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Abstracts

An abstract is a self-contained form that exists outside the body of the research paper, and as such, must be able to stand on its own merits, independent of the paper. An abstract *extracts* the most important points of a paper and presents them in a concise way. The abstract uses the same language of the paper. Within a specific word limit defined by the publishing journal or information service, the abstract reports the particulars of the scientific paper. The abstract must include the following information: (1) the issue, (2) how the experiment was done, (3) what the observations were, (4) the meaning of the observations. When appropriate, the abstract might also indicate the significance of the research. Because the abstract is an abbreviated form, one sentence for each of these points may be sufficient.

Notice that each of these four points represents one whole section from the body of the scientific paper. In specifying the issue, the abstract condenses the key point or points of the Introduction. In specifying how the experiment was done, the abstract represents the salient points of the Methods section. In representing the observations following the experiment, the abstract condenses the Results section. And in representing the meaning of the observations, the abstract condenses the important points of the Discussion section. Because the abstract, as a form, is independent of the science paper but uses the same language, it can function as a microcosm of the science paper, and, as such, offers the opportunity for close scrutiny as a prelude to engaging the scientific paper as a whole. For this reason, a separate chapter is devoted to abstracts.

The abstract will be more broadly read than the paper. Abstracts may be published by themselves in journals solely devoted to them. More importantly, electronic information sources will often contain the abstract, which can be subjected to a key word search. The time constraints which might restrict a scientist's interest in a whole paper would make the abstract a desirable form to survey relevant research.

Indexing and Key Words

Indexing is a service geared to the reader's benefit. Indexes offer a key for a reader to research information. For the benefit of readers, abstracts are published independently of papers; because the abstract can stand alone, it saves scientists time because they can study the abstract for salient points to determine whether or not they should read the paper. To accommodate the burgeoning swell of published information, some journals are devoted solely to publishing abstracts. Such journals must often balance the benefits of timeliness with those of comprehensiveness, sometimes favoring one over the other. At a meeting of the American Chemical Society, for instance, John Lane stated that

> The purpose of *Chemical Abstracts* has been defined as "preparing concise summaries . . . from the *indexing point of view.*" Here the goal is to provide a timeless reference tool for chemists. Speed in reporting must necessarily be sacrificed for the sake of comprehensive coverage of the world's literature and for thorough indexing and cross-indexing. . . . At the other extreme, *Current Chemical Papers*, which has replaced *British Abstracts*, cuts appearance time to only a matter of weeks, but at a sacrifice in comprehensiveness. It is primarily an indexed listing of titles.[1]

When you begin the literature search for your topic, your search will be geared to key words in the title of the abstract. In a similar vein, when you write a title, write it from the standpoint of a researcher: Use common key words in your title.

Two Kinds of Abstracts

Abstracts may be loosely grouped into two categories: the *indicative* and the *informative*. The indicative or descriptive abstract tells what topics were taken up in the report. The informative abstract gives precise information about what the report *says* on those topics. Most abstracts are a combination of both forms.

Example: Indicative Abstract

> (1) Studies of diseases caused by mitochondrial DNA mutations suggest that a variety of degenerative processes may be associated with defects in oxidative phosphorylation (OXPHOS). (2) Application of this hypothesis has provided new insights into such diverse clinical problems as ischemic heart disease, late-onset diabetes, Parkinson's disease, Alzheimer's disease, and aging.—Douglas C.

Wallace, "Mitochondrial Genetics: A Paradigm for Aging and Degenerative Disease?" *Science* 256 (1 May 1992): 628.

This abstract describes a hypothesis (1) and tells you that the application of this hypothesis has given insights into some medical disease (2). But what are these insights? How were they achieved? What was the procedure? The abstract presents the topics but not the specifics of their interaction. This kind of abstract may be the most appropriate to summarize a complex paper in a few number of words.

Example: Informational Abstract

(1) The purpose of this experiment is to replicate the studies performed by Spiegel (1979) and Gåssler (1954) and to calculate the critical bandwidth in the auditory system. (2) The tonal complexes of selected bandwidth (40–920 Hz) were constructed digitally using 3–46 pure-tone components spaced 20 Hz apart. (3) For Gåssler's replication, sinusoids were added in 20 Hz decrements from 1100 Hz; for Spiegel's replication, sinusoids were added symmetrically in 20 Hz steps about 1100 Hz. . . . (4) As the bandwidth increased to about 160 Hz, the threshold remained unchanged, thus creating a line with a slope of 0. —Excerpt from Yung-Chia Melissa Wang, "Summation Bandwidth at Threshold for Gåssler and Spiegel Experiment," *Journal of Undergraduate Research in the Biological Sciences* 21 (1991): 741.

