Health Science & Biomedical Program of Study

Career Explorations

INTEGRATED CURRICULUM UNIT ON HEALTH SCIENCE CAREERS

ConnectEd
The California Center for College and Career
Transforming today's education for tomorrow's economy

National Consortium on Health Science & Technology Education

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California
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Idaho
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Illinois
Westinghouse Career Academy (Chicago)
Dunbar Career Academy (Chicago)
New Millennium School of Health (Chicago)

Indiana
Owen Valley High School (Spencer)

Minnesota
John Marshall High School (Rochester)

New York
Gorton High School Academy of Medical Professions (Yonkers)

South Carolina
Beaufort High School (Beaufort)

Texas
Ben Barber Career and Technology Academy (Mansfield)

Utah
Northridge High School (Layton)

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Career Explorations

CONTENTS

National Healthcare Foundation Standards that apply to this unit include:

- Academic Foundations
- Communications
- Health Maintenance Practices
- Information Technology Applications
- Teamwork

Career Explorations

UNIT OVERVIEW

Essential Question for This Unit

What is the place for me in the health and biomedical sciences?

Unit Summary

In this unit, students will investigate the varied career opportunities available within the health and biomedical sciences. They will conduct research on possible career paths and investigate the skills needed for each one. This unit will also give students an opportunity to learn about typical activities in various jobs and help them identify potential careers that match their interests, strengths, and goals. In addition, students will explore the broader social and economic impact of their career choices, while reviewing the historical origins of various health-related careers and their significance to the welfare of humankind.

In Subunit 1, students will be introduced to the field of health and biomedical sciences through a survey of the many, often hidden, careers that exist within this industry sector. They will investigate the field's future prospects by analyzing society's growing demand for biomedical research and healthcare services. In one lesson, students will construct pyramid graphs to illustrate current and past population data for the United States. They will also calculate a population growth model and make projections to the year 2050. Next, students will compare projected demand for health and biomedical science workers with current supply. Subunit 1 will conclude with an introduction to the research process that continues throughout the unit.

In Subunit 2, students will identify and investigate several careers that interest them. They will begin by conducting a self-analysis of their interests, skills, strengths, and weaknesses. Using a variety of career resources, students will then identify individual careers and/or career sectors that match their interests and compile detailed information about these careers. In this subunit, students will also learn about many influential biomedical researchers and healthcare visionaries and the impact of their discoveries and contributions to science and society.

In Subunit 3, after concluding their research, students will analyze the benefits and drawbacks of their career choices. This comparison will include an analysis of projected earnings compared with financial and time outlays for education and training. Students will report on their work in a formal research paper and present their findings to their peers in an oral presentation.

Culminating Event

Several culminating events are appropriate for this unit. For example, students could hold a job fair for the school to share what they have learned about conducting education and career planning and about health and biomedical sciences career opportunities. Another possibility would be to have students summarize their research in one-page, career-specific informational pamphlets and compile a class resource binder for future students to use. Students could also be encouraged to make a personal connection with a professional in the career of their choice, do a "job shadow" or interview, and write-up results of their experience. Alternatively, the unit's research paper on a historical medical figure could lead to a series of presentations that would serve as the culminating event.

Key Questions/Issues

- Exactly what is health and biomedical science? What kinds of careers are there, and which ones might be interesting to me? (Health Science)
- What does the future look like in this industry sector? What will the employment picture look like when I graduate (from high school and from various types of postsecondary programs) and want to enter the workforce? (Algebra I)
- How is our country's population growing and changing? What will our population be like 10, 20, and 50 years from now? How will our country meet the challenges of a growing senior population? (Health Science and Algebra I)
- How can I learn to make thoughtful decisions about my future education and career goals? What social or economic issues might affect my choice? How can I obtain information on careers that interest me? (English Language Arts)

- What are my interests and abilities? What are my strengths and weaknesses? What careers are best suited for me? (Health Science)
- How do the various careers that interest me compare? Which careers have the best salary and job prospects? How do the educational and/or training requirements of the various careers compare? (Algebra I)
- What are the key qualities of major historical figures in biomedical research and healthcare? What events influenced them? How does their vision continue to affect us today? (World History)

Learning Scenario to Kick Off the Unit

Starting high school often signals students to start thinking about their first real job. Some of your friends want to work so they can help their family; some are looking forward to getting some cash to spend. No matter the reason, this is finally the chance to make your own money.

The burger joint down the street is a popular place to get a job. It has flexible hours, which allows students to work after school. But this restaurant pays only minimum wage. That seemed like a lot of money when you started, but some of your older co-workers complain that working full-time at minimum wage really doesn't pay the bills. Maybe it's time for you to start thinking about what kind of long-term career you'd like to have and what kind of education it will take for you to reach that goal. There are probably a lot of options you don't know about. How will you find out what is right for you?

Biomedical/Healthcare and Education Partner Roles

- The school librarian or media specialist can assist the Health Sciences and English instructors with teaching research skills, particularly in the use of print and other media resources.
- Career counselors from the school or local postsecondary institutions can visit to discuss career opportunities in health and biomedical sciences and their education requirements.
- Employees from various local biomedical research facilities or healthcare providers can be invited to speak to students in greater detail about their careers, either individually or as a panel.
- An additional speaker that can be invited to participate in the units and/or culminating event could include a Human Resource person from a healthcare system to discuss employee benefits like tuition assistance and the career ladder within healthcare systems and healthcare specialties.
- Contact the American Lung Association (www.lungusa.org) and the American Society of Respiratory Care (www.aarc.org) for resources and materials.

SUBUNITS AND MAJOR TOPICS (ACROSS ACADEMIC AND TECHNICAL SUBJECT AREAS)

Subunit 1 *A Growth Industry*	**Subunit 2** *Taking a Closer Look*	**Subunit 3** *Finding a Good Match*
HEALTH SCIENCE · ALGEBRA I · ENGLISH LANGUAGE ARTS	HEALTH SCIENCE · ENGLISH LANGUAGE ARTS · WORLD HISTORY	ALGEBRA I · ENGLISH LANGUAGE ARTS
• Survey of career pathways and opportunities within health and biomedical sciences • Percentages and percent change calculations • Single variable equations • Construction and interpretation of population graphs • Needs analysis • Purpose and format of research papers	• Developing clear research questions • Conduct research on several health and biomedical science careers using a variety of media resources • Synthesis of information from multiple media sources Integrate quotes and citations into written text • Social, economic, and cultural impact of major developments in biomedical research and healthcare • Contextual history and contributions of significant figures in the field	• Reading, interpreting, and graphing data • Single variable equations • Cost-reward analysis of various careers based on salary and training • Write research reports, including a coherent thesis, accurate background information from multiple sources, and development of an argument using evidence in support of a thesis or related claims • Delivery of formal oral presentation, including descriptive, expository, and persuasive rhetorical techniques

A Growth Industry

SUBUNIT 1 OVERVIEW

Essential Question for This Unit

What is the place for me in the health and biomedical sciences?

Subunit Goals

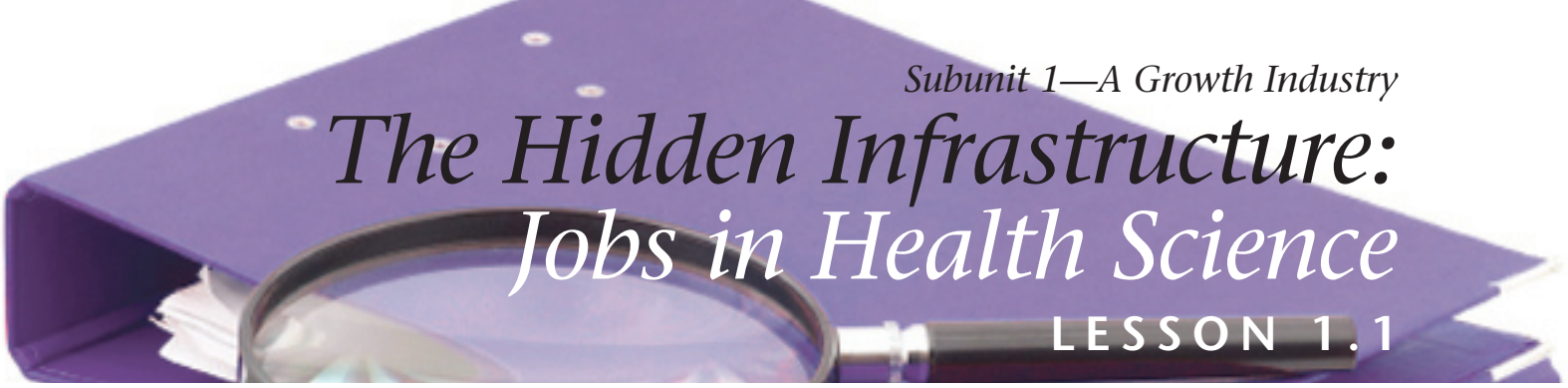
By the end of Subunit 1, students should be aware of the scope of career opportunities within the health and biomedical sciences, specifically identifying the five pathways within the field. They should be able to calculate percentages by age and gender groups using raw population data, as well as calculate percent changes within populations over time. From those calculations, students should be able to construct and interpret population distribution graphs by correlating the shape of the graphs with growth patterns in the populations. Based on the growth pattern of the U.S. population, students should be able to evaluate the need for workers in the health and biomedical sciences by calculating the expected demand and translating it into the number of future positions. Finally, students should be able to define the purpose of research papers; identify the characteristics that distinguish research papers from other forms of writing; and describe and evaluate structural sections within a research paper.

Subunit Key Questions

- What is the scope of the health and biomedical science field? What kinds of careers are there, and which ones might be interesting to me? (Health Science)
- What does the future look like in this industry sector? Will there be jobs when I graduate (from high school and from various types of postsecondary programs) and want to enter the workforce? (Algebra I)
- How much education will I need to complete to pursue various careers in the health and biomedical sciences? What can I expect to earn in various careers in this industry sector? (English Language Arts)
- How is our country's population growing and changing? What will our population be like 10, 20, and 50 years from now? What do these changes mean for the future of jobs in the health and biomedical sciences? (Health Science and Algebra I)
- How can I figure out what would be a good career for me? (English Language Arts)

Lesson Summaries

Lesson	Subject	Description
1.1	Health Science	***The Hidden Infrastructure: Jobs in Health Science*** Students survey and classify the various careers that fall within the health and biomedical sciences.
1.2	Algebra I	***Demand: Our Growing and Aging Population*** Students construct and interpret population graphs and pyramids in order to understand the growing and persistent need for biomedical research and healthcare services.
1.3	Algebra I	***Supply: The Problem in the Pipeline*** Students analyze employment demand, studying the current and projected future workforce in health and biomedical science occupations.
1.4	English Language Arts	***Writing a Research Paper: Overview*** Students learn the basic form of a research paper and are introduced to the unit's culminating event and related project activities.



The Hidden Infrastructure: Jobs in Health Science

LESSON 1.1

HEALTH SCIENCE

Time
90 minutes

Materials
Equipment
- Blank paper
- Post-it notes

Resources
- Health and Biomedical Science Careers worksheet
- Health and Biomedical Science Careers Classification (answer key)

Prior Student Learning
Students should have a general understanding of the definitions of healthcare and biomedical sciences.

Essential Question for This Unit
What is the place for me in the health and biomedical sciences?

Objectives
After completing this lesson, students should be able to

- Identify the five career pathways within the health and biomedical science industry sector.
- Explain the common purpose and attributes of careers within each of the five pathways.
- Describe a range of careers within each of the five pathways.
- Select several jobs for further exploration.

Lesson Activities
Unit Introduction
Introduce the unit to students by giving a brief overview of its scope and sequence. Include the essential question, how the unit objectives and subunits relate to the essential question, and describe how academic teachers will be participating with related lessons.

Lesson Springboard
Ask students what kind of careers they think of when someone talks about healthcare or biomedical science. Have two or three students share what they know about a *single* career example. Ask students to individually brainstorm all the careers that they can think of within the health and biomedical sciences and write them on a sheet of paper.

Classroom Management
Circulate among the class and check that students are not clustering careers by salary, status, or other criteria.

Have students gather together in groups of two to four and combine their lists. Give each group a pad of Post-it notes and have them record one career per Post-it. Ask students to organize the individual careers into a few clusters with common job functions or attributes. Have students place all the clustered Post-its together on a single sheet of blank paper and label the cluster. Go around the class and have each group share and define their career clusters and discuss the thinking they used to create the clusters.

Lesson Development
Class Discussion
Write all the groups' clusters on the board. Combine and/or collapse similar clusters (reassigning some careers, if necessary) into one or more of the five pathways (diagnostics, informatics, research and development, support services, and therapeutics) as appropriate. Students typically list careers that fall into the therapeutics pathway, but other career pathways are likely to be represented as well.

Direct Instruction and Discussion
Introduce and identify the defining characteristics of the pathways already discovered by the students. Ask students to give examples of careers within the various pathways from their clusters and list them on the board.

Provide additional examples of careers to ensure that a range of positions—from entry level to management—is included for each pathway. This discussion may continue in the next class session.

Finish discussing the student-identified pathways and then introduce and define the remaining pathways as needed. Introduce the key defining characteristics of each pathway. List and describe a range of careers within those pathways as well. During instruction, ask students to share any experiences they've had with health- and biomedical science-related careers—e.g., family or friends who are in this industry, interesting experiences they've had as patients, and so on.

Using the list of careers now generated on the board, explain that while the overarching function of the health and biomedical sciences is to address patient care and wellness, the industry encompasses many other types of careers as well. All of these careers are necessary to maintain a well-functioning healthcare industry. Explain that some of these essential careers are frequently hidden from healthcare consumers because they relate to relatively small numbers of patients or do not involve direct patient care at all.

Support Strategy
Allow students to work in pairs when classifying careers.

After all the pathways have been introduced, pass out the Health and Biomedical Science Careers worksheet. Have students classify the listed careers into the appropriate pathways.

Lesson Closure
Ask students to review what they've learned by recording and summarizing the defining characteristics of each career pathway. Looking at the lists of careers generated on the board, have students select either one or two pathways or three to five careers they think might be of interest for further exploration.

Possible Prior Misconceptions
Students may believe that all health and biomedical science careers involve direct patient care.

Student Assessment Artifacts
Completed Health and Biomedical Science Careers worksheet
Class notes on the five pathways
Career pathway selections

Variations and Extensions
To introduce the unit, you may wish to assemble a panel of speakers from the various pathways to give brief overviews of their professions

and describe how they became interested in and prepared for work in the field. Alternatively, you can ask speakers to come in individually and give longer presentations at various points throughout the unit.

Have students visit a healthcare industry website and discover as many health and biomedical science jobs as they can on their own. Have students classify any additional jobs into the five pathways.

Have students discuss their perceptions of the advantages and disadvantages of careers in each career pathway. Have students discuss the personal characteristics they think align well with careers in each pathway.

National and State Career Technical Education Standards

NATIONAL
NCHSTE National Healthcare Skill Standards

3.0 Systems
Healthcare workers will understand how their role fits into their department, their organization, and the overall healthcare environment.

CALIFORNIA
Health Science and Medical Technology Standards

3.0 Career Planning and Management

3.1 Understand the scope of career opportunities and know the requirements for education, training, and licensure.

Name ______________________________ Date__________ Period ________

Health and Biomedical Science Careers

Biotechnology Research and Development	Therapeutic Services	Diagnostic Services	Health Informatics	Support Services
Careers involved with bioscience research and development that applies to human health	*Careers involved in changing the health status of the patient and other clients over time*	*Careers involved in creating a picture of the health status of patients and other clients at a single point in time*	*Careers that involve documentation of client care*	*Careers involving direct or indirect patient and other client care that create a therapeutic environment*

Health and Biomedical Science Careers Classification (answer key)

Biotechnology Research and Development	Therapeutic Services	Diagnostic Services	Health Informatics	Support Services
Careers involved with bioscience research and development that applies to human health	*Careers involved in changing the health status of the patient and other clients over time*	*Careers involved in creating a picture of the health status of patients and other clients at a single point in time*	*Careers that involve documentation of patient and client care*	*Careers involving direct or indirect patient and other client care that create a therapeutic environment*
Biochemist	Acupuncturist	Cardiovascular Technologist	Admitting Clerk	Biomedical/Clinical Engineer
Bioinformatics Associate	Anesthesiologist Assistant	Clinical Lab Technician	Applied Researcher	Biomedical/Clinical Technician
Bioinformatics Scientist	Art/Music/Dance Therapist	Computer Tomography (CT) Technologist	Community Services Specialist	Central Services
Biomedical Chemist	Athletic Trainer	Cytogenetic Technologist	Data Analyst	Environmental Health and Safety
Biostatistician	Audiologist	Cytotechnologist	Epidemiologist	Environmental Services
Cell Biologist	Certified Nursing Assistant	Diagnostic Medical Sonographer	Ethicist	Facilities Manager
Clinical Data Management Associate/Consultant	Chiropractor	Electrocardiographic (ECG) Technician	Health Educator	Food Service
Clinical Data Management Specialist	Dental Assistant	Electronic Diagnostic (EEG) Technologist	Health Information Coder	Hospital Maintenance Engineer
Clinical Pharmacologist	Dental Hygienist	Exercise Physiologist	Health Information Services	Industrial Hygienist
Clinical Trials Monitor	Dental Lab Technician	Geneticist	Healthcare Administrator	Materials Management
Clinical Trials Research Associate	Dentist	Histotechnician	Medical Assistant	Transport Technician
Clinical Trials Research Coordinator	Dietician	Histotechnologist	Medical Biller	
Geneticist	Emergency Medical Technician (EMT)	Magnetic Resonance (MR) Technologist	Patient Financial Services	
Lab Assistant—Genetics	Exercise Physiologist	Mammographer	Medical Information Technologist	
Lab Technician	Home Health Aide	Medical Technologist/Clinical Laboratory Scientist	Medical Librarian	
Manufacturing Technician	Kinesiotherapist	Nuclear Medicine Technologist	Patient Advocate	
Medical Editor/Writer	Licensed Practical Nurse	Nutritionist	Public Health Educator	
Microbiologist	Massage Therapist	Pathologist	Reimbursement Specialist (HFMA)	
Molecular Biologist	Mortician	Pathology Assistant	Risk Management	
Packaging Technician	Occupational Therapist	Phlebotomist	Social Worker	
Patent Lawyer	Ophthalmic Medical Personnel	Positron Emission Tomography (PET) Technologist	Transcriptionist	
Pharmaceutical/Clinical Project Manager	Optometrist	Radiologic Technologist/Radiographer	Unit Coordinator	
Pharmaceutical Sales Representative	Orthotist/Prosthetist	Radiologist	Utilization Manager	
Pharmaceutical Scientist	Paramedic			
Pharmacokineticist	Pharmacist			
Pharmacologist	Pharmacy Technician			
Product Safety Associate/Scientist	Physical Therapist			
Processing Technician	Physician (MD/DO)			
Quality Assurance Technician	Physician's Assistant			
Quality Control Technician	Psychologist			
Regulatory Affairs Specialist	Recreation Therapist			
Research Assistant	Registered Nurse			
Research Associate	Social Worker			
Research Scientist	Speech Language Pathologist			
Toxicologist	Surgical Technician			
	Veterinarian			
	Veterinarian Technician			

Demand: Our Growing and Aging Population

LESSON 1.2

ALGEBRA I

Time
90 minutes

Materials
Equipment
- Graph paper
- Rulers
- Colored pencils (optional)
- Overhead projector

Resources
- World Population Pyramid transparency
- U.S. Census data summary tables: 1950–2005 and projections for 2010–2050

Prior Student Learning
Students should have a general understanding of graphing: axes, labels, keys, etc.

Students should have a general understanding of percentages.

Essential Question for This Unit
What is the place for me in the health and biomedical sciences?

Objectives
After completing this lesson, students should be able to

- Construct and interpret bar and line graphs from data sets.
- Calculate percentages and percentage changes from raw data.
- Derive linear equations from sets of points.
- Graph linear equations.

