Strategies for Success

A BENJAMIN CUMMINGS PUBLICATION FOR SCIENCE INSTRUCTORS

SPRING 2007 NO. 47

In This Issue

About The Newsletter

Strategies for Success **is published as a service to undergraduate science instructors. It is intended to stimulate ideas, disseminate solutions to common obstacles, and update readers on recent developments. We welcome contributed articles and suggestions for future issues. Please contact the Editor at strategies@aw.com or via fax at (978) 477-6550.**

Companion Web Site

Find resources related to these articles and past issues of the newsletter at www.aw-bc.com/events/strategies.

BUILDING ESSENTIAL SKILLS

So much to learn, so little time. And yet, science instructors often take time to teach students the skills they need. In this issue, our contributors bring you ideas for strengthening some of those essential skills. You'll find tips for "new" skills, such as searching online, how to help students write without plagiarizing, and a fun way to build skill in applying the scientific method. Our final article focuses on skills that students perhaps should have learned but may not have—studying effectively. You'll also find out what your colleagues had to say about the skills they teach on page 7.

Many thanks to our contributors, who continue to impress us with their innovative approaches to science education, and to all of you who "Sound Off" to share your strategies with our readers. We at Benjamin Cummings believe our collaboration with you is our most "essential skill" for producing high-quality teaching and learning resources!

Finding Appropriate Research Articles Online

Christopher Gillen, Kenyon College
gillenc@kenyon.edu

When I was an undergraduate, tracking down research articles was an arduous chore. I remember decoding Biological Abstract entries, combing the stacks for journal volumes, and scrounging for quarters to make copies. In contrast, students today have easy access to primary literature through searchable databases and online publications. However, although accessing research articles is simple, finding the best articles for a project is not. Training students to search well enables them to better use primary sources in their writing. Further, the skills students learn while searching for research articles are broadly useful. The increasing online availability of all types of information makes quickly finding and sorting sources a key tool for success in many settings. I offer here ten strategies that will help students search effectively for research articles.

Get Motivated

Using search engines such as Google to find information on the Internet requires no special skills or attention, and students may assume that searching for research articles is equally easy. Students need to be convinced that effective searches demand expertise and patience. Two strategies can help motivate students to develop the skills and mind set required for effective

continued on page 2

continued from page 1

searches. First, inform students of the benefits of careful searches. Remind them that writing will be easier using sources that are directly relevant to their topic. Students can readily see that trying to integrate several marginally related articles is a fruitless struggle. Second, give students clear search goals. Explain that good searches are both *comprehensive*, returning most of the relevant articles, and *well-focused*, returning very few irrelevant articles. Searches should also return many more sources than will be used in the assignment so that the best can be selected.

Identify Good Search Terms

Choosing good search terms is the key to a successful search, yet it can be difficult for students. To compile a list of search terms, students can scan their textbooks, the titles of research articles, and the keywords listed after the abstract of many papers. Remind students that scientific terminology is precise and that a similar concept may be described by multiple terms with slightly different meanings. Point students towards a good scientific dictionary, and encourage them to learn the exact meaning of potential search terms.

Use Trial and Error

Students don't need to compile a perfect set of terms before starting. Searches are free and fast, and poor searches can help students identify better search terms. In initial searches, students should look at article titles, abstracts, and subject headings for additional search terms. After they have developed a good list of terms, encourage students to perform different searches until they are satisfied that their strategy has been effective.

Link Search Terms

The operands AND and OR are the keys to comprehensive and well-focused searches. Linking search terms with OR generates more *comprehensive* searches. Remind students that multiple terms or phrases may be used to describe the same concept. For example, a comprehensive search for "heart" requires also using related terms such as "cardiac". Linking search terms with AND generates *well-focused* searches. Ask students to combine terms that describe different aspects of their project. Combining "cardiac" and "exercise" will result in a more focused search than either term alone. The syntax for using AND and OR varies among databases. Sometimes, AND is achieved by choosing to search for "all" terms, while OR is achieved by choosing to search for "any" term.

Narrow the Search

Sometimes, even well-focused searches return too many articles. Most databases have tools to limit searches by publication date, species, language, online availability, and other criteria. Searches can also be narrowed by restricting the search to only terms found in the title or abstract, rather than in the entire text. A good strategy for students is to first develop a comprehensive search, and then narrow the search to the most relevant articles.