This informative abstract provides precise information. Details are specified: (2) (3) (4). This abstract was so detailed, in fact, that only an excerpt was reproduced here. While such detail offers a great boon to the reader, many journals specify word limits which preclude extensive detail.

The decision to write an informative or indicative abstract should be constrained by the audience (implied by the journal to which you will submit it) or by other requirements, as for example, the recommendations by a colleague or your instructor.

Using Codes in Reading and Writing Abstracts

Science magazine gave the following specifications for abstracts:

Abstracts should explain to the general reader why the research was undertaken and *why the results should be viewed as important*. The abstract should convey the paper's main point and outline the results or conclusions. For general articles the abstract should be 50 to 100 words.[2]

Q. What makes your results important? How do you explain the significance of your research?

You cannot go into great detail in an abstract, especially one limited to 50–100 words. But you can adopt shorthand codes that a reader will recognize. Scientific criteria for significance are based on (1) recency of research, (2) discovery or innovation framed in the relationship: known to unknown, (3) definition of a problem/solution to the problem.

(1) Recency

Because science is built upon the idea of progress, one way to show the importance of your work is to emphasize its *recency*. Words which refer to the past have a slightly undesirable connotation. The old way or the traditional point of view is conceived of as being superseded by newer studies. Key words which show pastness imply that the work is dated or outmoded:

- *Previous studies* have shown . . .
- *Earlier work* indicated. . .

Your work, however, supplants the old studies.

- Although (previous studies) have shown some changes, our study shows *new advances.*

Or, perhaps your work is more advanced than even the most recent studies.

- *Contemporary* work shows this, but our work shows *new advances.*

Or, your work, while not exceeding the most contemporary work in the field, fits in with other leading-edges studies.

- Contemporary advances in such and such shows this; our study *builds upon those advances.*

When you read abstracts, look for the past/present arrangement; when writing, adopt this code if it applies to your studies.

Example: Past to Present

> Past experiments using *Drosophila melanogaster* have involved selecting for adult traits, inasmuch as direct selection for larval characteristics has proven less feasible and prone to artifact. *The present study* explores the possible effects of selection forces exerted in the adult state on a pertinent larval trait: *development time.*—Al-

exander E. Romualdez Olivido, "Larval Development as an Indirect Response Character of Imaginal Selection Regime," *Journal of Undergraduate Research in the Biological Sciences* 21 (1991): 122.

(2) Known to Unknown

Another way to signal the importance of your work is to indicate that your work makes an innovation; your points will be framed in terms of *Known to Unknown*. The following provides a series of paraphrases for expressing this relationship:

- We know a lot about X, but we do not know everything (why it works, how it got there, how it reacts under ultraviolet light);
- One of the pieces is missing, and we will attempt to fill in the blank;
- We know some of the causes but not all of the causes;
- We understand this in one situation but we do not know how it will behave in another situation.

Note: You need not to reinvent the wheel or the electric light. Every addition to the body of scientific knowledge, no matter how insignificant it may seem to you at the moment, advances the cause of research.

Example: Known to Unknown

Intra- and extra-cellular matrices are known to maintain cellular rigidity, membrane morphology, and membrane protein topography. Little is known, however, about the components of these matrices that may play a major role in neural connectivity, i.e., synaptic adhesion in the mammalian brain. This project tests for extracellular matrix (ECM) molecules and cytoskeletal components that are positioned in areas of the brain that make them likely to be involved in the formation of adhesive contacts between neurons. —Everard Tesoro Esteban, "Components of Structural Matrices May Help Promote Neural Connectivity in the Brain," *Journal of Undergraduate Research in the Biological Sciences* 21 (1991): 286.

(3) Problem/Solution

If common agreement exists about social, medical, or scientific problems, you can take the pragmatic approach: There is a problem and you have a solution, or part of a solution, or an attempt to offer a solution. The problem/solution structure obtains in the absence of a consensus. A problem need not be universally recognized as a problem for this strategy to obtain as long as you define the terms of the issue sufficiently to make the case. The abstract may state the problem, or it may assume you already know what the problem is. Sometimes this viewpoint is an indicator about what issues are relevant social issues.