Lesson Activities
Lesson Springboard
Introduce the lesson by reminding students of Lesson 1.1, where they identified the large number of occupations that are part of the health and biomedical science field and classified them into five pathways. Now that students have identified the long lists of jobs that involve people in health and biomedical sciences, they will learn about the numbers of people needed to fill these jobs, trends in demand for these individuals, and the reasons behind these trends. Tell them that in today's lesson they will be learning about the need (demand) and the growth prospects for this industry sector.

Lesson Development
Class Discussion and Direct Instruction
Connect this lesson to the essential question by asking students whether biomedical and health science is a growing industry. Tell them that in today's lesson they will be learning about the need (demand) and the prospects for employment growth in this industry sector. Ask students to consider the factors that determine the demand for workers in this field. For example, what segments of the country's population use the services of the health and biomedical science fields the most? Students should understand that the elderly will require more health services than younger populations, and if the elderly population rises, so will the need for healthcare and biomedical science workers. They should also learn that many of the diseases and conditions that drive biomedical research and technology development disproportionately affect older individuals. As a result, an aging population also influences biomedical research and development (R&D) and the need for appropriately trained scientific researchers.

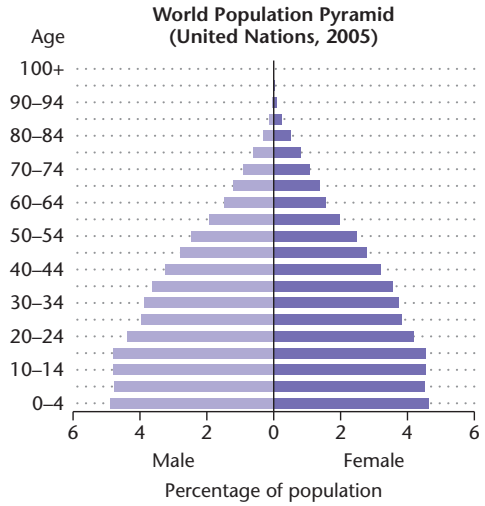
Demand: Our Growing and Aging Population

LESSON 1.2

Display the World Population Pyramid overhead, and explain to students that this is one type of graph used by population scientists (demographers) to study populations.

Classroom Management
This graph can be used either as a handout or as a transparency. Be sure the graph is large enough that students can identify percentage differences across cohorts.

Every leader dot along the x-axis represents 0.25 percent.



Ask students what kind of information the graph provides about the world population:

- Why do you think this type of graph is called a population pyramid?
- What percentage of the world population is high school age? About what percentage of the world population is 19 or under?
- Are there more people over 19 years old or 19 and under in the world?
- Based on the graph, what is the median age in the world, approximately?

Explain to students that each age-level grouping is called a *cohort*. In this (and most standard population pyramids), each cohort spans 5 years. Students should come to see that the graph sorts world population by cohorts along the *y*-axis, and provides percentages for each cohort by gender on the *x*-axis. The graph does not provide data on the total world population, only the relative percentages.

Classroom Management
If your class is large, multiple students can be given data from the same census year, but have each student do the work independently.

Individual or Small Group Work

Tell the class that they will be constructing population pyramid graphs for the United States for 1950 to the present. Remind students that graphs are a powerful way to visualize data, allowing demographers to see patterns that would otherwise be easy to miss in large sets of numbers.

Assign each student a census year. Distribute graph paper and the appropriate raw data from the U.S. Census Data Summary tables to each stu-

Demand: Our Growing and Aging Population

LESSON 1.2

Support Strategy
Allow students to work in pairs or groups for calculations and graphs.

dent. Introduce or review percentages as a ratio that compares a number to 100 and that they are calculated using the algebraic model:

$$a = \frac{p}{100} \cdot b$$

Provide graph paper with the axes and legend already labeled.

Have students make the calculations for each age cohort and graph their new data. Remind students that, unlike many other graphs they may have made in the past, pyramid graphs have a central *y*-axis. You may also wish to review basic graph construction—e.g., labeling axes, determining appropriate intervals. For U.S. population graphs, students will not need to go beyond 10% in either direction. Calculations and graphing may take some time. You may have students finish their calculations and graphs for **homework**.

Classroom Management
Try to ensure that students are making graphs that are the same size, as they will be comparing them in the next part of the lesson.

Review and Extend

Spot-check student graphs for correctness and then have students post their graphs on the board in chronological order. Have students make observations about the change in population distribution. Students should come to see the bulge in the population caused by the baby boom, and its subsequent effect on the population distribution.

Classroom Management
If pressed for time, you may wish to provide students with the census data already formatted in an *x*-*y* chart.

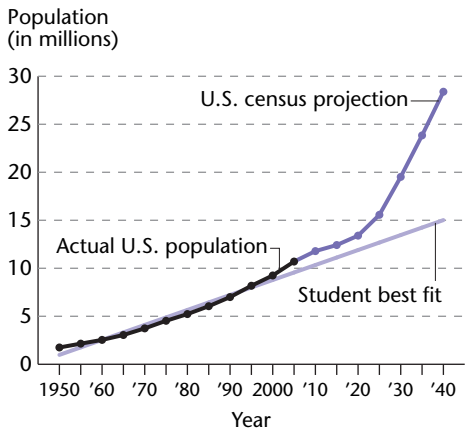
Using the data from each census year, have the class compile an *x*-*y* data chart of total population at 5-year intervals from 1950 to 2005 on graph paper. Have students graph each of the data points and then fit a line to the data. Using the graph (and/or the data chart), have students derive the linear equation that represents the population growth using the point-slope intercept formula.

$$y = mx + b \qquad m = \frac{y_2 - y_1}{x_2 - x_1}$$

Support Strategy
Provide worksheets that have appropriate equations set up. Ask students to fill in the variable they know and then to solve the equations.

Using the linear equation, have students extrapolate an estimated population for each cohort at years 2025 and 2050. Based on their equation, ask students what their estimate is for the growth rate of the U.S. population. Provide students with the U.S. Census Bureau estimate. Have students compare the two values. Provide students with U.S. Census estimates for the next 50 years at 5-year intervals and have them add these data to their graphs. The graphs will look something like this:

U.S. Population Over 80, With Projection



Demand: Our Growing and Aging Population

LESSON 1.2

Classroom Management
If pressed for time, have students make calculations for only two cohorts, one younger and one older.

Ask students to compare their predicted population to the U.S. Census Bureau's prediction.

- Was their prediction accurate?
- Does the addition of 2010–2050 data noticeably change the shape of the graph?
- What does the graph indicate about the rate of population growth in the United States?

Have students do the same for cohorts 0–4, 15–19, 30–34, and 80+. Ask students to compare the growth rate of each cohort to the other cohorts and to the population as whole.

Lesson Closure
Wrap-up the lesson by refocusing on the essential question. Ask students to identify which age cohort is growing fastest in the United States. Have students discuss what this lesson suggests about future job prospects in general. What is the impact of an aging population on all employers seeking workers? What industry sectors will experience the largest increase in employment demand as a result of an aging population? Have students speculate about which jobs have good future prospects and which jobs may experience a downturn. Have students write a few sentences about the information this lesson has provided to them regarding the future of the health and biomedical science industry sector, and about the information they still need to address the essential question. After recording students' thoughts and collecting their written materials, tell students that they will be gathering additional information in another Algebra lesson and in their Health Science course.

Possible Prior Misconceptions

When multiplying decimals by powers of 10, students will sometimes add zero to the end of a number, rather than move the decimal point.

The *y*-intercept for the students' best-fit line is likely to be a negative number. Some students have difficulty with the point-slope formula when *b* is a negative number.

Also, since the y-axis represents population, some students may become confused and think there can be a "negative" population. Remind students this is only an artifact of fitting a line to points that are not entirely linear.

Student Assessment Artifacts

U.S. Population Pyramid
Population projection graphs for the total population and various age cohorts

Demand: Our Growing and Aging Population

LESSON 1.2

Variations and Extensions

A follow-up activity on interpreting population pyramids can be found at http://www.populationeducation.org/media/upload/pyramids7-04.pdf.

When looking at the U.S. Population Pyramid, discuss the historical context of the baby boom. What historical event took place in the mid-1940s that coincided with the start of the baby boom era? If students are studying U.S. or World History, collaborate with the History teacher to link this lesson about the baby boom to material about World War II and the post-war era.

Introduce the concept of exponential growth after graphing the U.S. Census Bureau projection data. Or, instead of providing the data, give students a corresponding growth curve equation and have them graph the exponential function.

If students are using graphing calculators (or Excel) and are reasonably advanced, have them calculate the best-fit curve to the U.S. Census projection data using the least squares method.

Invite a healthcare professional that works with aging populations (e.g., gerontologist or geriatrician) to speak to the class. Contact your local chapter of AARP (American Association of Retired Persons) for more information.

National and State Academic Standards

NATIONAL
NCTM Standards for School Mathematics

Algebra

- understand relations and functions and select, convert flexibly among, and use various representations for them;
- analyze functions of one variable by investigating rates of change, intercepts, zeros, asymptotes, and local and global behavior;
- use symbolic algebra to represent and explain mathematical relationships;
- identify essential quantitative relationships in a situation and determine the class or classes of functions that might model the relationships;
- draw reasonable conclusions about a situation being modeled.
- approximate and interpret rates of change from graphical and numerical data.

CALIFORNIA
Mathematics Content Standards

Algebra

5.0 Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.

6.0 Students graph a linear equation and compute the x- and y- intercepts (e.g., graph $2x + 6y = 4$). They are also able to sketch the region defined by linear inequality (e.g., they sketch the region defined by $2x + 6y < 4$).

7.0 Students verify that a point lies on a line, given an equation of the line. Students are able to derive linear equations by using the point-slope formula.

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**1950**						
Total, all ages	152,274,000	75,851,000	76,423,000	100.0	100.0	100.0
0–4	16,410,000	8,362,000	8,048,000	10.8	11.0	10.5
5–9	13,375,000	6,811,000	6,564,000	8.8	9.0	8.6
10–14	11,213,000	5,707,000	5,506,000	7.4	7.5	7.2
15–19	10,675,000	5,381,000	5,294,000	7.0	7.1	6.9
20–24	11,680,000	5,794,000	5,886,000	7.7	7.6	7.7
25–29	12,362,000	6,071,000	6,291,000	8.1	8.0	8.2
30–34	11,675,000	5,733,000	5,942,000	7.7	7.6	7.8
35–39	11,347,000	5,585,000	5,762,000	7.5	7.4	7.5
40–44	10,290,000	5,121,000	5,169,000	6.8	6.8	6.8
45–49	9,142,000	4,566,000	4,576,000	6.0	6.0	6.0
50–54	8,311,000	4,149,000	4,162,000	5.5	5.5	5.4
55–59	7,293,000	3,656,000	3,637,000	4.8	4.8	4.8
60–64	6,103,000	3,058,000	3,045,000	4.0	4.0	4.0
65–69	5,049,000	2,447,000	2,602,000	3.3	3.2	3.4
70–74	3,444,000	1,644,000	1,800,000	2.3	2.2	2.4
75–79	2,155,000	1,005,000	1,150,000	1.4	1.3	1.5
80+	1,750,000	761,000	989,000	1.1	1.0	1.3

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**1955**						
Total, all ages	165,930,000	82,363,000	83,567,000	100.0	100.0	100.0
0–4	18,566,000	9,449,000	9,117,000	11.2	11.5	10.9
5–9	16,749,000	8,529,000	8,220,000	10.1	10.4	9.8
10–14	13,638,000	6,944,000	6,694,000	8.2	8.4	8.0
15–19	11,040,000	5,558,000	5,482,000	6.7	6.7	6.6
20–24	10,714,000	5,351,000	5,363,000	6.5	6.5	6.4
25–29	11,834,000	5,857,000	5,977,000	7.1	7.1	7.2
30–34	12,447,000	6,110,000	6,337,000	7.5	7.4	7.6
35–39	11,857,000	5,834,000	6,023,000	7.1	7.1	7.2
40–44	11,055,000	5,459,000	5,596,000	6.7	6.6	6.7
45–49	10,159,000	5,028,000	5,131,000	6.1	6.1	6.1
50–54	8,725,000	4,335,000	4,390,000	5.3	5.3	5.3
55–59	7,788,000	3,841,000	3,947,000	4.7	4.7	4.7
60–64	6,834,000	3,330,000	3,504,000	4.1	4.0	4.2
65–69	5,680,000	2,722,000	2,958,000	3.4	3.3	3.5
70–74	4,126,000	1,931,000	2,195,000	2.5	2.3	2.6
75–79	2,569,000	1,174,000	1,395,000	1.5	1.4	1.7
80+	2,149,000	911,000	1,238,000	1.3	1.1	1.5

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**1960**						
Total, all ages	180,673,000	89,320,000	91,353,000	100.0	100.0	100.0
0–4	20,341,000	10,339,000	10,002,000	11.3	11.6	10.9
5–9	18,810,000	9,565,000	9,245,000	10.4	10.7	10.1
10–14	16,925,000	8,602,000	8,323,000	9.4	9.6	9.1
15–19	13,443,000	6,803,000	6,640,000	7.4	7.6	7.3
20–24	11,135,000	5,569,000	5,566,000	6.2	6.2	6.1
25–29	10,935,000	5,423,000	5,512,000	6.1	6.1	6.0
30–34	11,983,000	5,904,000	6,079,000	6.6	6.6	6.7
35–39	12,543,000	6,140,000	6,403,000	6.9	6.9	7.0
40–44	11,678,000	5,732,000	5,946,000	6.5	6.4	6.5
45–49	10,914,000	5,379,000	5,535,000	6.0	6.0	6.1
50–54	9,664,000	4,763,000	4,901,000	5.3	5.3	5.4
55–59	8,471,000	4,145,000	4,326,000	4.7	4.6	4.7
60–64	7,155,000	3,414,000	3,741,000	4.0	3.8	4.1
65–69	6,280,000	2,936,000	3,344,000	3.5	3.3	3.7
70–74	4,774,000	2,197,000	2,577,000	2.6	2.5	2.8
75–79	3,081,000	1,370,000	1,711,000	1.7	1.5	1.9
80+	2,541,000	1,039,000	1,502,000	1.4	1.2	1.6

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**1965**						
Total, all ages	194,303,000	95,608,000	98,695,000	100.0	100.0	100.0
0–4	19,824,000	10,090,000	9,734,000	10.2	10.6	9.9
5–9	20,378,000	10,366,000	10,012,000	10.5	10.8	10.1
10–14	19,049,000	9,692,000	9,357,000	9.8	10.1	9.5
15–19	17,026,000	8,640,000	8,386,000	8.8	9.0	8.5
20–24	13,746,000	6,899,000	6,847,000	7.1	7.2	6.9
25–29	11,340,000	5,612,000	5,728,000	5.8	5.9	5.8
30–34	11,125,000	5,518,000	5,607,000	5.7	5.8	5.7
35–39	12,021,000	5,899,000	6,122,000	6.2	6.2	6.2
40–44	12,426,000	6,058,000	6,368,000	6.4	6.3	6.5
45–49	11,381,000	5,553,000	5,828,000	5.9	5.8	5.9
50–54	10,459,000	5,101,000	5,358,000	5.4	5.3	5.4
55–59	9,505,000	4,583,000	4,922,000	4.9	4.8	5.0
60–64	7,572,000	3,583,000	3,989,000	3.9	3.7	4.0
65–69	6,550,000	2,972,000	3,578,000	3.4	3.1	3.6
70–74	5,336,000	2,349,000	2,987,000	2.7	2.5	3.0
75–79	3,512,000	1,500,000	2,012,000	1.8	1.6	2.0
80+	3,053,000	1,193,000	1,860,000	1.6	1.2	1.9

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**1970**						
Total, all ages	205,051,000	100,354,000	104,697,000	100.0	100.0	100.0
0–4	17,166,000	8,751,000	8,415,000	8.4	8.7	8.0
5–9	19,920,000	10,152,000	9,768,000	9.7	10.1	9.3
10–14	20,852,000	10,622,000	10,230,000	10.2	10.6	9.8
15–19	19,333,000	9,816,000	9,517,000	9.4	9.8	9.1
20–24	17,202,000	8,655,000	8,547,000	8.4	8.6	8.2
25–29	13,736,000	6,821,000	6,915,000	6.7	6.8	6.6
30–34	11,588,000	5,716,000	5,872,000	5.7	5.7	5.6
35–39	11,155,000	5,475,000	5,680,000	5.4	5.5	5.4
40–44	11,995,000	5,847,000	6,148,000	5.8	5.8	5.9
45–49	12,150,000	5,873,000	6,277,000	5.9	5.9	6.0
50–54	11,166,000	5,380,000	5,786,000	5.4	5.4	5.5
55–59	10,006,000	4,781,000	5,225,000	4.9	4.8	5.0
60–64	8,676,000	4,052,000	4,624,000	4.2	4.0	4.4
65–69	7,026,000	3,139,000	3,887,000	3.4	3.1	3.7
70–74	5,467,000	2,322,000	3,145,000	2.7	2.3	3.0
75–79	3,871,000	1,573,000	2,298,000	1.9	1.6	2.2
80+	3,742,000	1,379,000	2,363,000	1.8	1.4	2.3

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**1975**						
Total, all ages	215,972,000	105,366,000	110,606,000	100.0	100.0	100.0
0–4	16,121,000	8,240,000	7,881,000	7.5	7.8	7.1
5–9	17,595,000	8,972,000	8,623,000	8.1	8.5	7.8
10–14	20,646,000	10,534,000	10,112,000	9.6	10.0	9.1
15–19	21,285,000	10,817,000	10,468,000	9.9	10.3	9.5
20–24	19,527,000	9,839,000	9,688,000	9.0	9.3	8.8
25–29	17,280,000	8,617,000	8,663,000	8.0	8.2	7.8
30–34	14,191,000	7,018,000	7,173,000	6.6	6.7	6.5
35–39	11,633,000	5,702,000	5,931,000	5.4	5.4	5.4
40–44	11,197,000	5,497,000	5,700,000	5.2	5.2	5.2
45–49	11,784,000	5,712,000	6,072,000	5.5	5.4	5.5
50–54	11,972,000	5,737,000	6,235,000	5.5	5.4	5.6
55–59	10,646,000	5,048,000	5,598,000	4.9	4.8	5.1
60–64	9,399,000	4,368,000	5,031,000	4.4	4.1	4.5
65–69	8,132,000	3,596,000	4,536,000	3.8	3.4	4.1
70–74	5,785,000	2,441,000	3,344,000	2.7	2.3	3.0
75–79	4,246,000	1,653,000	2,593,000	2.0	1.6	2.3
80+	4,533,000	1,575,000	2,958,000	2.1	1.5	2.7

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**1980**						
Total, all ages	227,726,463	110,859,060	116,867,403	100.0	100.0	100.0
0–4	16,451,184	8,414,215	8,036,969	7.2	7.6	6.9
5–9	16,602,353	8,491,414	8,110,939	7.3	7.7	6.9
10–14	18,236,335	9,313,212	8,923,123	8.0	8.4	7.6
15–19	21,165,372	10,779,171	10,386,201	9.3	9.7	8.9
20–24	21,589,949	10,884,885	10,705,064	9.5	9.8	9.2
25–29	19,792,494	9,888,501	9,903,993	8.7	8.9	8.5
30–34	17,810,424	8,836,010	8,974,414	7.8	8.0	7.7
35–39	14,120,501	6,960,677	7,159,824	6.2	6.3	6.1
40–44	11,746,798	5,757,209	5,989,589	5.2	5.2	5.1
45–49	11,053,414	5,376,515	5,676,899	4.9	4.8	4.9
50–54	11,695,953	5,617,519	6,078,434	5.1	5.1	5.2
55–59	11,611,552	5,478,072	6,133,480	5.1	4.9	5.2
60–64	10,142,678	4,697,364	5,445,314	4.5	4.2	4.7
65–69	8,809,479	3,915,788	4,893,691	3.9	3.5	4.2
70–74	6,841,235	2,871,581	3,969,654	3.0	2.6	3.4
75–79	4,829,832	1,862,070	2,967,762	2.1	1.7	2.5
80+	5,226,910	1,714,857	3,512,053	2.3	1.5	3.0

