in good repair. In these schools you would not find students filling out surveys as they do in a majority of American schools saying they are bored, or where they are rarely asked to stretch their imaginations or their brain muscles. Too often the talents of American students are underutilized, and too seldom are they asked to express the altruism that is burning within them.

4. *Continuity.* A life that is always in flux and a world that is highly unpredictable is hell. We all need some stability and continuity in our lives, children especially. Children benefit from multi-age grouping and other arrangements that allow them to stay with the same teachers for two or three years. My own children attended elementary school for a time in a two-room school in Sullivan, New Hampshire. One teacher taught grades 1-3; the other four through six. Children did not leave the primary classroom until they were good readers. At the Brearley School, a science teacher taught biology to those in grade school as well as those in high school. He long ago invented his own version of *Benchmarks for Science Literacy* (a text recently published by the American Association for the Advancement of Science), providing a continuity in subject matter that is missing in most American schools. Teachers need stability, too, particularly leadership that stays long enough to see things through. I am struck by how many of the principals I've recalled in this essay have been rooted in one school. Evy Halpert, head of the Brearley School, Dennis Littky at Winchester, and Deborah Meier at Central Park East have all been at their posts for ten years or more. We should provide more rewards for stable effective leadership that strengthens the bonds of community.

5. *Holistic focus.* Schools where children are known have developed simple structures for focusing on the whole child: The don rag at St. John's, the child study methods at Prospect, and the simple step on the part of Dennis Littky of saying he wanted to be part of planning each child's high school schedule. These are not complicated designs. They focus on what is most important and engage the faculty in reflection on the face of each child. There is an intensity and reality about these discussions that can't be faked. Faculty come alive. They know in their hearts this is their most important work. They don't want to be anyplace else. And you don't come to such meetings unprepared to discuss the vagaries and foibles, the achievements and disappointments of each child. These are schools where you are ashamed not to know the child.

Finally, it should be noted that doing these things does not cost a great deal of money, yet brings the greatest rewards. Nor is it difficult to imitate these models if one keeps three things in mind: Keep it small. Keep it simple. Keep awake to the whole child. □

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Second Thoughts About Interdisciplinary Studies

By Kathleen J. Roth

DISCIPLINARY INTEGRATION—also called interdisciplinary or cross-disciplinary studies or thematic learning—seems to be on everyone's mind these days. Students in the College of Natural Science at my university now have an Integrative Studies requirement, and our prospective teachers take a course that integrates what traditionally were taught separately as social studies methods, science methods, and social foundations of education. The National Science Teachers Association promotes replacing the traditional discipline-focused, layer-cake science curriculum—biology, chemistry, physics—with three to four years of "integrated science." Project 2061's *Benchmarks for Science Literacy* calls for an interdisciplinary, integrated development of knowledge organized around themes that cut across various science disciplines, mathematics, social science, and technology. Drafts of the evolving national science standards emphasize integrated cross-disciplinary knowledge. Whole-language advocates encourage elementary teachers to immerse their students in reading and writing activities that are integrated with their subject-matter studies and their personal lives. Across subject areas and grade levels, integration is being touted as a new goal for education. And this is one reform vision that classroom teachers aren't ignoring; rather, they seem to be welcoming it with enthusiasm—especially at the elementary level.

As a teacher, researcher, and teacher educator, I worry about how readily the idea of integrated curriculum is being accepted and supported. I do not hear the hard questions being asked: What are the various meanings that educators attach to the idea of "integration"? Why is "integration" placed so prominently in national and state reform documents? Where is the evidence that integrated teaching promotes meaningful learning? What kinds of integrated teaching and learning are compelling, powerful, and meaningful for children? Does one discipline become subservient to another—or to the "theme"—and thus get misrepresented or diminished? What are we giving up? Is this reform recommendation based on careful thinking about what we know about children's learning and understanding? By raising these questions, I am not suggesting a rejection of the goal of integrated knowledge and learning, but I do urge that as a professional community we be more questioning and reflective about integration issues.

I recently attempted to raise some of these questions at a conference of science educators. The room fell silent, like a scene from an E.F. Hutton ad. It became clear I was asking uncomfortable questions. But I am convinced that these questions have to be asked—and explored carefully. Otherwise, we are jumping blindly onto the latest bandwagon, which may be headed in a direction that is contrary to our students' best interests.

I WOULD like to begin such a dialogue by describing an example of integrated teaching and learning I was involved in, and the problems and questions it raised for me.