Exploit Online Formats

Articles are published online in PDF or full-text format. Articles in PDF format can be viewed using the Adobe® Reader, and they appear exactly as they do in the printed journal. Students should be encouraged to use this format when they wish to print an article. Although full-text versions don't usually print well, they do often contain features not found in the printed article that can be useful to students. For example, links allow users to navigate between different sections. Full-text versions also make it easy to find related articles. The reference list often has links to online versions of the cited references, making it convenient to access prior work. Additionally, there is sometimes a listing of articles that have cited the article, allowing newer work to be identified.

Analyze Papers While Searching

Most databases now include direct links to online articles, meaning that students can immediately access and read articles. Thus, students can rapidly assess whether an article fits their needs. Teach students to scan an article's title, abstract, graphs, tables, and figures. Also, point them toward the end of the introduction, where they are likely to find the study's hypothesis or purpose—and to the beginning and end of the discussion, to find a summary of the study's results and implications.

Distinguish Between Primary and Secondary Sources

Students can be confused about the difference between primary and secondary sources. Remind students that primary sources report original work and are written by the researchers who did the work. A telltale sign of a primary source is a detailed methods section. However, some of the most prestigious journals, such as *Nature* and *Science*, have begun reporting methods in supplementary online material. Teach students to look for signs that identify secondary sources. They are often labeled as a review, commentary, or summary. Also, when data are presented in a secondary source, a reference to the original source is always given.

continued on page 3

Finding Appropriate Research Articles Online
continued from page 2

Access Online Databases

The availability of databases varies among universities and colleges. However, three of the most useful databases are available free online. Many top journals can be accessed at Highwire Press, www.highwire.org, which indexes more than 3 million articles from approximately a thousand journals. More than a million of these articles are freely available. PubMed, www.pubmed.gov, is a comprehensive database of biomedical journals with over 14 million citations covering more than 4,800 journals. Finally, BioMed Central, www.biomedcentral.com, is a publisher of "open access" research articles. All of the research articles published by BioMed Central are available free of charge online. Each of these sites has user-friendly interfaces and help documentation.

Be Critical

Students often underestimate the time and expertise required to effectively search for research articles. However, their familiarity with Internet search engines gives them a head start and, with instruction, they quickly learn the needed skills. Students who have mastered basic search skills can be encouraged to critically assess searches. Ask students whether a search is comprehensive and well-focused, and require them to support their answers. For example, a student might show that a search is comprehensive by demonstrating that searching with additional terms or in other databases does not return any new articles relevant to the topic. Taking a critical stance toward search strategies will benefit students in their courses and in any setting where they need to find and evaluate information. ■

Editor's Note: Christopher Gillen is author of *Reading Primary Literature: A Practical Guide to Evaluating Research Articles in Biology* (Benjamin Cummings, 2007).

AVOIDING PLAGIARISM: LEARNING TO SUMMARIZE

Jan A. Pechenik, Tufts University
jan.pechenik@tufts.edu

Most students cannot summarize effectively, and that explains a lot about what else they cannot do. If you can't summarize one piece of information, you won't be able to see the connections between different pieces of information. If you can't summarize, you can't synthesize. In fact, all you can really do is cut and paste. Widespread plagiarism among students is probably due, to a large degree, to this inability to summarize. It is a skill that can be developed, though. All is takes is practice. Here are some ideas to try out with your students.

Start with a Paragraph

Ask students to write one-sentence summaries of individual paragraphs from a book or newspaper article. I have had great success with this using paragraphs from Rachel Carson's book *Silent Spring* (a book most students have never heard of) or articles by Stephen J. Gould, for example. A good one-sentence summary has the following characteristics:

1. It includes all key issues.
2. It is accurate.
3. It is self-sufficient; that is, it will make perfect sense to someone who has not read the original paragraph.
4. It is in the student's own words.

You might have to ask students to revise each of their sentences several times before you end up with a product that meets all four criteria, so don't give them more than two or three paragraphs to work on at any one time until they get the hang of it.

Summarize a Figure or Table

Ask students to summarize what they see in looking at a table or figure or picture. You might ask students to explain, for example, in one sentence, what question is being addressed by a graph. They should be able to determine this just by looking at the graph, the axis labels, and the figure caption. Or, you could ask them to list 2–3 interesting findings shown by the graph, writing one sentence per result.