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**1985**						
Total, all ages	238,466,283	116,217,185	122,249,098	100.0	100.0	100.0
0–4	17,841,621	9,126,958	8,714,663	7.5	7.9	7.1
5–9	16,664,857	8,528,140	8,136,717	7.0	7.3	6.7
10–14	17,027,433	8,718,569	8,308,864	7.1	7.5	6.8
15–19	18,762,678	9,585,293	9,177,385	7.9	8.2	7.5
20–24	21,478,486	10,912,881	10,565,605	9.0	9.4	8.6
25–29	21,804,381	10,965,046	10,839,335	9.1	9.4	8.9
30–34	20,101,924	10,013,407	10,088,517	8.4	8.6	8.3
35–39	17,657,680	8,729,107	8,928,573	7.4	7.5	7.3
40–44	14,108,907	6,937,423	7,171,484	5.9	6.0	5.9
45–49	11,611,814	5,678,197	5,933,617	4.9	4.9	4.9
50–54	10,854,915	5,245,636	5,609,279	4.6	4.5	4.6
55–59	11,228,901	5,327,031	5,901,870	4.7	4.6	4.8
60–64	10,906,507	5,057,207	5,849,300	4.6	4.4	4.8
65–69	9,343,205	4,180,380	5,162,825	3.9	3.6	4.2
70–74	7,515,455	3,158,447	4,357,008	3.2	2.7	3.6
75–79	5,510,861	2,128,936	3,381,925	2.3	1.8	2.8
80+	6,046,658	1,924,527	4,122,131	2.5	1.7	3.4

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**1990**						
Total, all ages	250,131,894	122,162,221	127,969,673	100.0	100.0	100.0
0–4	18,857,928	9,650,341	9,207,587	7.5	7.9	7.2
5–9	18,077,187	9,254,039	8,823,148	7.2	7.6	6.9
10–14	17,213,063	8,817,261	8,395,802	6.9	7.2	6.6
15–19	17,808,884	9,148,333	8,660,551	7.1	7.5	6.8
20–24	19,322,853	9,904,862	9,417,991	7.7	8.1	7.4
25–29	21,401,643	10,790,793	10,610,850	8.6	8.8	8.3
30–34	22,021,822	10,995,366	11,026,456	8.8	9.0	8.6
35–39	20,046,390	9,959,860	10,086,530	8.0	8.2	7.9
40–44	17,818,667	8,803,466	9,015,201	7.1	7.2	7.0
45–49	13,835,576	6,787,984	7,047,592	5.5	5.6	5.5
50–54	11,379,014	5,527,276	5,851,738	4.5	4.5	4.6
55–59	10,478,463	5,007,095	5,471,368	4.2	4.1	4.3
60–64	10,623,559	4,950,422	5,673,137	4.2	4.1	4.4
65–69	10,078,988	4,514,045	5,564,943	4.0	3.7	4.3
70–74	8,025,052	3,423,852	4,601,200	3.2	2.8	3.6
75–79	6,146,899	2,410,587	3,736,312	2.5	2.0	2.9
80+	6,995,906	2,216,639	4,779,267	2.8	1.8	3.7

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**1995**						
Total, all ages	266,557,091	130,459,431	136,097,660	100.0	100.0	100.0
0–4	19,653,169	10,056,596	9,596,573	7.4	7.7	7.1
5–9	19,443,701	9,954,842	9,488,859	7.3	7.6	7.0
10–14	19,206,669	9,839,186	9,367,483	7.2	7.5	6.9
15–19	18,388,275	9,454,662	8,933,613	6.9	7.2	6.6
20–24	18,396,614	9,393,490	9,003,124	6.9	7.2	6.6
25–29	19,753,951	9,973,387	9,780,564	7.4	7.6	7.2
30–34	22,419,775	11,265,749	11,154,026	8.4	8.6	8.2
35–39	22,517,975	11,227,308	11,290,667	8.4	8.6	8.3
40–44	20,228,499	9,999,225	10,229,274	7.6	7.7	7.5
45–49	17,625,138	8,659,093	8,966,045	6.6	6.6	6.6
50–54	13,855,420	6,754,301	7,101,119	5.2	5.2	5.2
55–59	11,181,319	5,377,051	5,804,268	4.2	4.1	4.3
60–64	10,135,727	4,778,783	5,356,944	3.8	3.7	3.9
65–69	9,975,466	4,538,420	5,437,046	3.7	3.5	4.0
70–74	8,887,305	3,853,676	5,033,629	3.3	3.0	3.7
75–79	6,704,261	2,703,812	4,000,449	2.5	2.1	2.9
80+	8,183,827	2,629,850	5,553,977	3.1	2.0	4.1

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**2000**						
Total, all ages	282,338,631	138,595,702	143,742,929	100.0	100.0	100.0
0–4	19,218,174	9,831,175	9,386,999	6.8	7.1	6.5
5–9	20,483,106	10,488,829	9,994,277	7.3	7.6	7.0
10–14	20,608,415	10,560,818	10,047,597	7.3	7.6	7.0
15–19	20,249,959	10,412,689	9,837,270	7.2	7.5	6.8
20–24	19,185,063	9,821,860	9,363,203	6.8	7.1	6.5
25–29	19,316,817	9,785,399	9,531,418	6.8	7.1	6.6
30–34	20,587,073	10,372,884	10,214,189	7.3	7.5	7.1
35–39	22,648,354	11,304,995	11,343,359	8.0	8.2	7.9
40–44	22,535,368	11,179,973	11,355,395	8.0	8.1	7.9
45–49	20,230,558	9,959,477	10,271,081	7.2	7.2	7.1
50–54	17,790,616	8,706,996	9,083,620	6.3	6.3	6.3
55–59	13,559,151	6,553,207	7,005,944	4.8	4.7	4.9
60–64	10,864,730	5,165,703	5,699,027	3.8	3.7	4.0
65–69	9,533,955	4,402,844	5,131,111	3.4	3.2	3.6
70–74	8,849,946	3,904,321	4,945,625	3.1	2.8	3.4
75–79	7,425,378	3,051,227	4,374,151	2.6	2.2	3.0
80+	9,251,968	3,093,305	6,158,663	3.3	2.2	4.3

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**2005**						
Total, all ages	295,734,134	145,308,783	150,425,351	100.0	100.0	100.0
0–4	20,495,480	10,471,237	10,024,243	6.9	7.2	6.7
5–9	19,466,535	9,954,140	9,512,395	6.6	6.9	6.3
10–14	20,837,707	10,670,348	10,167,359	7.0	7.3	6.8
15–19	21,183,457	10,871,031	10,312,426	7.2	7.5	6.9
20–24	20,896,619	10,719,062	10,177,557	7.1	7.4	6.8
25–29	19,803,914	10,059,989	9,743,925	6.7	6.9	6.5
30–34	19,885,361	10,020,964	9,864,397	6.7	6.9	6.6
35–39	20,903,027	10,479,205	10,423,822	7.1	7.2	6.9
40–44	22,748,215	11,294,246	11,453,969	7.7	7.8	7.6
45–49	22,457,604	11,080,254	11,377,350	7.6	7.6	7.6
50–54	19,984,208	9,771,858	10,212,350	6.8	6.7	6.8
55–59	17,359,270	8,415,070	8,944,200	5.9	5.8	5.9
60–64	13,016,833	6,202,703	6,814,130	4.4	4.3	4.5
65–69	10,123,368	4,711,828	5,411,540	3.4	3.2	3.6
70–74	8,500,392	3,803,718	4,696,674	2.9	2.6	3.1
75–79	7,376,085	3,094,088	4,281,997	2.5	2.1	2.8
80+	10,696,059	3,689,042	7,007,017	3.6	2.5	4.7

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**2010**						
Total, all ages	309,162,581	152,010,519	157,152,062	100.0	100.0	100.0
0–4	21,426,163	10,947,092	10,479,071	6.9	7.2	6.7
5–9	20,705,845	10,574,858	10,130,987	6.7	7.0	6.4
10–14	19,767,291	10,109,020	9,658,271	6.4	6.7	6.1
15–19	21,347,871	10,947,575	10,400,296	6.9	7.2	6.6
20–24	21,749,606	11,136,601	10,613,005	7.0	7.3	6.8
25–29	21,426,460	10,911,751	10,514,709	6.9	7.2	6.7
30–34	20,309,518	10,271,050	10,038,468	6.6	6.8	6.4
35–39	20,170,425	10,120,865	10,049,560	6.5	6.7	6.4
40–44	20,997,772	10,473,573	10,524,199	6.8	6.9	6.7
45–49	22,658,581	11,193,563	11,465,018	7.3	7.4	7.3
50–54	22,173,595	10,874,838	11,298,757	7.2	7.2	7.2
55–59	19,507,013	9,456,296	10,050,717	6.3	6.2	6.4
60–64	16,678,728	7,982,313	8,696,415	5.4	5.3	5.5
65–69	12,172,070	5,686,196	6,485,874	3.9	3.7	4.1
70–74	9,097,439	4,110,809	4,986,630	2.9	2.7	3.2
75–79	7,186,229	3,066,430	4,119,799	2.3	2.0	2.6
80+	11,787,975	4,147,689	7,640,286	3.8	2.7	4.9

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**2015**						
Total, all ages	322,592,787	158,684,644	163,908,143	100.0	100.0	100.0
0–4	22,358,358	11,423,345	10,935,013	6.9	7.2	6.7
5–9	21,622,808	11,043,894	10,578,914	6.7	7.0	6.5
10–14	20,983,708	10,718,354	10,265,354	6.5	6.8	6.3
15–19	20,254,519	10,375,583	9,878,936	6.3	6.5	6.0
20–24	21,883,278	11,198,492	10,684,786	6.8	7.1	6.5
25–29	22,246,034	11,313,190	10,932,844	6.9	7.1	6.7
30–34	21,896,073	11,108,146	10,787,927	6.8	7.0	6.6
35–39	20,576,948	10,367,494	10,209,454	6.4	6.5	6.2
40–44	20,263,362	10,120,209	10,143,153	6.3	6.4	6.2
45–49	20,930,060	10,390,871	10,539,189	6.5	6.5	6.4
50–54	22,376,632	10,993,285	11,383,347	6.9	6.9	6.9
55–59	21,649,543	10,532,411	11,117,132	6.7	6.6	6.8
60–64	18,760,737	8,984,755	9,775,982	5.8	5.7	6.0
65–69	15,621,458	7,336,341	8,285,117	4.8	4.6	5.1
70–74	10,986,874	4,988,452	5,998,422	3.4	3.1	3.7
75–79	7,760,859	3,351,398	4,409,461	2.4	2.1	2.7
80+	12,421,536	4,438,424	7,983,112	3.9	2.8	4.9

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**2020**						
Total, all ages	336,031,546	165,288,852	170,742,694	100.0	100.0	100.0
0–4	22,932,056	11,716,387	11,215,669	6.8	7.1	6.6
5–9	22,563,726	11,524,759	11,038,967	6.7	7.0	6.5
10–14	21,913,742	11,194,358	10,719,384	6.5	6.8	6.3
15–19	21,489,412	10,994,495	10,494,917	6.4	6.7	6.1
20–24	20,824,000	10,646,190	10,177,810	6.2	6.4	6.0
25–29	22,412,543	11,392,313	11,020,230	6.7	6.9	6.5
30–34	22,742,592	11,523,816	11,218,776	6.8	7.0	6.6
35–39	22,176,355	11,210,021	10,966,334	6.6	6.8	6.4
40–44	20,686,796	10,375,454	10,311,342	6.2	6.3	6.0
45–49	20,223,544	10,054,547	10,168,997	6.0	6.1	6.0
50–54	20,703,179	10,223,934	10,479,245	6.2	6.2	6.1
55–59	21,875,741	10,663,726	11,212,015	6.5	6.5	6.6
60–64	20,855,969	10,028,819	10,827,150	6.2	6.1	6.3
65–69	17,618,270	8,284,417	9,333,853	5.2	5.0	5.5
70–74	14,160,889	6,469,955	7,690,934	4.2	3.9	4.5
75–79	9,449,842	4,107,242	5,342,600	2.8	2.5	3.1
80+	13,402,890	4,878,419	8,524,471	4.0	3.0	5.0

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**2025**						
Total, all ages	349,666,199	171,918,242	177,747,957	100.0	100.0	100.0
0–4	23,518,395	12,015,262	11,503,133	6.7	7.0	6.5
5–9	23,163,016	11,831,125	11,331,891	6.6	6.9	6.4
10–14	22,887,752	11,692,274	11,195,478	6.5	6.8	6.3
15–19	22,468,725	11,496,334	10,972,391	6.4	6.7	6.2
20–24	22,124,985	11,296,473	10,828,512	6.3	6.6	6.1
25–29	21,441,130	10,882,110	10,559,020	6.1	6.3	5.9
30–34	22,993,294	11,646,783	11,346,511	6.6	6.8	6.4
35–39	23,079,676	11,654,430	11,425,246	6.6	6.8	6.4
40–44	22,318,979	11,232,276	11,086,703	6.4	6.5	6.2
45–49	20,682,133	10,327,250	10,354,883	5.9	6.0	5.8
50–54	20,044,368	9,914,318	10,130,050	5.7	5.8	5.7
55–59	20,291,558	9,945,218	10,346,340	5.8	5.8	5.8
60–64	21,128,456	10,184,920	10,943,536	6.0	5.9	6.2
65–69	19,646,750	9,283,604	10,363,146	5.6	5.4	5.8
70–74	16,040,825	7,346,016	8,694,809	4.6	4.3	4.9
75–79	12,267,624	5,376,751	6,890,873	3.5	3.1	3.9
80+	15,568,533	5,793,098	9,775,435	4.5	3.4	5.5

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**2030**						
Total, all ages	363,811,435	178,758,293	185,053,142	100.0	100.0	100.0
0–4	24,271,894	12,399,163	11,872,731	6.7	6.9	6.4
5–9	23,789,963	12,150,864	11,639,099	6.5	6.8	6.3
10–14	23,538,712	12,025,310	11,513,402	6.5	6.7	6.2
15–19	23,514,705	12,031,730	11,482,975	6.5	6.7	6.2
20–24	23,209,431	11,849,034	11,360,397	6.4	6.6	6.1
25–29	22,861,428	11,583,638	11,277,790	6.3	6.5	6.1
30–34	22,162,866	11,209,060	10,953,806	6.1	6.3	5.9
35–39	23,432,802	11,830,099	11,602,703	6.4	6.6	6.3
40–44	23,290,447	11,709,833	11,580,614	6.4	6.6	6.3
45–49	22,356,369	11,202,317	11,154,052	6.1	6.3	6.0
50–54	20,551,315	10,210,598	10,340,717	5.6	5.7	5.6
55–59	19,702,149	9,672,896	10,029,253	5.4	5.4	5.4
60–64	19,675,883	9,541,035	10,134,848	5.4	5.3	5.5
65–69	19,980,262	9,473,104	10,507,158	5.5	5.3	5.7
70–74	17,967,671	8,280,824	9,686,847	4.9	4.6	5.2
75–79	13,988,906	6,159,657	7,829,249	3.8	3.4	4.2
80+	19,516,632	7,429,131	12,087,501	5.4	4.2	6.5

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**2035**						
Total, all ages	378,113,238	185,695,458	192,417,780	100.0	100.0	100.0
0–4	25,262,296	12,905,477	12,356,819	6.7	6.9	6.4
5–9	24,561,671	12,544,388	12,017,283	6.5	6.8	6.2
10–14	24,185,799	12,355,710	11,830,089	6.4	6.7	6.1
15–19	24,193,889	12,379,849	11,814,040	6.4	6.7	6.1
20–24	24,300,286	12,406,246	11,894,040	6.4	6.7	6.2
25–29	23,993,934	12,155,694	11,838,240	6.3	6.5	6.2
30–34	23,643,672	11,940,743	11,702,929	6.3	6.4	6.1
35–39	22,661,007	11,425,120	11,235,887	6.0	6.2	5.8
40–44	23,682,442	11,905,893	11,776,549	6.3	6.4	6.1
45–49	23,354,554	11,693,179	11,661,375	6.2	6.3	6.1
50–54	22,234,990	11,088,322	11,146,668	5.9	6.0	5.8
55–59	20,240,926	9,985,633	10,255,293	5.4	5.4	5.3
60–64	19,156,357	9,309,298	9,847,059	5.1	5.0	5.1
65–69	18,683,192	8,919,907	9,763,285	4.9	4.8	5.1
70–74	18,349,552	8,497,350	9,852,202	4.9	4.6	5.1
75–79	15,764,313	7,001,769	8,762,544	4.2	3.8	4.6
80+	23,844,358	9,180,880	14,663,478	6.3	4.9	7.6

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**2040**						
Total, all ages	392,172,658	192,600,814	199,571,844	100.0	100.0	100.0
0–4	26,299,190	13,436,535	12,862,655	6.7	7.0	6.4
5–9	25,550,086	13,050,166	12,499,920	6.5	6.8	6.3
10–14	24,952,559	12,747,171	12,205,388	6.4	6.6	6.1
15–19	24,834,947	12,707,593	12,127,354	6.3	6.6	6.1
20–24	24,970,727	12,749,933	12,220,794	6.4	6.6	6.1
25–29	25,074,927	12,707,622	12,367,305	6.4	6.6	6.2
30–34	24,768,868	12,510,571	12,258,297	6.3	6.5	6.1
35–39	24,134,548	12,154,179	11,980,369	6.2	6.3	6.0
40–44	22,920,380	11,509,209	11,411,171	5.8	6.0	5.7
45–49	23,751,829	11,893,697	11,858,132	6.1	6.2	5.9
50–54	23,235,454	11,581,368	11,654,086	5.9	6.0	5.8
55–59	21,910,465	10,854,745	11,055,720	5.6	5.6	5.5
60–64	19,719,044	9,636,452	10,082,592	5.0	5.0	5.1
65–69	18,237,348	8,733,312	9,504,036	4.7	4.5	4.8
70–74	17,232,560	8,048,371	9,184,189	4.4	4.2	4.6
75–79	16,192,216	7,241,995	8,950,221	4.1	3.8	4.5
80+	28,387,510	11,037,895	17,349,615	7.2	5.7	8.7

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**2045**						
Total, all ages	406,089,392	199,558,699	206,530,693	100.0	100.0	100.0
0–4	27,233,173	13,914,737	13,318,436	6.7	7.0	6.4
5–9	26,586,301	13,581,131	13,005,170	6.5	6.8	6.3
10–14	25,938,372	13,251,831	12,686,541	6.4	6.6	6.1
15–19	25,598,606	13,097,813	12,500,793	6.3	6.6	6.1
20–24	25,607,522	13,075,713	12,531,809	6.3	6.6	6.1
25–29	25,741,154	13,049,295	12,691,859	6.3	6.5	6.1
30–34	25,846,487	13,062,490	12,783,997	6.4	6.5	6.2
35–39	25,256,366	12,723,866	12,532,500	6.2	6.4	6.1
40–44	24,389,460	12,236,687	12,152,773	6.0	6.1	5.9
45–49	23,005,114	11,508,131	11,496,983	5.7	5.8	5.6
50–54	23,641,694	11,788,127	11,853,567	5.8	5.9	5.7
55–59	22,915,999	11,351,868	11,564,131	5.6	5.7	5.6
60–64	21,369,832	10,493,962	10,875,870	5.3	5.3	5.3
65–69	18,829,389	9,077,051	9,752,338	4.6	4.5	4.7
70–74	16,879,051	7,916,346	8,962,705	4.2	4.0	4.3
75–79	15,304,358	6,920,239	8,384,119	3.8	3.5	4.1
80+	31,946,514	12,509,412	19,437,102	7.9	6.3	9.4

Name _____ Date_____ Period _____

U.S. Census Bureau. Midyear Population, by Age and Sex: 1950–2005 and Projections for 2010–2050

Country or area/Year/Age	Population both sexes	Population male	Population female	Percent both sexes	Percent male	Percent female
United States/**2050**						
Total, all ages	420,080,587	206,672,139	213,408,448	100.0	100.0	100.0
0–4	28,080,082	14,348,291	13,731,791	6.7	6.9	6.4
5–9	27,520,670	14,059,510	13,461,160	6.6	6.8	6.3
10–14	26,973,994	13,782,484	13,191,510	6.4	6.7	6.2
15–19	26,583,393	13,602,067	12,981,326	6.3	6.6	6.1
20–24	26,370,427	13,465,834	12,904,593	6.3	6.5	6.0
25–29	26,378,023	13,375,482	13,002,541	6.3	6.5	6.1
30–34	26,514,784	13,407,428	13,107,356	6.3	6.5	6.1
35–39	26,333,679	13,277,400	13,056,279	6.3	6.4	6.1
40–44	25,509,987	12,806,833	12,703,154	6.1	6.2	6.0
45–49	24,470,102	12,234,140	12,235,962	5.8	5.9	5.7
50–54	22,918,439	11,418,281	11,500,158	5.5	5.5	5.4
55–59	23,337,181	11,568,562	11,768,619	5.6	5.6	5.5
60–64	22,384,189	10,997,678	11,386,511	5.3	5.3	5.3
65–69	20,443,823	9,911,357	10,532,466	4.9	4.8	4.9
70–74	17,498,614	8,273,629	9,224,985	4.2	4.0	4.3
75–79	15,066,841	6,853,651	8,213,190	3.6	3.3	3.8
80+	33,696,359	13,289,512	20,406,847	8.0	6.4	9.6

Source: U.S. Census Bureau, International Data Base, table 094 (http://www.census.gov/ipc/www/idb).