In addition to teaching at the university, I also teach a fifth-grade science class every day in a local public school. During the year of the 500th anniversary of Columbus's "discovery" of America, I was working with a school-based group of teachers and researchers who became fascinated with the *Seeds of Change* exhibit at the Smithsonian Institution in Washington, D.C., and the supplementary *Seeds of Change* curriculum materials produced to address in classrooms the ideas raised in the exhibit. The group was also captivated by the notion of "integration" and decided to plan a year-long unit around a "1492" theme that would represent an integrated science and social studies approach. My particular team consisted of the regular fifth-grade teacher, a doctoral student with an interest in social studies education, and myself.

We entered this venture with some concerns about interdisciplinary theme units. We thought that there was something important missing from the typical theme-teaching approach to integration. Analyzing the content and organization of theme units that had been tried by teachers in our group, teachers in our school, and teachers in the literature we had read, we decided that one problem is that the content of theme units often does not focus on the powerful ideas or organizing concepts from the disciplines.

For example, while the American Association for the Advancement of Science is recommending interdisci-

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plinary themes such as systems, models, patterns of change, and interactions, we had taught or observed theme units focused around such things as a color (black), teddy bears, bubbles, and apples. These theme topics did not seem to be chosen in terms of powerful concepts that would help learners describe and explain their world in more connected ways. In these units, concepts seemed to get selected more for how well they fit with the theme, the availability of materials, the interests of the teacher, and whether they would lend themselves to fun activities for children, rather than how important and useful the ideas are within the discipline, how powerful the ideas might be for students, how well they might connect with children's knowledge and experience, and whether they are ideas that can be represented in meaningful ways to children (an appropriate pedagogy).

In the planning of interdisciplinary units, thoughtful teachers often and understandably become caught up in the themes—incredibly enthusiastic about them. The theme becomes the lens for seeing and connecting more and more of the world. It reminds me of when you start a collection of something and suddenly you begin to notice these things everywhere. The danger I worry about is that the teacher's enthusiasm for the new insights and connections she is experiencing in her own learning overshadows consideration of what is most important for our students to understand. I remember, for example, hearing about the class with the teddy bear theme. It was a lower elementary grade. The children read stories about teddy bears, everything they did in writing class was written on paper cut in the shape of a teddy bear, they wrote their own teddy bear stories, brought in teddy bears from home, did math problems with "Gummy Bear" candy, explored different kinds of "real" bears in science, and on and on. Thoughtful decisions about curriculum content and goals were superseded by one central command: how well something fit with the theme.

As we planned our 1492 unit with such concerns in mind, we also wondered about what we came to label as "forced" versus "natural" connections. In terms of students' learning, how important and helpful was it that they did math problems about apples while reading legends about Johnny Appleseed, making applesauce, and drawing apple trees and labeling their parts? Wasn't a

more powerful and natural connection between math and apples the use of math in making the applesauce? Wasn't a more powerful connection between art and science and apples the use of observational skills to study the changes in apple trees across seasons? And to wonder about the changes going on inside the apple trees using artistic and scientific imaginations?

THUS, WE began with reservations about interdisciplinary teaching and learning. Although we had read many reports of integrated teaching, these reports generally focused on the teachers' planned curriculum and did not explore the ways in which students did or did not integrate knowledge as they participated in such a curriculum. Studies of student transfer of knowledge across disciplinary boundaries makes many researchers skeptical that students will make many of the intended connections. Thus, we faced the challenge of interdisciplinary teaching with open eyes and many questions.

We were cautious about selecting a theme, central concepts, and guiding questions that would be rich and challenging for our students and that would represent natural and significant connections between history and science. In our curriculum, the 1492 theme was organized around guiding questions that were displayed prominently on classroom bulletin boards and that were intended to overarch the entire year's work: How has the land changed since 1492? How might it change in the next 500 years? How have the people changed since 1492? How might they change in the next 500 years? The social studies concepts we intended to target in this interdisciplinary study included diversity, adaptation, perspective, interdependency, social conflict, and change. The science concepts included diversity of species, ecosystems and interdependence, adaptations, evidence, and change. We realized that our list of concepts was ambitious, but we saw this theme as one that would continue across the school year.

To begin our study of life in the Americas 500 years ago, we studied the diversity of Native-American cultures at the time of the encounter of the "New" and the "Old" worlds. In the context of small-group research, students explored selected cultures in depth. Each small group became "experts" about either the Sioux, the Pacific Northwest Indians, the Pueblo, or the Aztecs. Whole-group lessons helped students consider Native Americans across time, including how they live today. We wanted to dispel misconceptions that Indians only lived in the past as well as many other stereotypes about Native Americans. Diversity of Native-American cultures was emphasized as were their ways of adapting their way of life both to the physical environment and to the changing social environment.