Write a One-Sentence "Abstract"

If students are writing a paper, ask them to tell you *in one sentence* what major question is addressed (or will be addressed) in the paper, or (again, in one sentence) to tell you one major conclusion that they came to or wish to make in the paper. If students are writing a laboratory report, you can ask them to summarize in one sentence one specific question the report addresses, and to describe in one sentence one specific result that they obtained. Good writing needs a sense of direction, and you can't convey direction if you don't know where you want to end up.

Summarize a Class Session

At the end of a class period, ask students to summarize what they thought was the major point of the session, or the most interesting thing they learned from the session.

continued on page 4

Avoiding Plagiarism: Learning to Summarize
continued from page 3

Teaching students to summarize information prepares them to evaluate that information, gives them confidence to express their own opinions and ideas, prepares them to ask their own questions, and gives them the confidence and skills to complete assignments without having to plagiarize. ■

Editor's Note: Jan Pechenik is the author of *A Short Guide to Writing About Biology, Sixth Edition*, which contains more ideas and specific examples about how to teach students to summarize information.

OWNING THE SCIENTIFIC METHOD

Eric J. Simon, New England College
ejs@ericjsimon.com

As science teachers, one of the most essential concepts we convey to our students is the scientific method: what it is, how it is applied, and its limitations. In many introductory biology courses, discussion of the scientific method occurs right at the start of the semester, when many students (particularly students forced to take a science course to fulfill their school's general education requirement) are at their most apprehensive. The scientific method can seem like a foreign concept, something that "those wacky scientists" do, replete with jargon and formality. Yet, with a minimum of prompting, most students can see that they are inherently familiar with the scientific method. Thus, one essential skill that I try to convey right off the bat to my introductory students is that they *can*, and indeed they *do*, apply the scientific method in their everyday lives.

The key is to make a connection between the formality of the scientific method (hypothesis, methodology, results, conclusions, etc.) and their normal mode of thinking. I start with an everyday example: Imagine that you have completed your homework and you want to relax by watching TV. You push the power button on the remote and nothing happens. I'll ask the first student in a row, "What would you do?" That student will make a suggestion, such as "Check the batteries," "Try again," or "See if the TV is unplugged." I then ask the next student how they would apply that idea. They will make a suggestion such as "Change the batteries" or "Look around the back of the TV and check the power cord." I provide the results of that inquiry to the next student, saying that the TV still doesn't work, so what now? We continue down the row, students making suggestions, testing them, and deciding what to do next, until on the third try I tell the students that they were successful and the TV now works.

I will then turn to the next row in the classroom and ask them to recast what just occurred using the terminology and formality of the scientific method. We'll start with an observation ("I observe that the TV isn't turning on") and then the first idea ("I hypothesize that the TV isn't coming on because the batteries are dead") and so on through designing an experiment, conducting the experiment, collecting data ("I checked the plug and it was in the wall"), drawing conclusions ("My hypothesis that the TV was unplugged was not supported by the data I collected"), and then revising the hypothesis and repeating.

The students see the humor in recasting their actions using formal language. But such an exercise quickly reinforces that the scientific method is just another way of describing how they act and think every day. They can quickly see that we all conduct a dozen such inquiries a day—although we do not normally formalize them. To reinforce this point, I give them a homework assignment on their first day: write down five more instances of conducting a scientific inquiry over the remainder of the day. I begin the next class by having students share their examples. They range from the mundane to the slightly profound, but they are all real and personal.

I further reinforce the common use of scientific inquiry during the first lab. After taking care of administrative business, I join the students in a circle with a cardboard box in the center. I ask one student to observe the box. (Unseen by the students, the box has a partition inside it as well as a rubber ball, a die, an envelope half-filled with sand taped to the inside of the box, and a cotton ball.) The first student states an observation and hands the box to the next student, who states a hypothesis. As the box is passed around the circle, successive students design an experiment to test the stated hypothesis, gather data, and draw a conclusion. If the students have settled upon a correct idea, I open the box, revealing the object, and the students start again. This continues, giving each student a chance to participate, until students conclude that "The box is empty." At that point, I reveal the presence of the cotton ball, demonstrating that the scientific method has limitations; it does not always bring scientists to correct conclusions.

continued on page 5

Owning the Scientific Method

continued from page 4

As a corollary to these activities, I ask the students to imagine themselves in a very different place and time, living in a culture in which the scientific method was not as accepted and prevalent as it is in ours. How might they answer questions about the natural world? I often find it is difficult for students to imagine living their lives without scientific inquiry. This leads to a discussion of alternative means of learning about the world—seeking the advice of elders, praying for enlightenment, etc.—that helps clarify the scientific method by defining what it is not.