Supply: The Problem in the Pipeline

LESSON 1.3

ALGEBRA I

Time
45 minutes

Materials
Equipment
- Graph paper
- Rulers
- Colored pencils (optional)

Resources
30 Fastest Growing Occupations Covered in the 2006–07 Occupational Outlook Handbook, 2004–14 handout

Prior Student Learning
Students should have a general understanding of bar graph construction.

Essential Question for This Unit
What is the place for me in the health and biomedical sciences?

Objectives
After completing this lesson, students should be able to

- Construct and interpret distribution graphs.
- Calculate percent change.

Lesson Activities
Lesson Springboard
Introduce the lesson by reminding students of Lesson 1.2, where they modeled the growth and aging of the U.S. population. Now that students have explored the source of the demand for biomedical and health science workers, this lesson will use statistics from the Bureau of Labor Statistics (BLS) in the U.S. Department of Labor to look more specifically at the employment outlook.

Ask students to consider what might be the fastest growing industries (besides healthcare) in the United States. Have students share their responses and ask them to provide reasons for their choices.

Lesson Development
Hand out the BLS table on the 30 Fastest Growing U.S. Occupations, 2004–14. Ask students to describe the kinds of information that are provided in the table. Define abbreviations and clarify any mistaken interpretations. Ask students to look for patterns or trends in the data. For example:

- What general occupational categories appear most frequently in the table? Did you predict correctly?
- Does the pay for these occupations seem to be generally high, in the middle, or low?

Have students highlight the health and biomedical science occupations. Based on the data, have them calculate the predicted percent change for each of the occupations and calculate the average percent change. How do the rates compare across these occupations? Is the growth rate for these occupations generally faster or slower than, or equal to, the growth rate of the total population? How about in comparison to the 80+ age cohort? How about compared to a young cohort?

Using the BLS data, have students construct distribution graphs of the U.S. population and labor force by age for 1984, 1994, and 2004 on graph paper. Ask them to describe the changes that occurred over this

period. Be sure to have them align their graphs vertically so that they can easily see the shift in distribution.

Have students complete any unfinished graphs for **homework**. You may wish to assign word problems in which students calculate additional percent changes. Also, provide students with the BLS table showing the fastest growing occupations in the U.S. workforce, and have them calculate percent change figures.

Lesson Closure
Have students discuss the relevance of this lesson for the essential question. For example:

- What trends can be observed in the progression of these distribution graphs?
- What are the implications of an aging population for the nation's workforce?
- What role can the information gained from this exercise play in my education- and career-planning process and in helping me address the essential question?

Possible Prior Misconceptions

Some students may believe that adding two zeros to the end of a number is always equivalent to multiplication by 100.

When calculating percent change, students often divide by the new value, rather than the original value.

Some students may not grasp the distinction between a *percentage increase* and a *percentage of* (e.g., a 30% increase vs. 130% of the previous value). They might not see that, for example, a 200% increase means three times the original value.

Student Assessment Artifacts

Labor force graphs and analysis

Variations and Extensions

Have students calculate and compare the percent changes of other occupational career pathways to their work on health and biomedical sciences.

Supply: The Problem in the Pipeline

LESSON 1.3

National and State Academic Standards

NATIONAL
NCTM Standards for School Mathematics

Algebra

- Represent and analyze mathematical situations and structures using algebraic symbols.
- Analyze change in various contexts.

CALIFORNIA
Mathematics Content Standards

Algebra

15.0 Students apply algebraic techniques to solve rate problems, work problems, and percent mixture problems.

Probability and Statistics

8.0 Students organize and describe distributions of data by using a number of different methods, including frequency tables, histograms, standard line and bar graphs, stem-and-leaf displays, scatterplots, and box-and-whisker plots.

Name ______________________ Date__________ Period ________

30 Fastest Growing Occupations Covered in the 2006–07 Occupational Outlook Handbook, 2004–14

Occupation	Employment #'s (in thousands)		Percent change	Quartile rank by 2004 Median Annual Earnings	Most Significant Source of Postsecondary Education or Training
	2004	2014			
Biomedical engineers	10	13		Very High	Bachelor's degree
Cardiovascular technologists and technicians	45	60		High	Associate's degree
Computer software engineers, applications	460	682		Very High	Bachelor's degree
Computer software engineers, systems software	340	486		Very High	Bachelor's degree
Computer systems analysts	487	640		Very High	Bachelor's degree
Database administrators	104	144		Very High	Bachelor's degree
Dental assistants	267	382		Low	Moderate-term on-the-job training
Dental hygienists	158	226		Very High	Associate's degree
Diagnostic medical sonographers	42	57		Very High	Associate's degree
Employment, recruitment, and placement specialists	182	237		High	Bachelor's degree
Environmental engineers	49	64		Very High	Bachelor's degree
Forensic science technicians	10	13		Very High	Associate's degree
Hazardous materials removal workers	38	50		High	Moderate-term on-the-job training
Home health aides	624	974		Very Low	Short-term on-the-job training
Hydrologists	8	11		Very High	Master's degree
Medical assistants	387	589		Low	Moderate-term on-the-job training
Medical scientists, except epidemiologists	72	97		Very High	Doctoral degree
Network and computer systems administrators	278	385		Very High	Bachelor's degree
Network systems and data communications analysts	231	357		Very High	Bachelor's degree
Occupational therapist assistants	21	29		High	Associate's degree
Occupational therapists	92	123		Very High	Master's degree
Paralegals and legal assistants	224	291		High	Associate's degree
Personal and home care aides	701	988		Very Low	Short-term on-the-job training
Physical therapist aides	43	57		Low	Short-term on-the-job trianing
Physical therapist assistants	59	85		High	Associate's degree
Physical therapists	155	211		Very High	Master's degree
Physician assistants	62	93		Very High	Bachelor's degree
Post-secondary teachers	1,628	2,153		Very High	Doctoral degree
Preschool teachers, except special education	431	573		Low	Postsecondary vocational award
Veterinary technologists and technicians	60	81		Low	Associate's degree

Source: U.S. Department of Labor, Bureau of Labor Statistics, Table 1. Fastest growing occupations covered in the 2006–07 Occupational Outlook Handbook, 2004–14 (http://www.bls.gov/news.release/ooh.t01.htm); U.S. Department of Labor, Bureau of Labor Statistics, Table 3. Occupations with the largest job growth, 2004–14 (http://www.bls.gov/emp/emptab3.htm).

Writing a Research Paper: Overview

LESSON 1.4

ENGLISH LANGUAGE ARTS

Time
45 minutes

Materials
Health and Biomedical Science Careers Research Paper assignment

Resources
- Health and Biomedical Science Careers Research Notes template
- Research paper examples

Prior Student Learning
Students should understand that writing can have many different purposes and audiences. They should know where their school library is located and when they can use the library facilities.

Essential Question for This Unit
What is the place for me in the health and biomedical sciences?

Objectives
After completing this lesson, students should be able to

- Distinguish how research papers differ from other forms of writing.
- Describe the general format of a research paper and explain the purpose of each of the traditional sections.

Lesson Activities
Lesson Springboard
Ask students to name all the different kinds of writing they've done in school: stories, poems, book reports, essays, and so on. Perhaps have some students share their favorite writing assignment or their favorite type of writing. Have students discuss how these types of writing are different from each other. Is some writing informative, or descriptive, or persuasive? Is some writing intended for entertainment, and some to teach a lesson or to illustrate a point? Can some writing serve multiple purposes? Help students recognize that various types of writing have certain characteristics, some of which are shared across types.

Lesson Development
Direct Instruction
In this lesson, explain to students that they will be learning about a specific type of writing known as the *research paper*. They will be researching career opportunities in the health and biomedical science field as part of a career exploration process.

Define and distinguish a research paper from other types of writing students have done in school. Research papers are more than descriptive reports or persuasive essays, although a good research paper contains a fair amount of both description and persuasion. Writing a research paper requires gathering information from experts in the field to build knowledge of the subject and then comparing new information with previous thoughts on the subject. A research paper presents both the results of an investigation into a topic and the writer's own analysis and conclusions.

Support Strategy
Provide students with a research paper template that they can annotate.

Tell students that although there are many different types of research papers and many different ways to organize them, most research papers have some common structural features. Have students take notes as you go through the general format of a research paper (recommended format may vary by school):

- Introduction—The introduction should identify the topic of the paper and explain the importance or relevance of the research that was

done. The introduction often includes some context and the plan for solving the problem. The introduction usually also contains your research question or thesis statement.

- Background Information—The body of a research paper contains two parts. The first is the background information, which is a report of the research that the writer conducted.
- Analysis—The second part of the body of a research paper is the analysis. The analysis provides the writer's thoughts on the background information and a discussion of how that information has helped to answer the research question.
- Conclusion—The conclusion should provide an answer to the research question, along with a short summary of the important supporting arguments and information.
- References—The references section provides the list of sources that were used and cited in the paper.

As you introduce each section, provide students with short examples, both good and bad. Have students evaluate these exemplars. Do they conform to the recommended research paper format, and do they fulfill their intended role within the research paper? If not, what is the problem, and how could it be fixed?

Classroom Management
Some teachers prefer to introduce the assignment at the beginning in order to provide context for the lesson.

Lesson Closure
Hand out the research assignment. Students will be writing a research paper that addresses the unit's essential question, and answering the question "What career best suits my interests and goals?" Students will use the research on careers they conducted in Health Science, the analyses done in Algebra and English Language Arts, and additional research and self-assessment they will do in Subunit 2 to write the paper. Review the assignment rubric and preview the timeline of upcoming lessons with the students. Conclude the lesson by describing the unit's culminating event, a series of classes in which students will present the results of their research papers.

Possible Prior Misconceptions
Research papers and reports are often confused. Many students may believe that any paper for which research was done is a research paper, but most such papers are merely reports.

Student Assessment Artifacts
Research paper annotated template notes
Research paper section evaluations

Variations and Extensions
Have students familiarize themselves with the assignment rubric by having them use it to evaluate a sample research paper on an interesting, but unrelated, topic.

Writing a Research Paper: Overview

LESSON 1.4

National and State Academic Standards

NATIONAL
NCTE Standards for the English Language Arts

3. Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).
6. Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.

CALIFORNIA
English Language Arts Content Standards

Reading

2.7 Critique the logic of functional documents by examining the sequence of information and procedures in anticipation of possible reader misunderstandings.

2.8 Evaluate the credibility of an author's argument or defense of a claim by critiquing the relationship between generalizations and evidence, the comprehensiveness of evidence, and the way in which the author's intent affects the structure and tone of the text (e.g., in professional journals, editorials, political speeches, primary source material).

Name _____ Date_____ Period _____

Health and Biomedical Science Careers Research Paper

Choose three health and biomedical science careers in which you are interested. Consider your own desires, aptitudes, and prior experience, and define your priorities for a satisfying career. Refer to the results of the Personality Inventory and Analysis that you are completing in Health Science when choosing these three careers.

Then, using print and Internet resources, research these careers. The research should contain the following information: education and experience needed for an entry-level position, job outlook, and salary expectations; the tasks, physical demands, and routine of a typical day at the job; and opportunities for advancement. In the final section of the paper, evaluate the three careers and explain why one of them may be best for you. Use the Health and Biomedical Science Careers Research Guidelines to organize your research and writing.

The research paper should be four to six pages, double-spaced, and must include a title, an introduction, at least four paragraphs, and a conclusion. All sources should be properly cited and listed in a References section, whether the sources are quoted, paraphrased, or summarized.

Health and Biomedical Science Careers Research Notes

Use the Internet and print resources to find as much of the following information as possible about the three careers you have chosen. The following are a few good places on the Internet to start your research. Be sure to record your sources.

- Occupational Outlook Handbook at http://www.bls.gov/oco/
- Career Guide to Industries at http://www.bls.gov/oco/cg/home.htm
- Career articles in the Occupational Outlook Quarterly at http://www.bls.gov/opub/ooq/ooqhome.htm
- Search engines like http://www.google.com, http://www.ask.com and http://www.yahoo.com

	Career Choices		
Career Information			
EDUCATION & TRAINING • What is the typical education required for this career? • How many years of study are involved? • Where would you obtain this education? (On-the-job training, junior college, technical school, college, or university?) • What are the entrance requirements for these training schools? How many years? Post graduate?			
Source			
EARNINGS • What is the typical range of salaries for this job? In this area? Elsewhere?			
Source			

Health and Biomedical Science Careers Research Notes

	Career Choices		
Career Information			
JOB SKILLS, TALENTS AND EXPERIENCE • What special skills, talents, or personality traits are necessary for this occupation? • Where could you gain experience? • In what ways are you suited for this career? • What personality characteristics or skills do you currently possess that you believe will benefit you in this career?			
Source			
EMPLOYMENT • What are the prospects for employment in this occupation? • What factors influence the availability of jobs in this field? • What is the growth potential for this job?			
Source			

Health and Biomedical Science Careers Research Notes

	Career Choices		
Career Information			
TYPICAL DAY • Describe a typical day for a person in this job. • What are the tasks involved in this career? • What are the usual hours? • What are the best parts of the day? • What would be the most challenging??			
Source			
APTITUDE (Your inherent ability/talent for the job) • What personality traits/skills do you possess that would make you suited for this job? • What "real life" experiences have you had that have prepared you?			
Source			

Taking a Closer Look

SUBUNIT 2 OVERVIEW

Essential Question for This Unit

What is the place for me in the health and biomedical sciences?

Subunit Goals

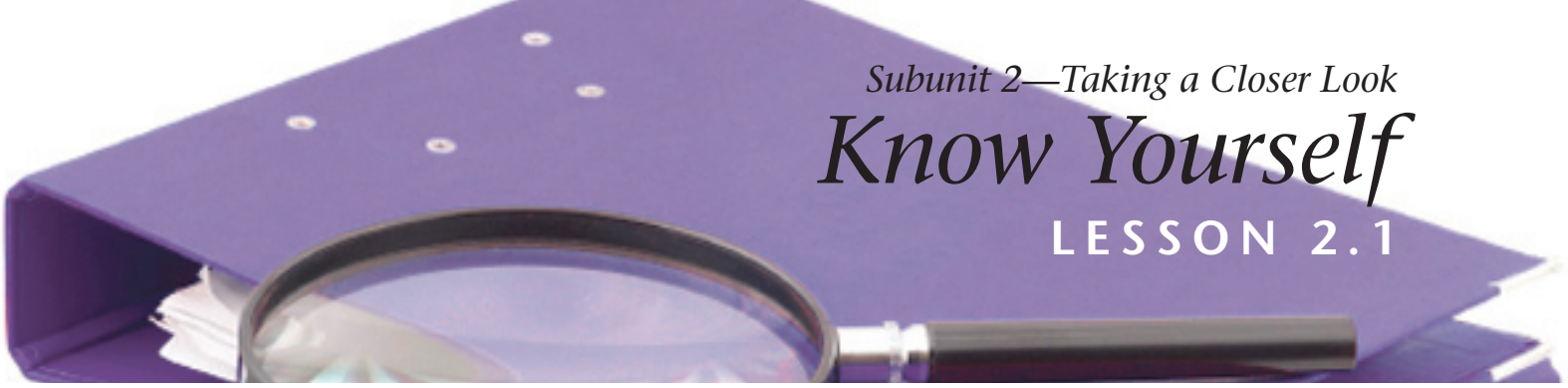
By the end of Subunit 2, students will have explored and gained insight into their own interests, strengths, and skills. Using that information, they will have selected three potential health and biomedical science careers for greater investigation. In preparation for writing a career-exploration research paper, students will become familiar with the structure and unique characteristics of an analytical research paper. They will also be able to critically evaluate web materials when searching for information on the Internet. Subunit 2 concludes with students researching the life of an important figure in the fields of biomedical research and healthcare and writing a biography of that individual.

Subunit Key Questions

- What are my career-related interests, my strengths, and my weaknesses? (Health Science)
- What factors should I take into account as I start to consider career possibilities? (Health Science and English Language Arts)
- How can I make reasoned and intelligent decisions about my career options? (English Language Arts)
- Is information accurate just because it's on the Internet? How can I know if my information source is reliable and trustworthy? (English Language Arts)
- What are the landmark accomplishments in the field of health and biomedical science? Who made those discoveries and advances? What were their life experiences? (World History or English Language Arts)

Lesson Summaries

Lesson	Subject	Description
2.1	Health Science	***Know Yourself*** Students complete interest and skill surveys and align their results with categories of biomedical and health science careers.
2.2	English Language Arts	***Writing a Research Paper: Introduction to Research*** Students review methods of gathering information from print and online sources. Students critically evaluate content found on the Internet as source material.
2.3	English Language Arts	***Writing a Research Paper: Organizing Information*** Students practice reading with a critical eye, as well as paraphrasing and summarizing sources that they will use in their Career Research paper.
2.4	World History or English Language Arts	***Biomedical Visionaries and Advances in Health*** Students study important figures and advances in biomedical research and healthcare throughout history. Students select one important figure and write a biography on his or her life and contributions.



Know Yourself

LESSON 2.1

HEALTH SCIENCE

Time
45 minutes

Materials
Equipment
Access to Internet

Resources
Personality Self-Evaluation and Career Matching Matrix handout

Essential Question for This Unit
What is the place for me in the health and biomedical sciences?

Objectives
After completing this lesson, students should be able to

- Identify characteristics of their personality.
- Match their personality characteristics to possible career choices.

Lesson Activities
Lesson Springboard
Introduce the following scenario to students:

> You are the only registered nurse (RN) on duty at a nursing home on the evening shift. It is 4 p.m. Two nursing assistants are also working this evening. Another registered nurse is on call if you need her, but she told you that she wants to attend her son's basketball game this evening. Your duties include the following:
>
> - Administer oral meds to 12 patients at 5 p.m., 8 patients at 8 p.m., and 3 patients at 10 p.m.
> - Administer intravenous meds to a patient starting at 6 p.m. This takes about 1 hour and must be checked every 10 minutes by an RN.
> - Change the dressings on a patient's open wound every 3 hours.
> - Complete several reports that were due last week.
> - Answer the phone whenever it rings.
> - Go over some quality assurance policies for the administrator.
>
> You get a call from the local hospital telling you that a patient is being discharged to your facility and will be there in about 1 hour. You'll be responsible for handling this admission and also for these other tasks.

If you were this RN, how would you organize your time to deal with all of these responsibilities? How would you figure out the priorities? If you were a student who is thinking about a career in nursing, is this the kind of work that you would enjoy doing? Would a different kind of nursing assignment suit you better? Or, would you be happier in an entirely different healthcare role?