Example: Problem/Solution

> (1) Insoluble plutonium- and americium-bearing colloidal particles form during simulated weathering of a high-level nuclear waste glass. (2) Nearly 100 percent of the total plutonium and americium in test ground water was concentrated in these submicrometer particles. (3) These results indicate that models of actinide mobility and repository integrity, which assume complete solubility of actinides in ground water, underestimate the potential for adenonucide release into the environment. (4) A colloid-trapping mechanism may be necessary for a waste repository to meet long-term performance specifications.—J. K. Bates, J. P. Bradley, A. Teetsov, C. R. Bradley, M. Buchholtz ten Brink, "Colloid Formations During Waste Form Reaction: Implications for Nuclear Waste Disposal," *Science* 256 (1 May 1992): 649.

If you have located a problem that has not yet been socially or scientifically legitimated—as may be the case in the discovery phase of research—you must provide sufficient detail to demonstrate that a problem exists. Do not be put off by establishment views that say there is no problem. Your job is to explain it.

Writing Abstracts

Certain factual information must be included in the abstract. The abstract must answer four questions: (1) what was the issue? (2) how was the experiment done? (3) what were the observations? (4) what did the observations mean? Allot one sentence (or more) to each point and provide transitions.

The title of the abstract is very important. The title should be reflect the content of the paper, and it should be succinct and brief. Use key words for indexing and for searches.

Example: Student Abstract

"Naturally Occurring Allergens that Cleave DNA"[3]

[Issue] Previous investigations on environmental toxins and dietary constitutes have shown that some of the chemicals that we ingest or come in contact with possess the capacity to cleave DNA. **[how experiment was done]** We have examined the sesquiterpene lactones, known to cause contact dermatitis, for their ability to damage DNA. **[what the observations were]** In vitro DNA cleavage assays have demonstrated that sesquiterpene lactones possess the capacity to cleave DNA to various degrees. **[meaning of observations]** Furthermore, from these preliminary findings we suggest that sesquiterpene lactones form free radicals as possible intermediates in the cleavage of DNA.

Exercises

1. Analysis of Sample Abstracts

Analyze the following abstracts using the questions that follow each selection.

Example 1

(1) American children are worse off than those in the previous generation in several important dimensions of mental, physical, and emotional well-being. (2) During the 1960s cultural changes adversely affected children while material conditions improved substantially. (3) By contrast, material conditions deteriorated in the 1980s, especially among children at the lower end of the income distribution. (4) Public policies to improve the material condition of children require a transfer of resources from households that do not have children to those that do. (5) Government programs such as tax credits and child allowances are more efficient and equitable than employer-mandated programs. —Victor R. Fuchs and Diane M. Reklis, "America's Children: Economic Perspectives and Policy Options," *Science* 255 (3 January 1992): 41.

a. Is this abstract informative, indicative, or both?
b. Identify the sentence that states the writer's purpose.
c. The first sentence contains a comparison: What is the comparison?
d. What span of time does the study cover?
e. Look at sentence (4). Is this a conclusion or a recommendation? In other words, is the writer saying this situation EXISTS or is the writer saying this situation SHOULD exist?

Example 2

(1) Recent experimental results are beginning to limit seriously the theories that can be considered to explain high-temperature superconductivity. (2) The unmistakable observations of a Fermi surface, by several groups and methods, make it the focus of realistic theories of the metallic phases. (3) Data from Angle-resolved photoemissions, positron annihilation, and de Haas–van Alphen experiments are in agreement with band theory predictions, implying that the metallic phases cannot be pictured as doped insulators. (4) The character of the low energy excitations ("quasi-particles"), which

interact strongly with atomic motions, with magnetic fluctuations, and possibly with charge fluctuations, must be sorted out before the superconducting pairing mechanism can be given a microscopic basis. —W. E. Pickett, H. Krakauer, R. E. Cohen, D. J. Singh, "Fermi Surfaces, Fermi Liquids, and High-Temperature Superconductors," *Science*, 255 (3 January 1992): 46

a. What kind of abstract is this?
b. What phenomenon are many researchers trying to explain? (1)
c. What relationship does experimentation have to theory? (1)
d. What aspect of superconductivity will the writers focus on, and why do they choose that aspect? (2)
e. How does data relate to theory? This sentence is like (2) in that it says something about the relationship between experiment and theory. How is sentence (3) different from (1)?
f. What do the writers need to determine to make a more complete analysis?