Through this series of exercises, I hope to guide the students into a state of ownership of the scientific method. Once students appreciate that they, too, apply the scientific method in their everyday lives, I can begin to teach them specific course content within the established context. This is a good first step in developing the next generation of "citizen scientists." ■

Editor's Note: Eric J. Simon is co-author of several textbooks from Benjamin Cummings, including *Essential Biology, Third Edition* and *Essential Biology with Physiology, Second Edition.*

BUT I STUDIED REALLY HARD LAST NIGHT ...

Lori Garrett, Danville Area Community College
lgarrett@dacc.edu

We have heard these or similar words countless times, and we greet them with a sigh of resignation, thinking that if our students *really* studied, they would be successful. The next time you hear this phrase, though, take a moment to ponder what is behind it. I hear it in all my classes and have learned that it doesn't matter whether it comes from students in remedial or advanced courses: they are almost always serious—and frustrated!

Many students simply don't understand what it means to study. Many are straight from high school where they sat in class five days a week for a whole year. Most of their learning occurred in class and many never needed to open a book outside of class. We get them just a few hours a week for one semester, so most learning must occur outside of class. What looks of shock have you seen when you tell students they should study 2–3 hours for each hour of class? They have never had to study this much before, so this is a challenging transition, and they often don't understand why it is necessary. Other students may have been out of school for a while, leading established lives with daily routines. They may be working and have family responsibilities, as well. Finding time for studying may seem impossible.

In short, students today often lack basic study skills. They must move past mere memorization to recognize relationships between concepts and how to apply their knowledge, but they may have had little practice doing so. Consequently, our students often really do spend hour upon hour memorizing information, but then the information becomes jumbled as it tumbles out of their brains during the exam, or they fail to realize that they know the answer to a question just because the wording is not exactly as memorized. Also, our students do tend to cram the night before or the day of an exam. For many students, this is the first time they have looked at the material outside of class, and it is too little too late. They just don't understand the importance of routine daily studying.

So how do we get them to study? It must begin with compassion. We must first acknowledge that most of our students truly do want to learn and be successful, but they have simply come to us unaware of and unprepared for the work that is required. We must mentor them, guiding them to become better students. We often bristle at this notion—this is college, after all. However, too often the reality is that we either assist these students, improving their shot at a bright future, or we fail them. As an educator, I always prefer success. Here are some ideas that might gently prod them into more and better studying.

Clear Expectations

Students should know our expectations from the beginning. Be very clear about what will be graded, how it will be graded, and the level of mastery expected. Then hold to it—if we vary our standards, curve exams, or give extra credit, students may take our classes less seriously and they may try to negotiate grades.

Take time at the beginning of your course to explain how you recommend that they study. Be explicit. Show them available resources, including online support from textbook publishers. Consider having previously successful students return to discuss their personal study strategies. Prior to each quiz or exam, provide a list of topics to be covered, or learning objectives for that section.

continued on page 6

But I Studied Really Hard Last Night …
continued from page 5

Evaluate Learning Styles

Consider having students evaluate their learning styles. Numerous online resources are available; having students complete an evaluation could be assigned as homework. Ask students to report on which source they used, their preferred learning styles, and the specific study techniques that they can use to compliment their styles. This exercise focuses students on how they process information and can really help them study more effectively. Afterward, you might supply a handout of suggested techniques for each learning style. Keep track of each student's results for reference later, if he or she begins to struggle.

Schedule a Time and Place for Studying

I find that most of our students do not schedule studying; it gets fit in randomly around their other activities. Unfortunately, it often is put off or left undone. Consider having students complete a schedule. First, have them list their daily activities and the times for each. Next, provide a blank schedule with a grid of days and times, and ask students to fill in the grid with all the commitments they just listed, including work, school, family, socializing, meals, and sleep. Have them mark remaining times during which they can study, and stress the importance of committing those times specifically for studying. By writing their schedules, students often see that there is time to study. This might lead to a discussion of time management.