In any job, important decisions need to be made, and multiple tasks must be accomplished. It is important to choose a career where many of the key responsibilities are ones that you find interesting and challenging.

Lesson Development

Class Discussion

Discuss briefly with students how being aware of our personality characteristics can help us make good career choices and be productive on the job. If students are aware of their personality type and activity preferences, they can approach their work in a manner that best suits their style. This includes knowing how they manage their time, how they solve problems, how they make decisions, and how they deal with stress. Knowledge of their personality type can also help students work effectively in cooperative groups and understand how best to work with others.

Tell students that when making decisions about careers or jobs, it's important to think about their personal interests and abilities. How they view themselves and their relationships with others is important. Work satisfaction often depends greatly on our attitudes toward our jobs.

Self-Evaluations

Pass out the Personality Self-Evaluation and Career Matching Matrix handout and have students answer the questions. Ask them to match their strongest personality type indicators to the list of corresponding careers. Remind students that many of the careers listed on the matrix are suited for individuals with several personality types. However, the matrix is a way to highlight one personality type that is a close match. If time allows, let students look up any unfamiliar careers online. They will be conducting in-depth research on several careers later in the unit.

Lesson Closure

Have students consider what kinds of rewards and challenges they expect from a career in health and biomedical sciences and then select a few occupations that seem interesting for further investigation.

Student Assessment Artifacts

Completed Personality Self-Evaluation
List of possible careers of interest

Variations and Extensions

Have students take a sample personality type test and share their results. A free Myers-Briggs-like assessment can be found at http://www.humanmetrics.com/cgi-win/JTypes2.asp.

Know Yourself

LESSON 2.1

National and State Career Technical Education Standards

NATIONAL
NCHSTE National Healthcare Skill Standards

4.41 Explore a potential health science career path in at least one of the following health care services: diagnostic, therapeutic, information, or environmental

4.42 Consider levels of education, credentialing requirements, employment opportunities, workplace environments, and career growth potential for a service area

CALIFORNIA
Health Science and Medical Technology Standards

3.0 Career Planning and Management
Students understand how to make effective decisions, use career information, and manage personal career plans

3.1 Know the personal qualifications, interests, aptitudes, knowledge, and skills necessary to succeed in careers.

Name _____ Date_____ Period _____

Personality Self-Evaluation and Career Matching Matrix[1]

First … make an inventory of your interests.

1. ☐ Work on a farm or help save a rainforest.
2. ☐ Solve complicated math problems.
3. ☐ Act in a movie or play.
4. ☐ Study social groups in society.
5. ☐ Interview strangers for the TV news.
6. ☐ Learn about and study the economy.
7. ☐ Study "how-to" mechanics manuals.
8. ☐ Perform science lab experiments.
9. ☐ Manage an art gallery.
10. ☐ Conduct a religious service.
11. ☐ Bargain at a flea market.
12. ☐ Write up graphs or charts with statistics.
13. ☐ Build cabinets or furniture.
14. ☐ Study nature outdoors or trace the effects of pollution on the environment.
15. ☐ Write a movie screenplay.
16. ☐ Lead a club or scout troop.
17. ☐ Buy merchandise for a store.
18. ☐ Work 9:00 to 5:00 in a corporate office.
19. ☐ Operate heavy machinery.
20. ☐ Play chess.
21. ☐ Work on an art or a music magazine.
22. ☐ Get involved in a charity or community organization.
23. ☐ Do fast-paced, high-pressure sales work.
24. ☐ Design computer games and programs.
25. ☐ Work outside in a national park.
26. ☐ Research a law case.
27. ☐ Play a musical instrument.
28. ☐ Work with babies or children.
29. ☐ Run for class office.
30. ☐ Work after school to save money.
31. ☐ Set up a sound system.
32. ☐ Read science fiction.
33. ☐ Write a short story, play, or novel.
34. ☐ Entertain at a party.
35. ☐ Work in a politician's office.
36. ☐ Enter documents into a computer.
37. ☐ Build a jet aircraft model.
38. ☐ Use an electron microscope or high-tech medical instrument.
39. ☐ Design a new line of clothes.
40. ☐ Read and discuss literature.
41. ☐ Debate political and social issues on TV.
42. ☐ Keep accurate records of a business.
43. ☐ Repair a car engine.
44. ☐ Identify constellations of stars.
45. ☐ Take pottery classes.
46. ☐ Work with senior citizens.
47. ☐ Sell products on commission.
48. ☐ Set up a budget for running a large company or government agency.

Name _____ Date_____ Period _____

Second … add up your scores.

Below, circle the numbers you checked off. Count the number of circles in each line. Then enter that total in the blank space at the end of each line.

Personality Types										Total
A.	Doers	1	7	13	19	25	31	37	43	
B.	Investigators	2	8	14	20	26	32	38	44	
C.	Artists	3	9	15	21	27	33	39	45	
D.	Helpers	4	10	16	22	28	34	40	46	
E.	Enterprisers	5	11	17	23	29	35	41	47	
F.	Detailers	6	12	18	24	30	36	42	48	

Third … evaluate yourself.

In what two personality types did you score the highest? Write the names in the blank spaces below.

Match your personality type with potential health and biomedical science careers using the chart on the next page.

Career Marketing Matrix

A. Doers	B. Investigators	C. Artist	D. Helper	E. Enterpriser	F. Detailer
If you love working with your hands, chances are you're a "doer." You like to build and fix things. Using tools comes naturally. You may prefer solving concrete rather than abstract problems. Many doers grow up to have "hands-on" careers, such as the following: Athletic trainer Biomedical engineer or technician Chiropractor Dentist Dental hygienist or assistant Dental laboratory technician Dietitian Environmental health and safety manager Facilities manager Home health aide Hospital maintenance engineer Internist Medical assistant Nurse Nursing assistant Ophthalmologist Optometrist Optician Physical, respiratory or other therapist Surgeon Surgical technician Veterinarian Veterinary technician	Investigators are observant and curious. They have a feel for gathering and figuring out information. Many love science, math, or history. They may prefer to work more on their own than with others. Does that sound like you? Perhaps you'd like to be one of these professionals: Biochemist Biomedical engineer or technician Computer security specialist Data analyst Epidemiologist Geneticist Health writer Hospital maintenance engineer Medical assistant Medical technologist Medical librarian Medical researcher Medical video producer Nuclear medicine technologist Pharmacist Pharmacy technician Physician Radiologic technologist Radiologist Research scientist Veterinarian	Artists are creative, imaginative, and like to express themselves. They may work with words and pictures or music and dance. They also may work with materials and machines that produce artistic products. The following may be ways to use your artistic talents: Art therapist Athletic trainer Dance therapist Dental laboratory technician Hospital or health agency public relations director Medical editor or reporter Medical illustrator or photographer Music therapist Orthodontist Plastic surgeon Prosthetist Prosthodontist Robotics engineer	Helpers are expert communicators. They work well in groups and interact well with all kinds of people. Do you see yourself working on a healthcare team? Can you imagine teaching people new skills or helping them with health problems, like these professionals? Admitting clerk Athletic trainer Biomedical engineer or technician Clinical department director Health educator Home health aide Hospital chaplain Maintenance/repair technician Medical assistant Nurse Nursing assistant Nutritionist Ophthalmologist Optometrist Optician Patient advocate Physical, respiratory, or other therapist Physician Psychiatrist Psychologist Social worker Veterinarian Veterinary technician	Do you have strong leadership qualities? Can you organize and prioritize? Are you competitive, a risk-taker? Can you persuade others to see things your way? Enterprisers have the social skills of helpers and the hands-on skills of doers like these: Biomedical patent attorney Financial, marketing, human resources, or other top manager Fund-raising director Gerontology service provider Hospital or health agency executive director Laboratory owner or operator Medical equipment entrepreneur Medical practice owner or partner Medical scientist Pharmaceutical distributor Pharmaceutical scientist Private research laboratory owner Specialized surgical clinic owner/operator Visiting nurse	Detailers have great focusing skills. They analyze facts and numbers. They're observant and able to evaluate what they perceive. They often prefer a steady routine. They like being part of a team, though not always in leadership roles. The health services career cluster has many careers for detailers like these: Accountant Administrative assistant Admitting clerk Billing office representative Biochemist Biomedical engineer or technician Biomedical patent attorney Coder Dental laboratory technician Environmental health and safety manager Facilities manager Geneticist Epidemiologist Health information technician Laboratory technician Medical illustrator Medical records manager Medical researcher Medical secretary Medical scientist Medical technologist Pathologist or medical examiner Pharmaceutical scientist Pharmacist Pharmacy technician Transcriptionist

Writing a Research Paper: Introduction to Research

LESSON 2.2

ENGLISH LANGUAGE ARTS

Time
135 minutes

Materials
Equipment
- Access to a library media center
- Access to a computer lab

Resources
- Critical Evaluation of Web Resources handout
- A Web Page Evaluation checklist or rubric, designed by the teacher or accessed from the Internet
- A Library Media organization handout that reflects the arrangement at your school

Prior Student Learning
Students should be familiar with the Dewey Decimal System

Essential Question for This Unit
What is the place for me in the health and biomedical sciences?

Objectives
After completing this lesson, students should be able to

- Describe the organization of a library media center, particularly the one at their school.
- Select and utilize appropriate reference tools.
- Critically evaluate Internet resources.
- Take concise and organized notes from reference materials.

Lesson Activities
Lesson Springboard
Ask students if they've ever read anything on the Internet that struck them as inaccurate. Chances are, they have. Find a recent example of a highly biased, or comically error-filled web page to share with students. Have students quickly go through the site to find as many errors or questionable statements as possible.

Lesson Development
Library Media Center
Explain that in today's lesson, students will learn to be critical consumers of information. The first step in that process is to locate information. The two most common venues for research are the Library Media Center and the Internet.

Take students to the Library Media Center. Together with the Media Specialist, review the basic organization of a library media center and any special features of your own media center. Be sure to cover the organization of various collections and use of the catalog system and cross-references. Describe how many libraries are connected through Interlibrary Loan.

Internet Research
Explain to students that when they are using the Internet for research, it is important to remember that not everything they find there is reliable. The Internet can be a great information resource on many topics. But putting documents or pages on the Web is easy, cheap or free, unregulated, and largely unmonitored. Even sites that seem reliable at first glance, like Wikipedia, can have substantial numbers of errors, both accidental and intentional. The burden is on users to establish the validity, authorship, timeliness, and integrity of what they find. Tell students that it is important to cultivate a habit of healthy skepticism regarding information found on the Web.

Writing a Research Paper: Introduction to Research

Review the following questions that students should keep in mind when doing research on the Internet:

- What can the URL tell you? For example, who wrote the page? Is he, she, or the authoring institution a qualified authority?
- Is the information dated? Is it current, timely?
- Is information that is cited authentic?
- Does the page have overall integrity and reliability as a source?
- Is there a bias? What is the bias?
- Could the page or site be ironic, like a satire or a spoof?
- If you have questions or reservations, how can you satisfy them?

You may wish to review a sample site with students, going through the preceding questions. And, you may refer students to one of the many websites that provide checklists for evaluating Internet resources. Two examples are Kathleen Schrock's *Critical Evaluation of A Web Site, Secondary Level*, http://school.discovery.com/schrockguide/evalhigh.html and *24/7—A Library Research Guide and Webletter—Evaluating the Web*, from the Oakton Community College Library, http://servercc.oakton.edu/%7Ejmayzel/247/evalchart.htm.

Allow students to begin research on their own topics chosen in Lesson 1.4. Have students identify a minimum of three credible resources for their research and one suspect resource.

Lesson Closure
Remind students that they will be using the resources they have located to continue research on their career selections. Go around the room and have students share an example of a credible source and a suspect source; have them justify their classifications.

Possible Prior Misconceptions

Many students believe that most information published on the Internet is accurate. Students often have difficulty in thinking critically about sources of information, especially if the publishing format looks professional. Students are especially susceptible to extensive, well-known sites like Wikipedia.

Student Assessment Artifacts

List of resources for continued research

Writing a Research Paper: Introduction to Research

LESSON 2.2

National and State Academic Standards

NATIONAL
NCTE Standards for the English Language Arts

1. Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
3. Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).
7. Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.
8. Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

CALIFORNIA
English Language Arts Content Standards

Writing

1.3 Use clear research questions and suitable research methods (e.g., library, electronic media, personal interview) to elicit and present evidence from primary and secondary sources.

Name _____ Date_____ Period _____

Critical Evaluation of Web Resources

Whenever you are using the Internet for research, it is important to remember that not everything you find there is reliable. The Internet can be a great information resource on many topics. But putting documents or pages on the Web is easy, cheap or free, unregulated, and largely unmonitored. Even sites that seem reliable at first glance, like Wikipedia, can be have subtle (or glaring!) errors. The burden is on you—the reader—to establish the validity, authorship, timeliness, and integrity of what you find. It is important to cultivate a habit of healthy skepticism regarding information you find on the Web.

Here are seven questions to ask when doing research on the Internet:

1. What can the URL tell you? For example, who wrote the page? Is he, she, or the authoring institution a qualified authority?
2. Is the information dated? Is it current, timely?
3. Is the information that is cited authentic?
4. Does the page have overall integrity and reliability as a source?
5. Is there a bias? What is the bias?
6. Could the page or site be ironic, like a satire or a spoof?
7. If you have questions or reservations, how can you satisfy them?

Writing a Research Paper: Organizing Information

LESSON 2.3

ENGLISH LANGUAGE ARTS

Time
45 minutes

Materials
- Writing Skills worksheets on Summarizing, Paraphrasing, Citing References, and Using Quotations
- Model research paper on an unrelated topic

Prior Student Learning
Students should know how to use the library and Internet as research tools.

Students should be able to skim documents for essential information.

Essential Question for This Unit
What is the place for me in the health and biomedical sciences?

Objectives
After completing this lesson, students should be able to

- Read with a critical eye.
- Take notes and site sources correctly.
- Summarize, paraphrase, and know when and how to use direct quotations.

Lesson Activities
Lesson Springboard
Research is already a big part of our lives—more than we might think. Consider the following:

- You have a chance to visit London, but you can stay only 1 week. You want to plan that week.
- You decide to get more exercise and have to pick one of several gyms in your neighborhood.
- You have taken a new job and have to choose a health plan. There are four options. Which one will be the best for you?
- Some friends tell you that a song you like is dedicated to the "victims of Darfur." You decide to find out all you can about the song and the dedication.

As these examples show, much of our work, as well as our personal lives, depend on research: we find something out and then report on it. But good research takes skill in seeking out pieces of information, evaluating their usefulness, and fitting them together to answer a question or make a decision. In this lesson, we will be researching potential health and biomedical science career options that are suited to our interests and skills.

Lesson Development
Class Discussion—Reading with a Critical Eye
Research calls for active, inquisitive reading. You must respond to what you read, and read with your research question in mind. What is your author's point of view? Is he or she an advocate or a critic? An insider or an impartial observer? How much evidence is there? What kind? How persuasive is it?

Skimming a source can tell you a lot about its value for your research question. Look at the introduction, subheadings, and at the first sen-

tences of paragraphs. Some sources end with a summary of their contents that can save you time.

Taking Useful Notes
Take notes, using your research question to guide you. What will your source help you to demonstrate? To which part of your research is the source relevant? What more do you need to know? Record the author, title, page number, and a short reference to the URL for each note: this will help to create your list of citations (see Lesson 3.3).

Student Note-Taking Project
Distribute guidelines and worksheets on summaries, paraphrases, citations, and direct quotation. Define the principles for writing effective summaries. Allow students time to write a one-paragraph summary. Then have them compare their summaries.

If time remains, let the students complete the remaining worksheets on paraphrasing, citations, and direct quotations. Otherwise, allow them to do these worksheets as **homework**.

Lesson Closure
Ask the students how they may benefit from these note-taking skills in their lives. Return to the examples from the Lesson Springboard and have the students add examples of their own.

Possible Prior Misconceptions
Some students think they must take notes on everything they read. They may think that in a summary or paraphrase, *every* word from the source must be changed. They may also overuse direct quotations in their writing.

Student Assessment Artifacts
Notes for research paper

Variations and Extensions
Divide students into groups and have them practice summarizing, paraphrasing, and quoting by using sources from their own research.

Writing a Research Paper: Organizing Information

LESSON 2.3

National and State Academic Standards

NATIONAL
NCTE Standards for the English Language Arts

7. Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.
8. Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

CALIFORNIA
English Language Arts Content Standards

Writing

1.3 Use clear research questions and suitable research methods (e.g., library, electronic media, personal interview) to elicit and present evidence from primary and secondary sources.

Name _____ Date_____ Period _____

Writing Skills: Summarizing a Reading

Summaries, which are common in academic writing, are usually a part of an essay, term paper, or written response in a test. Their purpose is to provide a brief and accurate account of ideas and information from another source or (sometimes) sources. Several principles will help you write effective summaries.

- A summary should include only the information and ideas from the source. You should not include additional information or your own opinions.
- A summary is written in complete sentences in paragraph form.
- A summary includes the main ideas and most important information from the source. It does not include secondary support, details, or digressions.
- The language of a summary should be paraphrased and not copied precisely from the source. (Not every word will require a synonym, however. Don't summarize an article on seatbelts with the phrase *vehicular restraint devices*. No synonym is needed for *seatbelt*.)

Read the section below from the article "History of Medicine" (2007) in Encyclopedia Britannica Online. Some of the text has been highlighted because it is *not* necessary for a summary.

Medicine in the 20th Century

The 20th century has produced such a plethora of discoveries and advances that in some ways the face of medicine has changed out of all recognition. In 1901, for instance, in the United Kingdom the expectation of life at birth, a primary indicator of the effect of health care on mortality (but also reflecting the state of health education, housing, and nutrition), was 48 years for males and 51.6 years for females. After steady increases, by the 1980s life expectancy had reached 71.4 years for males and 77.2 years for females. Other industrialized nations showed similar dramatic increases. Indeed, the outlook has so altered that, with the exception of diseases such as cancer and AIDS, attention has become focused on morbidity rather than mortality, and the emphasis has changed from keeping people alive to keeping them fit.

The rapid progress of medicine in this era was reinforced by enormous improvements in communication between scientists throughout the world. Through publications, conferences, and—later—computers and electronic media, they freely exchanged ideas and reported on their endeavours. No longer was it common for an individual to work in isolation. Although specialization increased, teamwork became the norm. It consequently has become more difficult to ascribe medical accomplishments to particular individuals.

Why have these parts been highlighted? Why do the other parts remain? Why are they important for a summary?

_____

_____

_____

_____

_____

Name _____ Date_____ Period _____

In the rest of this section, cross out the parts you would not include in a summary.

In the first half of the century, emphasis continued to be placed on combating infection, and notable landmarks were also attained in endocrinology, nutrition, and other areas. In the years following World War II, insights derived from cell biology altered basic concepts of the disease process; new discoveries in biochemistry and physiology opened the way for more precise diagnostic tests and more effective therapies; and spectacular advances in biomedical engineering enabled the physician and surgeon to probe into the structures and functions of the body by noninvasive imaging techniques like ultrasound (sonar), computerized axial tomography (CAT), and nuclear magnetic resonance (NMR). With each new scientific development, medical practices of just a few years earlier became obsolete.

Using the information from the sections that have not been crossed out or highlighted, write a one-paragraph summary of "Medicine in the 20th Century." Then compare your summary with those of your classmates. Remember to paraphrase the language.

Name _____ Date_____ Period _____

Writing Skills: Paraphrase

When referring to another writer's ideas, it is often necessary to *paraphrase* (restate in other words) rather than directly quote the writer's words (excerpts from "History of Medicine" [2007], Encyclopedia Britannica Online).

Examples:

"In the years following the turn of the century, ongoing research concentrated on the nature of infectious diseases and their means of transmission. Increasing numbers of pathogenic organisms were discovered and classified."

Paraphrase with different vocabulary only (often inadequate or awkward)

"Since 1900, scientists studied infections and how they spread. More and more germs that cause disease were found and defined."