The students' study of Native-American cultures was linked to their study of diversity of species and adaptations in science. As the groups researched the Native-American cultures assigned to them, they also examined the ecosystems in which their Native Americans live(d)—the diversity and interdependence of species in the desert (Pueblo), the plains (Sioux), the ocean (Pacific Northwest), and the rainforest (Aztecs). The plan was to consider how the land has changed since the Encounter, identifying species that are now extinct or endangered and considering the effects of human activity on the desert, ocean, plains, and rainforest ecosystems.

We intended to explore the nature of science by discussing the differences and similarities between Native-American beliefs about nature and the beliefs of scientists today. The exploration of species in the different ecosystems was organized around central questions, designed to make the book-focused research address a genuine inquiry problem: Are there more different species in the desert, the rainforest, the plains, or the ocean? Does it matter if there are a lot of different species in an ecosystem? Why should we in Michigan care if species in these distant ecosystems are endangered?

We planned for the science explorations to continue along the 1492 theme in a subsequent unit about plants and food. Focusing on another central question—"How do plants get their food?"—we hoped to help students apply their science concepts to the social world, examining what happened when plants from the New and Old Worlds were exchanged. We had grand visions of exploring the close links between sugar and slavery. We wanted to trace potatoes from the Incas in the Andes to Europe to the Irish potato famine to Irish immigration to the United States. Thus, students could explore U.S. history in the context of plants and study plants in the context of history and social conflicts and problems. The connections fascinated us as adults.

BUT MANY of our intentions were never enacted. By late November, three months into the school year, we felt that the theme was not helping students connect with these important concepts—especially the science concepts—as powerfully as we had hoped. As a science teacher, I was frustrated with the constraints placed on the science by the needs of the social studies concepts. Yes, diversity and interdependence are powerful concepts both in science and in social studies. And it made sense to begin by defining and exploring the diversity of Native-American cultures and environments. From a scientific perspective, however, this was a difficult starting place for the fifth graders. Without understanding ideas about plants as producers, food chains, cycling of matter and flow of energy in ecosystems, it was difficult for the students to do more than collect facts about plants, animals, and their habitats (and they paid attention mostly to the animals). Students were not developing meaningful ideas about diversity and interdependence in a biological sense.

In addition, the social studies links seemed to constrain activity choices. Despite careful, collaborative planning, I was unable to create activities that fit the theme and connected with the social studies activities while simultaneously engaging students in active, meaningful scientific inquiry. With books as a primary source, it was difficult to challenge students to think scientifically, to raise questions, and to gather evidence. I longed to engage students in activities that would stimulate more active predicting, conjecturing, observing, describing, and explaining.

We called this unit integrated science/social studies, but it really felt like social studies. If you asked me what science my students had learned at the end of this three-month period, I would have to say it was limited to a basic descriptive level. Students could describe plants and ani-

mals that lived in the particular area their group worked on, but they could not go beyond these descriptions to explain interactions among species and the importance of diversity in ecosystems. They could not explain human impact on these ecosystems over the last 500 years except in quite superficial ways. The students did not develop meaningful understanding of ecosystems and interactions in ecosystems, nor did they wrestle with and construct ideas about why it would matter that there are many different kinds of species in an environment. Because the theme had pulled us immediately into ecosystem diversity, I had not been able to start this unit with basic biological concepts that would have helped students understand the importance of species diversity. Thus, the students reduced the task to one of naming and cataloging. I can't list any powerful science concepts that the students really learned. So what that we know the names of all these different plants and animals? I also question how much they understood about the ways in which scientists raise questions and figure things out.

The 1492 theme made the curriculum flow in a certain direction—a direction that left me unable to engage the students in a serious science problem. I kept comparing what these students were getting compared with the students I had taught the year before. And I worried about what had been given up. That's what really bothered me. The previous September I had begun with an introductory unit that engaged the children in simultaneously thinking about the nature of science and the concept of adaptation. We had a central inquiry problem for the unit, similar to the one we formulated for the 1492 unit: Are there more different kinds of species in Michigan or in the desert? But without the constraints of the 1492 theme, I was able to approach this question on its own terms. The children began by making predictions and giving reasons for why they thought one area would have more diversity than another. We worked on concepts of adaptation—how animals and plants adapted to different environments—and the notion of structures and functions. We used that terminology, introduced students to these serious sci-

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ence concepts. Another concept we explored was organisms: What makes something an organism? And what makes something a plant instead of an animal? I wanted to introduce these notions of adaptation, structure, function, and interactions so that the students could use and build on these concepts in other units throughout the year. In the context of exploring these ideas, I wanted the students to investigate and experience the nature of scientific inquiry, of what it means to have a scientific way of thinking, of gathering evidence, of building argumentation. We developed a list of the methods scientists use, of the different ways they go about learning and studying, and the kinds of questions that intrigue them.