You might also discuss where they study. It needs to be quiet, comfortable, and relatively free of distractions. For parents with older children, a daily family study time might be effective, and reinforce the importance of studying for the next generation. Students who have the constant distraction of younger children might study on campus or go to a library. Identifying potential obstacles allows us to help students develop coping strategies to improve their success.

Use Pre- and Post-Test Assessments

I often have students complete pre- and post-test assessments. A pretest assessment may be just a few questions at the start of an exam: How much time did you study for this, and when? Specifically, *how* did you study? Do you feel that you prepared adequately for this exam? If not, why not? What grade do you anticipate?

After they complete the exam, I give them another assessment, sometimes as a take-home assignment. Among its questions are:

1. Now that it is over, do you feel that you prepared adequately, and if no, why not?
2. How do you think you did, overall, on this test?
3. What section(s) were most difficult for you?
4. What section(s) were easiest for you?
5. Did the test cover material you were told it would cover? If not, please explain.
6. On a scale of 1 (I could do this in my sleep) to 100 (Einstein couldn't pass this test), how difficult did this test seem to you?
7. On the same scale, how difficult do you think it actually was?
8. How satisfied are you with your performance on this exam?

The last two questions can be asked after students get their grades. This exercise helps them think about how their efforts translate into graded performance. With practice, they get better at perceiving how well they really prepare for an exam, and many alter their study habits accordingly.

Pop quizzes are also handy tools. Knowing that many students neither read nor study until they must, tossing in an occasional pop quiz can rock their world enough to get them into the books more often. These can be just a few questions at the beginning of class, and classroom clicker systems can make this a rather efficient process. When they realize that they are missing out on points and not understanding material previously covered, serious students will study more frequently.

To focus on the goal of our job—education—we must have genuine concern for our students' success. However, we should also emphasize personal accountability. I frequently remind my students that I do not give grades—they earn grades. Nonetheless, part of our responsibility must also be to teach them how to be students. ■

Editor's Note: Lori Garrett is author of *Get Ready for A&P*, (Benjamin Cummings, 2007), a workbook and online tool that saves classroom time and frustration by helping students quickly prepare for the two-semester Anatomy and Physiology course.

OUR READERS SOUND OFF ...
ESSENTIAL SKILLS

Here is a selection of readers' responses to, "Beyond the science material that you cover in class, do you teach your students any essential skills that help them succeed in the course?"

To read more and longer responses, visit www.aw-bc.com/events/strategies.

Because all students "Google" for information, we offer a web credibility exercise (created by a science librarian) to train them to analyze the validity and credibility of web sites.

—Corinne Ulbright, Indiana University/ Purdue University at Indianapolis

Sometimes being a good lecturer interferes with student learning. New-to-science students think that if they understand in class they will be able to tackle the exam. I now present dilemmas for them to struggle with instead of doing example after example for them.

—Midge Hall, Clark State Community College

I emphasize writing, speaking, and working in groups through semester-long group research projects. While not rocket science, this has enabled many of my students to get internships. When writing a letter of recommendation or speaking to an employer about a student, I can tell them about those skills, as well as other traits revealed in the projects, such as leadership ability, being motivated, etc.

—Curt Coffman, Vincennes University

Simple Data Analysis: In some of my classes at the beginning of the quarter I spend time developing the students' skills in using Excel. We go over data analysis, presentation, the use of graphs, etc.

—William Klopfenstein, Sinclair Community College

After I finish covering a section of material in my anatomy and physiology classes, I ask students to reorganize the material in tabular form. Initially I give them table headings, but as the semester progresses I try to have them establish the pattern. Another challenge I give them is to find pairs of terms from a thematic unit which are similar but distinct and have them compare and contrast those terms.

—John Pellegrini, College of St. Catherine

I offer sessions on math for chemistry and reinforce what I teach in these sessions in the content of the chemistry class. Students who attend these sessions are very successful.

—Kasem K. Kasem, Indiana University, Kokomo

How to Answer an Essay Question: I teach students to differentiate between key essay question requests: "describe," "compare," and "contrast." I ask students to write a question, then ask group members to respond so they can see whether the answers are what they expected.