Paraphrase with different vocabulary and different sentence structure (much better)

"After 1900, infectious diseases and their transmission became the focus of research. Scientists discovered and classified a growing number of disease-causing germs."

Change the vocabulary and the sentence structure of the following two examples without altering the meaning.

1. "In the field of nutrition, the outstanding advance of the 20th century was the discovery and the appreciation of the importance to health of the 'accessory food factors,' or vitamins."

Paraphrase with different vocabulary <u>and</u> different sentence structure.

2. "While progress was the hallmark of medicine after the beginning of the 20th century, there is one field in which a gloomier picture must be painted, that of malignant disease, or cancer. It is the second most common cause of death in most Western countries in the second half of the 20th century, being exceeded only by deaths from heart disease."

Paraphrase with different vocabulary <u>and</u> different sentence structure.

Name _____ Date_____ Period _____

Writing Skills: Citation

The APA (American Psychological Association) style is widely used in the social sciences. It uses parenthetical citations within a text. When you refer to the authors' ideas within your essay, you need the authors' last names and the date of publication. For example:

> Many companies are now hiring temporary and contract workers in order to increase their flexibility in a fluctuating global market (Micklethwait & Wooldridge, 2003).
>
> Micklethwait and Wooldridge (2003) report that approximately 10 percent of American workers are temporary employees or independent contractors.

You will also need a list of *References* at the end of your Career Research Paper, arranged in alphabetical order by author's last name. For example:

References

Micklethwait, J., & Wooldridge, A. (2003). *A future perfect: The challenge and promise of globalization.* New York: Random House.

Note that it is necessary to cite the source of an idea even if the language is paraphrased.

Add citations for two of the sources you will be using for your report on careers in the health sciences. If you are not sure which sources you will use, choose two that are likely candidates.

Name _____ Date_____ Period _____

Writing Skills: Using Quotations

Be careful not to overuse direct quotations. When should you quote?

- When another writer has stated something so clearly, concisely, or eloquently that you want to include his or her exact words and comment on them.
- When you want to agree or disagree with another writer and you want to be certain that his or her words are accurately reported.
- When you interview someone and want to include his or her spoken statement.

Remember that all works that you paraphrase or quote must be included in your list of references. Punctuate the quotations correctly and include in-text citations.

> Battista (2005) insists that "single payer universal health care costs [in a system that bypasses insurance companies] would be lower than the current US system" due to lower administrative costs.
>
> According to Patterson (2004), "Childbirth and reproductive care are the most common reasons for women of childbearing age to use health care."

Note that the bracketed phrase, "in a system that bypasses insurance companies" was not in the original article. It was added to clarify the meaning of the quotation.

Practice writing sentences that include quotations:

Author's name (date) defines/states/claims/declares "_____."

According to author's name (date), "_____."

Biomedical Visionaries and Advances in Health Science

LESSON 2.4

HISTORY OR ENGLISH LANGUAGE ARTS

Time
1–2 weeks

Materials
Equipment
- Access to a library media center
- Access to a computer lab

Resources
- Resources on biomedical professionals from various eras in history for the station rotation
- A Sample Research Paper

Prior Student Learning
Students should be familiar with the Dewey Decimal System and the basic organizational structure of a library media center.

Students should be comfortable using an Internet search engine and identifying effective search terms for use.

Essential Question for This Unit
What is the place for me in the health and biomedical sciences?

Objectives
After completing this lesson, students should be able to

- Briefly describe the history of medical advances throughout history.
- Explain how medical advances influence culture.
- Research and write a biographical research report complete with appropriate reference citations.

Lesson Activities
Teacher Preparation

Set up 6–12 stations around the room using a set of trifold presentation boards. Each station should cover an era in history and provide some interesting information for students on medical practices of the time, as well as health and biomedical visionaries associated with that era. You should also include some questions at each station for students to discuss during the station rotation. You may wish to focus primarily on earlier eras in history, as students will be researching more contemporary medical professionals. The following is a suggested breakdown and a few key examples:

Era 1: Earliest Human Society—trepanning

Era 2: Early civilizations—Mesopotamia, Hammurabi, Africa and Egypt, Indus Valley

Era 3: Classical Traditions, 1000 BC to 300 AD
Hippocrates, Galen, Asclepius, Susruta

Era 4: Expanding Zones of Exchange and Encounter, 300 to 1000 AD
Rhazes, Abu al-Qasim, Ibn Sina

Era 5: Intensified Hemispheric Interactions, 1000 to 1500 AD
Ibn al-Nafis, Paracelsus, Ambroise Paré, Andreas Vesalius

Era 6: The 16th and 17th centuries
William Harvey, Thomas Sydenham, Antony van Leeuwenhoek

Era 7: The Age of Revolution, 18th and 19th centuries
John Hunter, John Morgan, Benjamin Rush, Philippe Pinel, Edward Jenner, René Théophile Laënnec, James Marion Sims, Ignaz Semmelweis, Rudolf Virchow, Hermann von Helmholtz, Elizabeth Blackwell, Joseph Lister, Paul Ehrlich

Era 8: A Half-Century of Crisis 1900–1945
Santiago Ramón y Cajal, Walter Reed, Harvey Cushing, Walter B. Cannon

Biomedical Visionaries and Advances in Health Science

LESSON 2.4

Era 9: 20th Century After 1945
Ian Donald, Godfrey Hounsfield, Christiaan Barnard, James D. Watson and Francis Crick

Additional information is included at the end of the lesson.

Lesson Springboard

Ask students to share some of their role models with the rest the class. You may wish to share one of your own role models. Have students describe the characteristics of their role models that make them worthy of admiration. Briefly discuss the importance of role models and their influence on the lives of those they inspire. Tell students that over the next several days they will each be learning about a potential role model within the health and biomedical sciences.

Lesson Development

Station Rotation

Break up the class into small groups. Have students take a "walk through history" by circulating to the various stations displayed around the room. While at each station, students should answer the station's questions as a group and discuss the contributions of that era's visionaries.

Class Discussion

After students have rotated to every station, bring the class back together to discuss how medicine has evolved throughout history. Do students notice any pattern in when the greatest advances occurred? Did certain cultures tend to make advances in certain sectors of health science? You may also wish to have students speculate about how history might have been different if certain medical advances had come earlier or later.

Assignment

Tell students that they will be researching and writing a report on a historical medical visionary. Have them select at least three visionaries or eras they would like to learn more about. Remind students that a research report presents facts about a specific topic that are derived from research. A research report may also include ideas from books, magazines, newspapers, interviews, or the Internet. All ideas borrowed from different sources must be credited to the original writer or speaker. A research report should include a title page, introduction, the body of the report, a conclusion, and a list of references. Tell students that the length of a research report varies greatly according to the subject, the complexity of the topic, and the audience for which it is written. The length of the research report for this assignment is three to five pages.

Review the steps of the writing process with the class (see the outline below): (1) Prewriting—choosing a purpose, subject, and audience; gathering ideas and conducting research; arranging information (note-taking, writing an outline). (2) Writing a draft—putting ideas down on paper, including new ideas you discover as you write. (3) Evaluating and revising—making judgments about content, organization, and style; making

changes to improve the draft. (4) Proofreading—correcting errors in grammar, usage and mechanics. (5) Publishing—sharing your writing.

Provide students with the rubric that will be used to grade their final paper in English, Health Science, and History and a Sample Research Paper. Remind them that they will receive three grades for this paper.

Over the next several days, allow time for students to go through the research and writing process for this assignment. Coordinate with the English Language Arts and History teachers to determine which activities will take place in each class.

Prewriting
Note Taking—The Cornell Note-Taking strategy will help you identify the major ideas and supporting details in the text.

- Preview what you will read.
- Read the title, subheadings, first and last paragraphs, and topic sentences.
- Read the text carefully. Then note the main points in the Main Points column and the supporting details in the Evidence/Details column of your Cornell chart.
- Summarize what you have read about your subject.
- Review what you have learned about your subject.

Outlining—Use the information contained in your notes to create an outline of the report. For example:

Title: Name of historical medical visionary you have chosen to write about.

I. Introduction. Your opening paragraph will introduce the topic and get the reader's attention. It will include background information about the person you have chosen.
   A. His/her early years
   B. Education
   C. Interesting details about his/her life

II. Body paragraph(s).
   A. What were the major accomplishments of the medical visionary you have chosen to write about?
   B. What were his/her contributions to science/medicine?
   C. How did his/her contributions influence the field of science/medicine?

III. Conclusion. Write a conclusion that summarizes the important points in the paper and leaves the reader with a lasting impression.

A. What have I learned from this medical visionary? How do his/her contributions to science/medicine affect me today?

B. How can I emulate this person? What do I want to contribute to the field of science/medicine in the future?

Writing/Drafting
If you have a complete and well-organized outline, writing your paper should be no problem. Your opening paragraph must state the main point of your paper and also say something interesting or catchy to get your reader's attention.

Your closing paragraph (conclusion) should summarize the main points made in the paper and end with a strong closing sentence—one that will make a lasting impression.

Remember: Use your own words. Your writing should sound like it comes from you, a student writer. (Use quotation marks when you use someone else's words.)

Revising
Read your paper aloud. Make necessary corrections. Ask the following questions:

- Does my opening paragraph introduce the topic and get the reader's attention?
- Are my body paragraphs clear? Do they contain a main idea and details about the topic?
- Do I have a conclusion? Does it summarize the important points? Does it leave my readers with a lasting impression?
- Did I use my own words?

Editing
Check for spelling, grammar, usage, punctuation, and capitalization.

Be sure you have given credit for an author's ideas or words. Make sure you follow the guidelines for compiling your bibliography (reference list).

Be sure you have a title page.

Publishing
Type your final copy. Number your pages, along with your last name, in the upper right-hand corner starting with the first page of the body copy. **Double-space** the entire paper and leave a 1- to 1 1/2-inch margin on all sides.

Student Assessment Artifacts
Biomedical Visionary Research report

National and State Academic Standards

NATIONAL
NCTE Standards for the English Language Arts

1. Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
3. Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).
7. Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.
8. Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

CALIFORNIA
English Language Arts Content Standards

Writing

2.1 Write biographical or autobiographical narratives or short stories:

a. Relate a sequence of events and communicate the significance of the events to the audience.
b. Locate scenes and incidents in specific places.
c. Describe with concrete sensory details the sights, sounds, and smells of a scene and the specific actions, movements, gestures, and feelings of the characters; use interior monologue to depict the characters' feelings.
d. Pace the presentation of actions to accommodate changes in time and mood.
e. Make effective use of descriptions of appearance, images, shifting perspectives, and sensory details.

Sample Biomedical History Resources for Station Rotation

Era 1: Earliest Human Society (Prehistoric)

Quick Facts: Prehistoric Medicine

- Rituals, symbols, and magic used for healing
- Drinking blood
- Eating plants
- Possibly splints for broken bones
- Trepanning

Trepanning

Trepanning is one of the oldest known forms of surgery. It consists of drilling, grinding, or scraping a hole in the human skull. This process, which has been documented to ancient times 4,000 years ago, was thought to be performed to relieve headaches, cure insanity, release evil spirits, or relieve cranial pressure resulting from head trauma. There is evidence that suggests some people survived the surgery and had additional trepanning. Trepanning is still done today. In the realm of pseudoscience, it is done without medical need. In cases of head trauma, doctors can perform a similar operation called a craniotomy.

Illustrated Histories:
http://neurophilosophy.wordpress.com/2007/06/12/an-illustrated-history-of-trepanation
http://library.thinkquest.org/J0111742/Trepanning.htm
http://www.uic.edu/classes/osci/osci590/6_2Trephination.htm

Era 2: Early Civilizations

Quick Facts: Medicine of Early Civilizations

- Beginning of surgery.
- Use of prescriptions.
- Documentation of medical conditions and practices.
- Misconceptions include that disease and healing are linked with religion, inaccurate concepts of organs, and blood flow.
- Beginning of medical conduct and patients' rights codes.

Mesopotamia

Ancient tablets with cuneiform writings have been discovered in the ancient region of Mesopotamia. One of these tablets contained the "Treatise of Medical Diagnosis and Prognoses" which dates as far back as 1600 BC, and contains detailed descriptions of diseases and medical procedures. It is also said that Mesopotamians performed two types of medical care, with one practitioner treating illness with potions and other remedies while another practitioner performed magical or supernatural treatments.

History of Ancient Medicine in Mesopotamia and Iran:
http://www.iranchamber.com/history/articles/ancient_medicine_mesopotamia_iran.php

Hammurabi (1792–1750 BC)

Hammurabi was the king of the Babylonian empire that included Mesopotamia. He created the Code of Hammurabi. In addition to explaining standards for human conduct and punishments, the Code explained a fee schedule for surgery that was dependent on the outcome of the procedure. This code also listed patients' rights.

Code of Hammurabi (218–223 relate to medical care):
http://eawc.evansville.edu/anthology/hammurabi.htm

Africa and Egypt

Much of Egypt's history is documented on papyrus scrolls. Egyptian mummification indicates advanced knowledge of anatomy, because the internal organs of the deceased were removed. Egyptians also performed embalming, faith healing, surgery, and autopsy. Even though Egyptian medicine was advanced for its time, Egyptians still had a few mistaken beliefs. For instance, they believed the heart was the center of thought—because it often responded, with a quickened heartbeat, to emotion and thought—and that the brain pumped blood.

Edwin Smith Surgical Papyrus:

http://faculty.washington.edu/chudler/papy.html

Egyptian mummies:

http://www.si.edu/Encyclopedia_SI/nmnh/mummies.htm

http://www.pbs.org/wgbh/nova/chinamum/mummies101.html

Indus Valley

Ayurvedic medicine was formed in the Indus Valley, which is located in the region of Pakistan and India. This form of medicine is composed of eight highly developed branches:

- Internal medicine
- Surgery
- Ears, eyes, nose, and throat
- Pediatrics
- Toxicology
- Purification of the genetic organs
- Health and longevity
- Spiritual healing/psychiatry

Map of 500 BC India:
http://www.fsmitha.com/h1/map06ind.htm
The history of Ayurveda:
http://www.floridavediccollege.edu/ayurveda/history.htm

Era 3: Classical Traditions, 1000 BC–300 AD

Quick Facts: Medicine of the Classical Era

- Belief that health was related to the body's balance of four *humors*: blood, black bile, phlegm, and yellow bile.
- Surgery was practiced.
- Diet was considered important to health.
- Documented animal dissections provided insight into internal organs.
- Beginning of separation between religion and medicine.

Hippocrates (ca. 460–377 BC)

Hippocrates is known as the founder of medicine. He rejected previous ideas that illness was caused by supernatural forces, and this led to the separation of medicine from religion. His methods of treatment were disciplined. He observed patients with great detail and took copious notes. Hippocrates' oath of medical ethics is the foundation of the Hippocratic Oath that many physicians still take today.

Works by Hippocrates:
http://classics.mit.edu/Browse/browse-Hippocrates.html

Hippocrates' Oath:
http://classics.mit.edu/Hippocrates/hippooath.html

The Modern Hippocratic Oath:
http://www.pbs.org/wgbh/nova/doctors/oath_modern.html

Galen (ca. 129–199 AD)

In an age when human dissections were not allowed, Galen dissected Barbary apes and other animals and documented his work in *On the Natural Faculties*. His animal dissections and other experiments were central to human anatomy until a later period when human bodies were dissected and internal differences were discovered.

Biography:
http://scienceworld.wolfram.com/biography/Galen.html

Galen's *On the Natural Faculties*:
http://classics.mit.edu/Galen/natfac.html

Asclepius (Greek Mythology)

In ancient Greek mythology, Asclepius is the god of medicine and healing. His staff, The Rod of Asclepius, features a rod with a snake wrapped around it. It serves as a symbol for medicine for many medical organizations today.

Biography:

http://www.pantheon.org/articles/a/asclepius.html

Medical Symbols:

http://humanism.med.ufl.edu/symbol.htm

Image and explanation of the EMT Star of Life:

http://159.238.148.163/ems/starpage.htm

Susruta (ca. 5th century BC)

Susruta was a physician and surgeon, known as the father of Indian Surgery, who lived in ancient India. In his book, *Sushrutasamhita*, he detailed many surgical procedures and instruments. It is also claimed that he performed the first plastic surgeries.

Biography:
http://www.infinityfoundation.com/mandala/t_es/t_es_agraw_susruta.htm

Era 4: Expanding Zones of Exchange and Encounter, 300–1000 AD

Quick Facts: Medicine 300–1000 AD

- Introduction of alchemy and chemistry to medicine.
- Use of medicines.
- Medical advances stalled in Western Europe as the region entered the Dark Ages.

Rhazes (al-Razi) (ca. 864–930)

Rhazes was born in what is now Iran. He was a physician and alchemist whose contributions to medicine include

- Authoring many works, including the *Al-Hawi* (The Complete Book of Medicine), which incorporated other known medical knowledge, and *Al-Judari wa al-Hasabah*, which contained his research that differentiated the deadly smallpox virus from the less severe chicken pox virus.
- Introducing the use of alcohol in medicine.
- Discovery of sulfuric acid.

Biographies:
http://www.trincoll.edu/depts/phil/philo/phils/muslim/razi.html
http://www.unhas.ac.id/~rhiza/saintis/razi.html

Abu al-Qasim (936–1013)

Al-Qasim was an Arabic physician who is considered the father of surgery. He authored much medical writing and developed tools to be used in surgery.

Biography:
http://www.ummah.net/history/scholars/ZAHRAWI.html

Ibn Sina (Avicenna) (ca. 980–1037)

Ibn Sina was a Persian physician who authored many books including his famous *Book of Healing* and *The Canon of Medicine*. The latter was used as a medical text in Europe for many centuries.

Biography:
http://www.sjsu.edu/depts/Museum/avicen.html

Era 5: Intensified Hemispheric Interactions, 1000–1500 AD

Quick Facts: Medicine 1000–1500 AD

- Medical advances remained slow in Western Europe during the Middle Ages due to conflicts between science and religion.
- Specialized centers for the study of medicine were established in Europe
- Bloodletting was used as a medical treatment

Roger Frugard (1140-1195)

Frugard was a surgeon trained Salerno, Italy. He wrote the first dominant text on surgical procedures. His work contributed to the establishment of the Salernitan medical school as the primary site for the medical training and treatment in medieval Europe. Medical texts compiled and translated at Salerno were the basis for European medical education for several centuries.

Biography:
http://en.wikipedia.org/wiki/Rogerius_(physician)

Theodoric de Lucca (1205-1248)

De Lucca was an early proponent of maintaining cleanliness during surgical procedures. De Lucca surgical technique also included the use of an opium mixture as an anesthetic during difficult procedures. Opium had previously been used by the Chinese as a pain reliever.

Background:
http://www.medscape.com/viewarticle/468454_2

Ibn al-Nafis (1213–1288)

Al-Nafis, an Arabic physician, disputed Galen's concepts of blood flow and became the first to accurately describe the pulmonary circulation of blood.

(Note: William Harvey (1578–1657) is also credited with describing blood circulation.)

Biography:
http://www.timelinescience.org/resource/students/blood/ianafis.htm

Era 6: The 16th and 17th Centuries

Quick Facts: Medicine of the 16th and 17th Centurty

- Better wound treatment reduced infections
- Human dissections provided accurate descriptions and functions of organs
- Discovery of microorganisms through improved microscopes
- Accurate identification of the circulation of blood

Paracelsus (1493–1541)

Paracelsus was a Swiss physician who used chemicals and minerals in medicine. Many consider Paracelsus the father of toxicology. He discovered that pouring boiling water over wounds to close them was not the best treatment because of the resulting infections. Paracelsus found that wounds had less incidence of infection if allowed to properly drain and heal naturally.

Biography:
http://www.alchemylab.com/paracelsus.htm

Ambroise Paré (ca. 1510–1590)

Paré is considered to be the father of modern surgery. He was a specialist at treating wounds and he introduced the use of *ligature* (the tying off of arteries) after amputations. The previous method was called *cauterization*; it involved burning and led to increased tissue damage.