This unit provided a good basis for the next topic—photosynthesis. The children had learned that plants have structures which enable them to get water, and they had seen some unique ways in which desert plants are adapted to conserve water. This led naturally to a discussion of why plants need water, what plants do with water, is water their food? In this way, we worked ourselves into a new inquiry problem: How do plants get their food? We built on the concepts of organisms, structure, and function, but in the photosynthesis unit I tried to help the students think more about structures and functions you can't see, things happening *inside* the plants. Again, the class composed a list of hypotheses about how plants get their food, and then we systematically began to do experimental work accompanied by some readings of short pieces of text, trying to look at our hypotheses and gain evidence either to support or refute different ones. The students were constantly challenged and encouraged to create their own ideas for experiments, which then led us to examine how one sets up a good, fair test, and so forth. There was constant reflection on the process of science and how we were doing as scientists.

The contrast between that level of work, that depth of science learning, and the merely descriptive information my students in the 1492 unit were gathering was, to me, a dramatic one. In the 1492 unit, my students were not being challenged and supported to think in scientific ways, and I felt like I was denying them access to new ways of seeing and making sense of their world. I wanted them to become flexible thinkers who could see their world through different lenses and ways of knowing—including scientific ones. So when it came time to move into the unit about plants and food, we abandoned the 1492/*Seeds of Change* theme. I wanted to teach my students about the *biology* of plants. I wanted the time and focus to do that. I wanted to help students construct increasingly sophisticated and interconnected explanations and conceptional understandings about plants. I wanted them to understand, use, and reflect on scientific ways of thinking. And I wanted to increase the power of those concepts and ways of knowing by basing their selection solely on considerations concerning the discipline and considerations concerning the children. I didn't want any of this to be compromised or diluted by the need to fit with a theme.

WAS MY dissatisfaction with the science part of the 1492 unit just the result of faulty design, the kinks of a first try? That was undoubtedly part of the problem; I'm sure what we did could be improved upon. But I have also come to believe that, at least from the perspective of my discipline—science, it is very difficult to work within an integrated theme without in some way distorting or diminishing one or another of the disciplines involved. Is that all right once in a while? Yes, but not as an organizing focus for significant portions of the curriculum.

There are many who believe that the only way to see the world holistically is to erase disciplinary boundaries, and to do so from the earliest years of schooling. I would urge caution. An alternative view is that we best develop our students' understanding of the world and its connectedness by giving them access to a variety of powerful lenses through which to view it, and that the best way to craft those lenses is to immerse our students deeply (though perhaps not solely) in disciplinary study. Before we jump on the interdisciplinary bandwagon, let us engage in debate and study of the *kinds* of integration that are compelling, meaningful, and powerful for children. □

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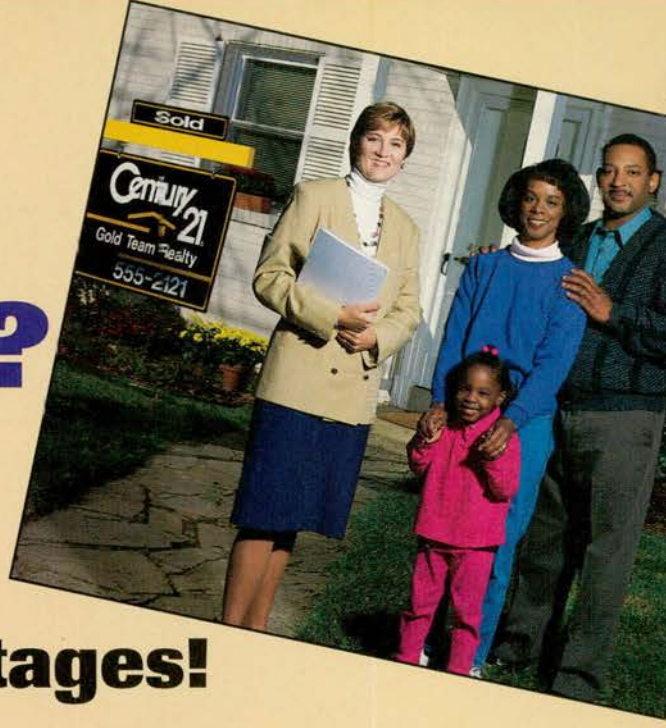

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