—P. Roger Sweets, University of Indianapolis

Students do PowerPoint presentations during lab on concepts I don't always have time for in lecture. For example, in Developmental Biology, students presented on different birth defects or anomalies. The presentations allow them to research, organize material, put a presentation together, present (speak in public), and write questions summarizing their topic. Other students critique the presentations.

—Nancy Traiser, Ohio Dominican University

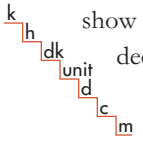
Absolutely. Critical thinking skills are emphasized in the undergraduate anatomy and graduate physiology courses, especially those related to clinical diagnoses and neurotrauma evaluation and treatment. The ability to incorporate and discuss key concepts is essential.

—Michael Yard, Indiana University/ Purdue University at Indianapolis

I teach students the following:

- Analyzing practical examples and case studies
- Exam-taking skills
- Relaxation techniques prior to exam
- Time-management skills and how to prioritize tasks
- Using regular, assigned hours for review

—Najma Javed, Ball State University



Students struggle with metric unit conversions, so I show them the "staircase" method: move the decimal point the same number of steps on the staircase, and in the same direction traveled on the staircase.

—Peggy Lepley, Cincinnati State College

One of the skills I teach my Microbiology students is how to write a scientific project paper. They pick a topic from a list of three or four, perform a lab exercise related to the topic, collect data, and present their findings in a short paper. The paper must include a title page, introduction, purpose, list of materials, procedure, data, observations/conclusions, and a reference page. …

It is a challenging exercise for many students since they have not done this kind of writing before. Most of them do very well however, and seem to enjoy picking their own topics to explore.

—Jeanne A. Ferguson, Ivy Tech Community College

Strategies for Success Workshops

The Benjamin Cummings faculty development workshop series covers a wide variety of teaching strategies, from techniques for improving student participation to methods for incorporating online media and critical thinking skills into science courses. These free events are open to all full-time and part-time life science educators.

February 10, 2007	Valencia Community College, West Campus, Orlando, FL
February 24, 2007	Mini-workshop, University of Texas, Austin, TX
March 31, 2007	Massachusetts Bay Community College, Wellesley, MA

To register, please visit www.aw-bc.com/events/strategies, or call 800-950-2665, extension 2433.

Upcoming Conferences

Texas Community College Teachers Association
February 22–24, 2007 Austin, TX
www.tccta.org

Experimental Biology 2007
April 28–May 2, 2007 Washington, DC
www.eb2007.org

Human Anatomy & Physiology Society (HAPS)
May 26–30, 2007 San Diego, CA
www.hapsweb.org

American Society for Microbiology Conference for Undergraduate Educators
May 18–20, 2007 University at Buffalo, SUNY North Campus, Buffalo, NY
www.asmcue.org

Overcoming Information Overload

Given the rapid pace of new research discoveries in the life sciences, many educators feel pressured to know more information—and to teach more—than ever before. For our next issue, we invite you to share your practical strategies for filtering the amount of information that you cover in class.

Question: **Considering the time constraints of a lecture or lab session, how do you decide which information to cover, and which information to leave out?**

Sound Off entries will be entered in a random drawing for a $50 gift certificate from Amazon.com. To enter, please email your response to strategies@aw.com by May 31, 2007. Additional drawings will be held at our upcoming *Strategies for Success* workshops.

Offering You More of the Best in Life Science

We are pleased to announce that as of January 1, 2007, Benjamin Cummings became the exclusive publisher of Biology titles for Pearson Education. The high-quality textbooks and supporting materials formerly published by Prentice Hall can now be found on the Benjamin Cummings web site at www.aw-bc.com.

Newsletter Editor:	Cindy Johnson
Creative Director:	Lillian Carr
Editor-In-Chief:	Beth Wilbur
Editorial Director:	Frank Ruggirello
Acquisitions Editors:	Serina Beauparlant, Leslie Berriman, Chalon Bridges, Deirdre Espinoza, Jim Smith, and Susan Winslow
Director of Marketing:	Christy Lawrence
Marketing Managers:	Lauren Harp, Scott Dustan, and Gordon Lee

Benjamin Cummings
1301 Sansome Street
San Francisco, CA 94111
(800) 950-2665
www.aw-bc.com

PRESORTED STANDARD
U.S. POSTAGE
PAID
SAN FRANCISCO, CA
PERMIT NO. 571