Biography:
http://www.strangescience.net/pare.htm

Andreas Vesalius (1514–1564)

A physician and anatomist, Vesalius was the founder of modern human anatomy. He authored an influential book in the field of anatomy, *De Humani Corporis Fabrica* (On the Workings of the Human Body), which included many meticulous drawings of his human dissections. Before this time, human dissections were not allowed.

De Humani Corporis Fabrica:
http://vesalius.northwestern.edu

Biography:
http://www.bbc.co.uk/history/historic_figures/vesalius_andreas.shtml

William Harvey (1578–1657)

Harvey was an English physician. He accurately described blood circulation and how the heart pumps blood around the body, dismissing previous ideas that the human body contained two different types of blood.

Biography:
http://www.williamharvey.org/wm_harvey.htm

Thomas Sydenham (1624–1689)

Sydenham has been described as both the father of English medicine and the English Hippocrates because of the detail in his observations and accuracy of his records, in which he documented descriptions of numerous diseases.

Biography:
http://www.sydenham.org.uk/thomas_sydenham.html

Antony van Leeuwenhoek (1632–1732)

Van Leeuwenhoek is the father of microbiology. He improved the microscope and became the first to see microorganisms, which he called *animalcules*.

Biography:
http://www.ucmp.berkeley.edu/history/leeuwenhoek.html

Images of specimens:
http://www.brianjford.com/wavintr.htm

Era 7: The Age of Revolution, 18th and 19th Centuries

Quick Facts: Medicine in the Age of Revolution

- Acceptance of the importance of hand washing and sterility.
- Acceptance of humane treatment for the mentally ill.
- Development of vaccines, antiseptics and the stethoscope.
- Beginning of U.S. medical schools.

John Hunter (1728–1793)

Hunter was a Scottish surgeon whose contributions to medicine include
- Authoring *Natural History of Human Teeth*, in which he coined the terms *molars, incisors, cuspids,* and *bicuspids*.
- Study of inflammation.
- Improving treatment of gunshot wounds.

Biography:
http://www.surgical-tutor.org.uk/default-home.htm?surgeons/hunter.htm~right

John Morgan (1735–1789)

Morgan founded the first U.S. medical school at the College of Philadelphia (now the University of Pennsylvania).

Biography:
http://www.archives.upenn.edu/histy/features/1700s/people/morgan_john.html

Benjamin Rush (1745–1813)

Rush was an American physician, a signer of the Declaration of Independence, and writer, educator, and humanitarian. His contributions to medicine include
- The belief that mental illness could be cured with proper treatment.
- The concept of addiction.

Biographies:
http://www.colonialhall.com/rush/rush.php
http://www.nsfoundation.org/rush.htm

Philippe Pinel (1745–1826)

A founder of modern psychiatry, Pinel pioneered humane treatment for the mentally ill, for whom the previous treatment was often cruel and inhuman. In 1806, he wrote his *Treatise on Insanity*, which had a major influence on many psychologists in the 19th century.

Biography:
http://www.nsfoundation.org/pinel.htm

Edward Jenner (1749–1823)

Jenner discovered that material from the cowpox virus could be used as a vaccination for smallpox (a deadly and feared disease). This was the first vaccine.

Jenner Museum:
http://www.jennermuseum.com

René Théophile Laënnec (1781–1826)

Laënnec, a French physician, invented the stethoscope in 1816 and wrote a classic book referred to as the *Treatise*, in which terms were introduced that doctors still use today in reference to chest diseases.

Images of early stethoscopes:
http://www.antiquemed.com/monaural_stethoscope.htm

Biography and images:
http://www.clinmedres.org/cgi/content/full/4/3/230

James Marion Sims (1813–1865)

Sims is considered the "father of American gynecology" and was also a surgical pioneer.

Biography:
http://www.archives.state.al.us/famous/j_sims.html

Ignaz Semmelweis (1818–1865)

Semmelweis has been termed the savior of mothers. In a time when puerperal fever proved fatal in as many as 3 out of 10 women who gave birth in clinics, Semmelweis used inductive reasoning to determine that doctors washing their hands would reduce the incidence of these postpartum infections.

Biography:
http://www.cdc.gov/ncidod/eid/vol7no2/cover.htm

Hermann von Helmholtz (1821–1894)

Von Helmholtz was a German physician and physicist. His contributions include his theories on vision and visual perception. He also invented the first recognized ophthalmoscope, an instrument that allowed internal examination of the eye.

Biography:
http://www.helmholtz.de/en/Who_we_are/History_of_the_Helmholtz_Association/Hermann_von_Helmholtz.html

Biography and images:
http://www.aaofoundation.org/what/heritage/exhibits/online/ophthalmoscope.cfm

Rudolf Virchow (1821–1902)

Virchow was a German doctor who became known as the "father of pathology" for his theory that every cell originates from an exact existing cell. His theory rejected prior beliefs that cells were created through spontaneous generation.

Biography:
http://www.mnsu.edu/emuseum/information/biography/uvwxyz/virchow_rudolf.html

Elizabeth Blackwell (1821–1910)

In 1849, Blackwell graduated at the top of her class while becoming the first female to earn a medical degree in the United States.

Biography:
http://www.nlm.nih.gov/changingthefaceofmedicine/physicians/biography_35.html

Clara Barton (1821-1912)

Barton was an educator, Civil War nurse, and founder of the American Red Cross.

Biography:
http://www.nps.gov/archive/anti/clara.htm

Joseph Lister (1827–1912)

Lister was an English surgeon who made important contributions to the use of antiseptics in surgery. He saw the need for sterility. He began requesting surgeons to wash their hands with a solution of carbolic acid and began using carbolic acid on wounds and surgical equipment to prevent infections that sometimes led to amputation.

Biography:
http://campus.udayton.edu/~hume/Lister/lister.htm

Paul Ehrlich (1854–1915)

Ehrlich was German scientist who in 1908 was awarded a Nobel Prize for his efforts in the field of immunization. He is also credited with creating the first antibiotic. After overcoming tuberculosis he began to search for "magic bullets," compounds that would seek out and disable disease-causing organisms without harming the infected person. He became a central figure in the field of chemotherapy with his discovery of two compounds that were effective against syphilis and that would become the standard treatment.

Biography:
http://nobelprize.org/nobel_prizes/medicine/laureates/1908/ehrlich-bio.html

ERA 8: A Half-Century of Crisis, 1900–1945

Quick Facts: Medicine During the Half-Century of Crisis

- Medical technology and technology use improved, e.g., better x-ray images and microscopes.
- Causes of diseases were identified.
- Public health methods improved.
- Mass production of antibiotics.
- Lobotomies (cutting portions of the brain's frontal lobe) were performed to treat psychiatric disorders. This controversial operation often left patients in a lifelong vegetative state.

Santiago Ramón y Cajal (1852–1934)

Cajal was a Spanish physician and histologist and is considered a founder of neuroscience. He won the 1906 Nobel Prize in medicine, which he shared with another scientist, for their research on the nervous system. Cajal's conclusion that the nervous system is made up of individual cell elements instead of one continuous element is the organizational principle that is used today. He also published many science writings.

Biography and images:
http://nobelprize.org/nobel_prizes/medicine/articles/cajal

Walter Reed (1851–1902)

Reed was a U.S. Army doctor who opened the fields of epidemiology and biomedicine by isolating the cause of yellow fever in Cuba. He confirmed the hypothesis of Dr. Carlos Finlay that yellow fever was transmitted by mosquitoes, not by the clothing and bodily fluids of yellow fever victims.

Biography:
http://yellowfever.lib.virginia.edu/reed/reed.html

Harvey Cushing (1869–1939)

Cushing was a pioneer of brain surgery and 1926 Pulitzer Prize winner for his biography of William Osler, the father of modern medicine. His contributions to medicine include

- Improving the survival rate for brain surgery
- Diagnosing brain tumors with X-rays
- Discovery of Cushing's disease (a malfunction of the pituitary gland)
- His teachings

Biography:
http://www.surgical-tutor.org.uk/default-home.htm?surgeons/cushing.htm~right

Walter B. Cannon (1871–1945)

Cannon was an American physiologist. His contributions to medicine include

- Using salts of metals for ingestion to improve X-ray images during investigations of the digestive tract
- Researching the emergency function of the sympathetic nervous system and coining the term fight or flight to describe the physiological response to threat
- The concept of homeostasis (the ability of an organism to maintain an internal equilibrium)

Cannon also published several writings.

Biography:
http://www.harvardsquarelibrary.org/unitarians/cannon_walter.html

ERA 9: 20th Century After 1945

Quick Facts: Late 20th Century

- Discovery of DNA
- Inventions: pacemaker, CAT scan, ultrasound, and the artificial heart
- Organ transplants
- Controversial medical research dealing with cloning and stem cells created the need to revisit medical policy and ethics

Ian Donald (1919–1987)

Donald pioneered the use of ultrasound in medicine. Ultrasounds are commonly used today during pregnancy. Ultrasounds are used to provide a view of the fetus inside of the mother. Ultrasounds also serve other uses such as identifying internal abnormalities.

Ultrasound images:
http://www.ob-ultrasound.net/frames.htm

Christiaan Barnard (1922–2001)

Christiaan Barnard was a South African surgeon who performed the first successful human heart transplant in 1967.

Biography:
http://www.pbs.org/wgbh/aso/databank/entries/bmbarn.html

James D. Watson (b. 1928) and Francis Crick (1916–2004)

This pair of biologists won the 1962 Nobel Prize in medicine, along with another scientist, for their discovery of the structure of DNA molecules. DNA is often referred to as the "Code of Life," which made this discovery one of the most important of the 20th century.

Discovery of DNA:
http://www.pbs.org/wgbh/aso/databank/entries/do53dn.html

DNA image:
http://www.pbs.org/wgbh/nova/sciencenow/3214/01-coll-04.html

PBS DNA slide show:
http://www.pbs.org/wgbh/nova/photo51/picturing.html

Helen Brooke Taussig (1898-1986)

Taussig is known as the founder of pediatric cardiology. Her most significant contribution to the field of medicine was her discovery of the cause for anoxemia, or "blue baby" syndrome, and her suggestion of its operative treatment. The operation resulting from her initiative was a major breakthrough in the development of cardiac surgery.

Useful Links

- United States National Library of Medicine: http://www.nlm.nih.gov
- Images from the History of Medicine (image database): http://wwwihm.nlm.nih.gov/cgi-bin/gw_44_3/chameleon?skin=nlm
- History of Medicine: http://www.nlm.nih.gov/hmd/index.html
- A Short History of Medical Careers: http://library.thinkquest.org/15569/hist-1.html
- Sir William Osler's *The Evolution of Modern Medicine*: http://etext.virginia.edu/toc/modeng/public/OslEvol.html

Finding a Good Match

SUBUNIT 3 OVERVIEW

Essential Question for This Unit

What is the place for me in the health and biomedical sciences?

Subunit Goals

By the end of Subunit 3, students will have completed analyzing the three potential career choices they selected in Subunit 2 and will have chosen one as best matching their current interests. As part of this education and career planning activity, they will have conducted a comparison and analysis of education levels and salaries in a variety of health and biomedical science careers. Students will also have compared typical tasks and responsibilities for each career to their own interests and skills. Finally, students will have written up this analysis in a formal research report—including an introduction, report, analysis, conclusions, and citations—and reported results of this research to the class.

Subunit Key Questions

- Is continuing my education really important for my future? Will finishing high school and going on to postsecondary education have a significant effect on my earning potential? (Algebra I)
- What factors should I take into account when choosing a career? (English Language Arts)
- What are the appropriate ways to communicate findings from research to an outside audience? How can my research be presented to others in a formal and concise manner? (English Language Arts)
- Why is it important to acknowledge where I found my information? Why are citations important? (English Language Arts)

Lesson Summaries

Lesson	Subject	Description
3.1	Algebra I	***Comparing Salary and Education*** Students compare the educational requirements and expected salaries of a wide range of health and biomedical science careers and draw conclusions about the monetary value associated with each additional year of education attained.
3.2	English Language Arts	***Writing a Research Paper: Writing Process*** Students organize their notes and research into an outline and produce drafts of a final report. Students share and critique each other's efforts in peer editing groups.
3.3	English Language Arts	***Writing a Research Paper: Citations*** Students learn the proper way to cite their sources in a research paper following APA style and incorporate this knowledge into their final research paper.

Comparing Salary and Education

LESSON 3.1

ALGEBRA I

Time
50 minutes

Materials
Equipment
- Calculators
- Graph paper
- Chart paper
- Markers

Resources
- Education and Salary worksheet
- Data for Education and Salary Analysis table
- Linear Regression on a TI-85 Graphing Calculator handout (optional)
- Where Do They Work? worksheet (optional)

Prior Student Learning
Students should have a basic understanding of linear and exponential graphs.

Students should have some familiarity with using a graphing calculator.

This lesson can be done with data from students' career research, provided they have completed lessons from Subunit 2.

Essential Question for This Unit
What is the place for me in the health and biomedical sciences?

Objectives
After completing this lesson, students should be able to

- Analyze the educational requirements and salaries for careers in the health and biomedical sciences and apply this knowledge to more general education and career planning.
- Analyze the number of people employed in various medical careers and the type of organization in which they work, and use this information for education and career planning.

Lesson Activities
Lesson Springboard
Ask students what they expect, or hope, their salary will be in 10 years and in what jobs they can earn that salary. If students have completed their career research, they should have a fairly realistic impression of salary expectations in various healthcare positions.

Lesson Development
Class Discussion
Pass out the Education and Salary worksheet. Explain that in today's lesson students will be conducting an analysis of how education influences earning potential in biomedical research and healthcare professions. Have students provide the required education and average salary for each of the careers they have been researching for their Career Research Paper. Record this information on the board so that students can use it to complete their data chart.

Support Strategy
If students have not completed their career research, or they did not bring the information to class, use data from the *Occupational Outlook Handbook*.

Small Group Work
Give students time in class to calculate the average salary difference per year of education. You may have students work individually or in pairs. Students will also be constructing graphs representing their data. Have students discuss in pairs or small groups the type of graph that would best represent their data. Have each group report and justify its decision to the class.

Lesson Closure
Have students display their graphs around the classroom. Discuss the answers to the questions from the worksheet. Were differences in salaries similar to students' expectations? Why or why not? What conclusions can students draw from this analysis?

Comparing Salary and Education

LESSON 3.1

Student Assessment Artifacts

Graph and calculations from Education and Salary worksheet
Completed Where Do They Work? Worksheet (optional)

Variations and Extensions

Ask students to graph the class data on salary and education level in a scatter plot. Using linear regression, have student find the best-fit line for their data. Discuss how this differs from their calculations of average salary compensation per additional year of education.

You can use employment data as a review for percentage calculations as well. Pass out the Where Do They Work? worksheet. As a class, interpret the data chart by answering the questions on the worksheet.

National and State Academic Standards

NATIONAL
NCTM Standards for School Mathematics

Algebra
Understand patterns, relations, and functions

Represent and analyze mathematical situations and structures using algebraic symbols

Use mathematical models to represent and understand quantitative relationships

CALIFORNIA
Mathematics Content Standards

6.0 Students graph a linear equation and compute the *x*- and *y*- intercepts (e.g., graph $2x + 6y = 4$). They are also able to sketch the region defined by linear inequality (e.g., they sketch the region defined by $2x + 6y < 4$).

7.0 Students verify that a point lies on a line, given an equation of the line. Students are able to derive linear equations by using the point-slope formula.

10.0 Students add, subtract, multiply, and divide monomials and polynomials. Students solve multistep problems, including word problems, by using these techniques.

13.0 Students add, subtract, multiply, and divide rational expressions and functions. Students solve both computationally and conceptually challenging problems by using these techniques.

16.0 Students understand the concepts of a relation and a function, determine whether a given relation defines a function, and give pertinent information about given relations and functions.

18.0 Students determine whether a relation defined by a graph, a set of ordered pairs, or a symbolic expression is a function and justify the conclusion.

Content Standards for Probability and Statistics

8.0 Students organize and describe distributions of data by using a number of different methods, including frequency tables, histograms, standard line and bar graphs, stem-and-leaf displays, scatter plots, and box-and-whisker plots.

Name _____ Date_____ Period _____

Education and Salary

Collect the following data from the class and enter the information in the table provided: occupation, type of degree or certification, number of years of education required, and salary.

Occupation	Degree/Certification	Years of Education	Salary

1. Group the data shown above by the years of education; compute the average salary for each group. Graph the results on a separate sheet of paper (years of education versus average salary).

Education Level	Average Salary
Certificate	
Associate's (2 years)	
Bachelor's (4 years)	
Master's (6 years)	
Doctorate (8+ years)	

2. Once the average salaries for certificate, 2-year, 4-year, 6-year, and 8+ years are computed, calculate the average increment in salary for every year of education.
3. At each average salary level, how long would it take to "earn back" the extra years spent in school?
4. If you worked for 40 years, what would be the total difference in earnings over a lifetime between careers that require different levels of education?

Name _____ Date_____ Period _____

Data for Education and Salary Analysis

Use the following data obtained from the U.S. Department of Labor, Bureau of Labor Statistics, *Occupational Outlook Handbook 2006–07* (http://www.bls.gov/oco/cg) to do your analysis.

Occupation	Degree/Certification	Years of Education	Annual Salary
Audiologist	Doctorate	8	$51,740
Cardiovascular Technician	Associate's	2	$38,960
Clinical Laboratory Technologist	Bachelor's	4	$40,186
Clinical Laboratory Technician	Associate's	2	$31,928
Dental Assistant	Certificate	<1 year	$28,330
Dental Hygienist	Associate's	2	$58,344
Dentist	Doctorate	8	$128,000
Diagnostic Medical Sonographers	Associate's	2	$52,490
Registered Dietician	Bachelor's	5	$43,630
Diet Technician	Associate's	2	$29,998
EMT/Paramedic	Certificate/Associate's	1 semester to 2 years	$25,310
Licensed Practical Nurse	Certificate	1	$33,970
Medical and Health Services Manager	Master's	6	$67,430
Medical Assistant	Certificate	1	$24,610
Medical Records and Health Informatics Technicians	Associate's	2	$25,590
Nuclear Medical Technologist	Bachelor's	4	$56,450
Home Health Aide	Program	80-120 hours	$20,987
Occupational Therapist Assistant	Associate's	2	$38,450
Occupational Therapist	Master's	6	$54,660
Optometrist	Doctorate	8	$88,410
Pharmacists	Doctorate	8	$84,900
Pharmacy Technician	Certificate	1 semester	$23,649
Physical Therapy Technician	Associate's	2	$37,890
Physical Therapist	Master's	6	$60,180
Physician Assistant	Master's	6	$69,410
Physicians and Surgeons	Doctorate	11+	$193,328
Podiatrist	Doctorate	8+	$94,400
Psychologist	Doctorate	8	$54,950
Radiological Technologist	Associate's	2	$43,350
Registered Nurse	Associate's/Bachelor's	2/4	$53,330
Respiratory Therapist	Associate's	2	$43,140
Social Worker	Master's	6	$34,820
Surgical Technician	Associate's	2	$34,010
Veterinarian	Doctorate	8	$66,590
Veterinary Technologist	Associate's	2	$24,940

Name _____ Date_____ Period _____

Linear Regression on a TI-85 Graphing Calculator

When you analyze a set of data, it is often helpful to see the data represented as a graph. Graphing calculators are capable of plotting points and finding the equation of a line that best fits your data. The most basic relationship is a linear relationship. Follow these steps to curve fit a line to a data set.

1. Clear the statistical memory.
   Clear any data by pressing [STAT] [EDIT] [ENTER] [ENTER] [CLRxy].

2. Enter new data set.
   To enter data, move the cursor with the arrow keys to the appropriate *x* or *y* values.
   Press [ENTER] after each value.

3. Size the graph.
   Press [GRAPH], and then press [RANGE] to adjust the scale of the viewing screen.
   Enter appropriate values for xMin, xMax, xScl, yMin, yMax, and yScl.
   Press [EXIT].

4. Plot the data points.
   Press [STAT] [DRAW] [SCAT] to display the scatter plot of your data points.
   If you wish to connect the points, press [xyLINE].
   To clear the line, or the scatter plot, press [CLDRW].
   Press [EXIT].

5. Find the equation for the best-fit line.
   Press [CALC] [ENTER] [ENTER] [LINR] to have the calculator best fit a linear equation.
   The numbers displayed are for the linear equation form: $y = a + bx$.
   In this case, *a* is the y-intercept and *b* is the slope.

The number "corr" should be between 1 and –1. This number is the correlation coefficient. It is a measure of the goodness of fit of the line to the data points. If the absolute value of the correlation coefficient is close to 1, than the line is a good fit. If the correlation coefficient is closer to 0, the fit is not very good.

6. Draw in the best fit line.
   Press [EXIT] [DRAW] [DRREG] [EXIT] to draw in the straight line represented by the equation.

Other instructions for using the TI-85 Graphing Calculator can be found on the following web pages:
http://www.lcc.edu/mcs/handouts/math121/linear_regression/linreg85.htm

http://www.prenhall.com/esm/app/calc_v2/calculator/medialib/Technology/Documents/TI-85/desc_pages/ti85techskills2.html

Name _____ Date_____ Period _____

Where Do They Work?

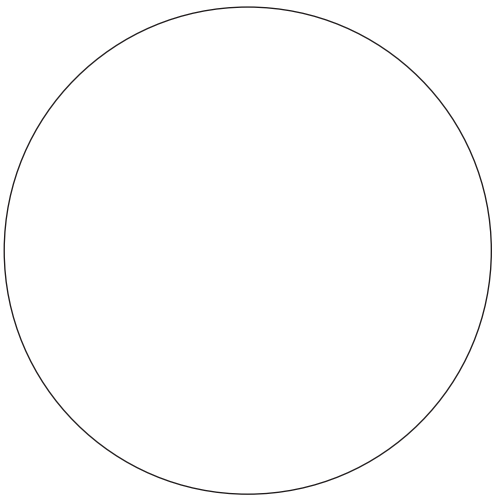
Percent Distribution of Wage and Salary Employment and Establishments in Health Services, 2004

Establishment Type	Establishments	Employment
Health Services, total	**100.0%**	**100.0%**
Hospitals, public and private	1.9	41.3
Nursing and residential care facilities	11.6	21.3
Offices of physicians	37.0	15.5
Offices of dentists	21.0	5.7
Home healthcare services	3.0	5.8
Offices of other health practitioners	18.7	4.0
Outpatient care centers	3.2	3.4
Other ambulatory healthcare services	1.5	1.5
Medical and diagnostic laboratories	2.1	1.4

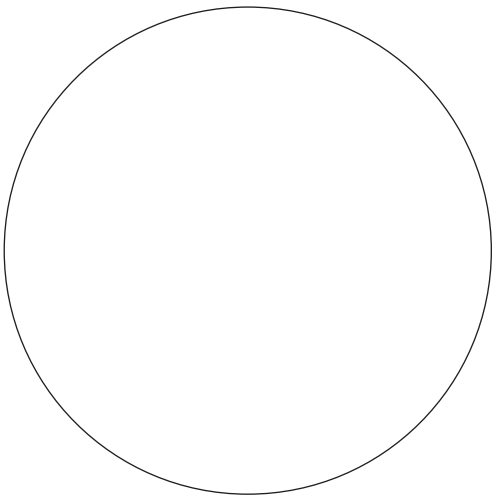
Source: U.S. Department of Labor, Bureau of Labor Statistics (http://www.bls.gov/oco/cg/cgs035.htm).

1. What percentage of establishments are offices? What percentage of employees work in offices?
2. Using the above data, construct a pie chart for the types of establishments that employ health services workers. Construct a second pie chart showing the distribution of health services employees working in various types of establishments. In which type of establishment is there the biggest discrepancy between the number of establishments and the number of employees? What do you think is the reason for this?

Type of Establishment



Employment in Each Type of Establishment



3. If there are 545,000 establishments, how many of each type of establishment are there?

Writing a Research Paper: Writing Process

LESSON 3.2

ENGLISH LANGUAGE ARTS

Time
135 minutes

Materials
- Health and Biomedical Science Careers Research Notes Template from Lesson 2.3
- Other student research notes
- Model research paper
- Peer Editing worksheet

Prior Student Learning
Students need to have completed Lessons 2.2 and 2.3 and taken notes required by the Health Careers Research Guidelines.

Essential Question for This Unit
What is the place for me in the health and biomedical sciences?

Objectives
After completing this lesson, students should be able to

- Organize notes.
- Create an outline.
- Write a rough draft of a six-paragraph paper.
- Craft a skillful introduction.
- Organize body paragraphs with topic sentences.
- Distinguish analysis from reporting.

Lesson Activities
Lesson Springboard
Class Discussion
Begin with a discussion on how to organize the paper. Refer students to their Research Notes Template and other notes and ask them how their information may be organized into a paper.

The Introduction
After conducting your research, you have two types of information: about yourself, your desires and aptitudes; and about careers, their nature and requirements. Does this suggest a principle for organizing your paper? How could you include both in an introduction? Remember that the introduction *forecasts your main points and ends with a thesis statement.*

The Body Paragraphs: Report
Is it best to report on each career, one at a time? If so, how do you organize your findings on each career? You have six categories in the Research Notes Template; can they be combined into two coherent paragraphs? Three paragraphs?

Or is it better to report on each *category* one at a time?

The Body Paragraphs: Analysis and Conclusion
What's the difference between reporting on careers and analyzing them? (The answer is, analysis means connecting the reports to your *research question*: "What is the best career for me?")

Say that you've described yourself and your career desires in the introduction. Could you return to this in your analysis—without just repeating what you said? Allow for some discussion and then distribute the sample outline.

Writing a Research Paper: Writing Process

Sample Outline
Present the major sections of the research paper that students might include in an outline.

- Introduction: Myself, my hopes, a brief description of three careers
- First Section (two or three paragraphs): Report on first career
- Second Section: Report on second career
- Third Section: Report on third career
- Fourth Section: Analysis of the three careers. Which is best for me?

Invite students to discuss, even criticize, the outline. Ask them to criticize the fourth section, in particular. How can we compare three careers when the student has so many aspirations to consider (aspirations for job security, pay and promotions, intellectual challenge, satisfying colleagues, travel opportunities, reasonable hours, etc.)?

Clearly, one must have grounds for comparison, and these must be limited to a reasonable number. Suggest to students that they select their two most important desires to serve as grounds for comparison.

Class Project
Students begin to incorporate their notes into the outline. Tell them they may change the outline if they have an alternative. Refer them to the model research paper for help. At the end of class, invite students to share what they've done. Check to make sure they're connecting their analysis to their research question, using the career reports as relevant supporting evidence.

Student Presentations
Invite students who are well under way on their rough drafts to read their introductions to the class. Return to the points from last period regarding an effective introduction. Does the introduction concisely describe the student's aspirations and the three careers in question? Does it include a clear thesis statement?

Group Work: Peer Editing
Distribute the Questions for Peer Editing worksheet so that each student can edit another student's paper. Review the questions on the worksheet that the peer editor will be addressing.

The Introduction
1. Does the introduction identify the topic of the paper?
2. Does the introduction define any special terms that are important for discussion (such as *biomechanics*)?
3. Does the introduction provide background information on the topic?
4. Does the introduction include a clear thesis statement?

The Body Paragraphs: Reporting Careers

1. Does the body of the essay develop the thesis?
2. Does each paragraph begin with a topic sentence (not a quotation or paraphrase of someone else's idea)?
3. Does each paragraph discuss and cite research on the topic?
4. Is the paper clearly organized to lead the reader from one idea to the next?
5. Is the tone of the paper objective (not emotional or opinionated)?

The Body Paragraphs: Analyzing Careers for Me

1. Are the grounds for analysis and comparison limited and clearly defined?
2. Is the analysis connected to the desires and expectations stated in the introduction?
3. Is comparable attention given to all three careers?

Format

1. Does the paper have a good title?
2. Are the citations clear and ready to be collected into a Reference list?

Suggestions for improvement?

Class Discussion

Ask students to volunteer some of the most important suggestions they made during their editing of a peer's work. Use these observations as the basis for a class discussion.

Lesson Closure

With the experience of writing still fresh in your mind, note what went well, what gave you problems and why, and what you'd like to change or improve. One of the best ways to improve your process of planning and writing a draft is to make the effort to analyze it from time to time. You can do this best by keeping a *writing log*, a notebook in which you jot down your thoughts about a writing project while you are working on it.

Possible Prior Misconceptions

Students may not grasp the difference between a report and an analysis.

Students may not know how to use the introduction to forecast their main points. They may say too much in the introduction, or too little, about the body of the paper.

Students often begin paragraphs with a direct quotation or paraphrase, rather than with a topic sentence.

Writing a Research Paper: Writing Process

LESSON 3.2

Student Assessment Artifacts

Career Research paper

Variations and Extensions

Students submit their research paper to a second peer for editing; then they compare responses from the two peers. In examining responses to their writing, they can proceed by looking first for areas of agreement ("Both reviewers were confused by my first topic sentence") or strong disagreement ("One person said my introduction was 'perfect' and someone else said it was 'repetitive'— I'd better look at it again").

National and State Academic Standards

NATIONAL
NCTE Standards for the English Language Arts

4. Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
5. Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
6. Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.
7. Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.
8. Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

CALIFORNIA
English Language Arts Content Standards

Writing

1.3 Use clear research questions and suitable research methods (e.g., library, electronic media, personal interview) to elicit and present evidence from primary and secondary sources.

1.4 Develop the main ideas within the body of the composition through supporting evidence (e.g., scenarios, commonly held beliefs, hypotheses, definitions).

1.5 Synthesize information from multiple sources and identify complexities and discrepancies in the information and the different perspectives found in each medium (e.g., almanacs, microfiche, news sources, in-depth field studies, speeches, journals, technical documents).

2.3 Write expository compositions, including analytical essays and research reports:

a. Marshal evidence in support of a thesis and related claims, including information on all relevant perspectives.
b. Convey information and ideas from primary and secondary sources accurately and coherently.
c. Make distinctions between the relative value and significance of specific data, facts, and ideas.
d. Include visual aids by employing appropriate technology to organize and record information on charts, maps, and graphs.
e. Anticipate and address readers' potential misunderstandings, biases, and expectations.
f. Use technical terms and notations accurately.

Name _____ Date_____ Period _____

Questions for Peer Editing

Questions to Ask About the Research Paper You Are Editing	Your Answers
The Introduction • Does the introduction identify the topic of the paper? • Does the introduction define any special terms that are important for discussion (such as *biomechanics*)? • Does the introduction provide background information on the topic? • Does the introduction include a clear thesis statement? *Suggestions for improvement?*	
The Body Paragraphs: Reporting Careers • Does the body of the essay develop the thesis? • Does each paragraph begin with a topic sentence (not a quotation or paraphrase of someone else's idea)? • Does each paragraph discuss and cite research on the topic? • Is the paper clearly organized to lead the reader from one idea to the next? • Is the tone of the paper objective (not emotional or opinionated)? *Suggestions for improvement?*	
The Body Paragraphs: Analyzing Careers for Me • Are the grounds for analysis and comparison limited and clearly defined? • Is the analysis connected to the desires and expectations stated in the introduction? • Is comparable attention given to all three careers? *Suggestions for improvement?*	
Format • Does the paper have a good title? • Are the citations clear and ready to be collected into a Reference list? *Suggestions for improvement?*	

Writing a Research Paper: Citations

LESSON 3.3

ENGLISH LANGUAGE ARTS

Time
45 minutes

Materials
Students' rough drafts

Resources
- APA Citations Guide handout
- APA Bibliography Guide handout

Prior Student Learning
Students should be aware of the difference between paraphrasing and plagiarism.

Essential Question for This Unit
What is the place for me in the health and biomedical sciences?

Objectives
After completing this lesson, students should be able to

- Cite sources accurately and in proper style.
- Capture sources through summary, paraphrase, and direct quotation.
- Avoid plagiarism.

Lesson Activities
Lesson Springboard
Ask students to imagine the following scenario:

> You've worked hard to find reliable sources, but you're having trouble starting your paper. You've eaten all the leftover pizza and emailed your friends, and now it's the night before the paper is due. Finally, you get down to work, writing a few paragraphs, then cutting and pasting in quotations and notes, then writing again. You suddenly wonder how you'll figure out where all this came from when you have to add your source citations. What if your teacher thinks you are plagiarizing if you don't identify a few sources or add the page numbers for quotations?

Ask students how they've coped in this situation. Suggest that it's crucial to supply an immediate, brief reference in the text itself at the moment they refer to a source. This can be as simple as the author's name and the page number in the original. Suggest they put quotation marks around any words directly from the source.

Lesson Development
Remind students that in Lesson 2.3 they learned how to summarize, paraphrase, and use direct quotations. Indicating the sources for these quotations is important, because failure to do so constitutes plagiarism.

Ask students why they think plagiarism is wrong. Suggest that careful researchers want to give credit to the scholars and writers that came before them. They also must respect their readers, who are likely to be curious about the discoveries, arguments, and evidence marshaled by others. Finally, good researchers respect themselves. Copying passages from an article or a friend's paper or lifting them from the Web harms one's opportunity to think and to learn.

Writing a Research Paper: Citations

LESSON 3.3

Crediting sources is important, but doing so for every single idea you build upon is an impossible task. Ask students where, in practical terms, do we draw the line?

Materials that do not require credit include common knowledge, facts that are widely available, and your own findings from field research.

Materials that do require credit are direct quotations, assertions that are arguable or facts that are not widely known, opinions and claims of others, and all statistics, charts, or graphs.

Explain that the class will be using *APA style*, the format for crediting sources that is recommended by the American Psychological Association. Because this style emphasizes author and date, it is used in many of the sciences, which are concerned with timely information from credible sources.

In APA style, there are two ways to cite sources within the text. The author or source may be named within a sentence. For example, "As Wood (2003) explains, the emphasis in American healthcare must shift from cures to prevention." Or, "Stein's argument focuses on stem cell research, but his discussion of ethical implications (2002) also applies to other kinds of medical investigation." On the other hand, the source may be noted in parentheses at the end of the idea that is cited. For example, "The current concern with obesity in America has developed for six different reasons (Brownell & Horgan, 1998)."

Tell students to examine their rough drafts. Explain that once they have decided where they want to add supporting information from a source, they should weave these ideas into their papers so that they effectively support the point to be made. Whether the source is quoted, summarized, or paraphrased, it can be "launched" into a sentence in various ways. For example, the "launch" may emphasize professional authority: "According to Joan Lewis (2005), a biomedical ethicist at UC Berkeley … " Or the launch can relate one source to another: "In contrast, Henley's report (2002) determined that, … "

Lesson Closure
Distribute the APA Citations Guide handout. Provide time for students to practice launching source material from their own research, as they use APA in-text citations.

Direct students to the "Web Materials" section of the APA Citations Guide. Provide time for them to practice citing Internet source material in proper style.

Distribute the APA Bibliography Guide handout. Students will record at least three of their in-text citations into their Reference List, following APA format.

Student Assessment Artifacts

Career Research paper with quotes and bibliography

Writing a Research Paper: Citations

LESSON 3.3

National and State Academic Standards

NATIONAL
NCTE Standards for the English Language Arts

5. Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
6. Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.
7. Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

CALIFORNIA
English Language Arts Content Standards

Writing

1.6 Integrate quotations and citations into a written text while maintaining the flow of ideas.

1.7 Use appropriate conventions for documentation in the text, notes, and bibliographies by adhering to those in style manuals (e.g., *Modern Language Association Handbook*, *The Chicago Manual of Style*).

Name _____ Date_____ Period _____

APA Citations Guide

PRINT MATERIALS

Single author named in parentheses

When you do not mention the author in a launching phrase, give the name and the date, separated by a comma, in parentheses at the end of the cited material.

> *The tendency to come to terms with difficult experiences is referred to as a "purification process" whereby "threatening or painful dissonances are warded off to preserve intact a clear and articulated image of oneself and one's place in the world" (Sennett, 1980, p.11).*

Single author named in a launching phrase

Use the author's name in a launching phrase to introduce the quoted material, and place the date of the work in parentheses, immediately after the author's name. For a quotation, the page number, preceded by p., appears in parentheses after the quotation.

> *Social historian Richard Sennett (1980) names the tendency to come to terms with difficult experiences a "purification process" whereby "threatening or painful dissonances are warded off to preserve intact a clear and articulated image of oneself and one's place in the world" (p. 11).*

In subsequent references, when a work has three or more authors, use just the first author's name plus *et al.*

> *In assessing the educational quality of our schools, it is important to remember that, as Kintgen et al. (1988) explain: "The contemporary asymmetry between reading and writing can be related to use in a particular socioeconomic context" (p. xvii).*

Works with no author

> *Several critics of the concept of the transparent society ask if a large society would be able to handle the complete loss of privacy ("Surveillance Society," 1998, p. 115).*

WEB MATERIALS

The variety of material available on the Web, and the variety of ways in which it is structured and presented, can present challenges for creating usable and useful references. Regardless of format, however, authors using and citing Internet sources should observe the following two guidelines.

1. Direct readers to the specific information being cited; whenever possible, reference specific documents rather than home or menu pages.
2. Provide addresses that work.

At a minimum, a reference of an Internet source should provide a document title or description, a date (either the date of publication or update or the date of retrieval), and an address (in Internet terms, a uniform resource locator, or URL). Whenever possible, identify the authors of a document as well.

It is important to provide the directory path, and not just the host name, because home pages and menu pages typically consist mainly of links, only one of which may be to the document or information you want the readers to find. If there are hundreds of links (or even just 10 to 20), readers may give up in frustration before they have located the material you are citing.

Name _____ Date_____ Period _____

APA Bibliography Guide

The following rules for handling works by a single author or multiple authors apply to all APA-style references in your reference list, regardless of the type of work (book, article, electronic resource, etc.):

Single Author
Last name first, followed by author initials.

Berndt, T. J. (2002). Friendship quality and social development. *Current Directions in Psychological Science, 11*, 7–10.

Two Authors
List by their last names and initials. Use the "&" instead of "and."

Wegener, D. T., & Petty, R. E. (1994). Mood management across affective states: The hedonic contingency hypothesis. *Journal of Personality & Social Psychology, 66*, 1034–1048.

Three to Six Authors
List by last names and initials; commas separate author names, while the last author name is preceded again by "&." If there are more than six authors, list the first six as above and then et al., which means "and others."

Reference List: Articles in Periodicals

Basic Form
APA style dictates that authors are listed by last name followed by initials; publication year goes inside parentheses and is followed by a period. The title of the article is in sentence-case, meaning only the first word of the title and subtitle and proper nouns in the title are capitalized. The periodical name is in title case and is followed by the volume number which, with the title, is also italicized or underlined.

Author, A. A., Author, B. B., & Author, C. C. (Year). Title of article. *Title of Periodical, volume number*(issue number), pages.

Article in a Magazine

Henry, W. A., III. (1990, April 9). Making the grade in today's schools. *Time*, *135*, 28–31.

Article in a Newspaper
In APA style, p. or pp. precedes page numbers for a newspaper reference, unlike references to other types of periodicals. Single pages take *p.*, e.g., "p. B2"; multiple pages take *pp.*, e.g., "pp. B2, B4" or "pp. C1, C3–C4."

Schultz, S. (2005, December 28). Calls made to strengthen state energy policies. *The Country Today*, pp. 1A, 2A.

Name _____ Date_____ Period _____

Reference List: Electronic Sources

Article From an Online Periodical

Online articles follow the same guidelines for printed articles. Include all information the online host makes available, including an issue number in parentheses.

Author, A. A., & Author, B. B. (Date of publication). Title of article. *Title of Online Periodical, volume number* (issue number if available). Retrieved month day, year, from http://www.someaddress.com/full/url/.

Bernstein, M. (2002). 10 tips on writing the living Web. *A List Apart: For People Who Make Websites, 149*. Retrieved May 2, 2006, from http://www.alistapart.com/articles/writeliving.