Example 3

(1) It is known that some moths and butterflies (*Lepidoptera*) contain venoms either in the larval, pupal, and/or adult stages, which can cause epidemics of contact dermatitis in various parts of the world. (2) The physiological effects of skin contact with these *Lepidoptera* range from skin eruptions to severe pain, hemorrhage, and in some extreme cases, death. (3) The chemistry of the poisons found in toxic butterflies and moths appears to vary from species to species. (4) Very little is known about the toxins, especially their chemical structures, functions, and modes of action. (5) We examined the chemistry and toxicology of the venom from the larval stages of the Costa Rican butterfly, *Heliconius ismenius clarescens*, and the closely related Californian butterfly, *Agraulis vanillae*, whose caterpillars are covered with spines. (6) We describe the isolation of the venoms from these particular species, and show that they are found to be contained within a cavity in the center of the spine. (7) Preliminary chemical analysis of these venoms, by the use of paper chromatography, indicate that the major toxic component of these venoms is histamine. (8) In order to establish the potency of this toxin, hair extracts were prepared and tested using the Guinea Pig Irritancy Test for contact venoms. (9) The two venoms produced very similar reactions to the histamine standard when applied topically to slightly abraded skin. (10) The reaction was the classic inflammatory response consisting of localized redness, flare, and localized oedema.—Rebecca Torres, "The Biology and Chemistry of Lepidoptera Venoms," *Journal of Undergraduate Research in the Biological Sciences* 21 (1991).

a. Mark distinct divisions in this abstract. Where does the introduction end? Where does the description of the experiment begin? Where do the results begin and end?
b. Take the first five sentences and, without substantially changing the content, write them as three sentences. Do not simply combine the sentences.

2. Editing an Abstract

The abstract (above) by Rebecca Torres has 234 words. While it is a fine and thorough abstract, the writer wants to submit her article to *Science* magazine. She will need to cut her abstract down from 234 to 50–100 words. You volunteer to act as her editor. Revise the text of the abstract to reduce it by three-quarters to one-half.

3. Writing an Abstract

a. Take the "Results" section from a scientific paper and write a 200-word abstract for it.

b. Turn to the Reading Selections at the back of the book and write a 50–150 word abstract to accompany Beijerinck's paper, "*Contagium vivum fluidium* as the Cause of the Mosaic Diseases of Tobacco."

4. Analysis of an Abstract

Find an abstract from either a scientific journal or a popular science magazine and explain how the abstract argues for the importance of its subject matter. Then find another abstract on the same topic but from a different journal, and compare and contrast the two.

5. Write a Punctuation Rule

Consider the following sentences from abstracts already cited. Why do "plutonium" and "intra" have a hyphen after them? Write a punctuation rule that describes this use of the hyphen.

- Insoluble plutonium- and americium-bearing colloidal particles form during simulated weathering of a high-level nuclear waste glass.
- Intra- and extra-cellular matrices are known to maintain cellular rigidity, membrane morphology, and membrane protein topography.

6. Sentence Analysis

You do not always need to know all the words to understand the point that a passage makes. The key to comprehending an otherwise undecipherable passage is to grasp the *relationships* expressed in the sentence, particularly through verbs. For instance, the identity of a particular substance may not be known to you, but you can understand whether or not the substance *increases, decreases, changes phase or form,* or *disappears.*

Paraphrase the following sentences, already cited, emphasizing *relationships* between terms.

TIP: To help you figure out the relationship expressed in the sentence, look for simple grammatical relationships. Because structure expresses thought, the grammatical relationship will tell you something about the relationship expressed in the report. Look for the relationships asserted through the subject-verb-object arrangement of the sentence. You may want to make a separate paraphrase for subordinate clauses or descriptive phrases.

- Nearly 100 percent of the total plutonium and americium in test ground water was concentrated in these submicrometer particles.
- These results indicate that models of actinide mobility and reposi-

tory integrity, which assume complete solubility of actinides in ground water, underestimate the potential for adenonucide release into the environment.

- As the bandwidth increased to about 160 Hz, the threshold remained unchanged, thus creating a line with a slope of 0.
- This project tests for extracellular matrix (ECM) molecules and cytoskeletal components that are positioned in areas of the brain that make them likely to be involved in the formation of adhesive contacts between neurons.
- Data from Angle-resolved photoemissions, positron annihilation, and de Haas–van Alphen experiments are in agreement with band theory predictions, implying that the metallic phases cannot be pictured as doped insulators.
- Preliminary chemical analysis of these venoms, by the use of paper chromatography, indicate that the major toxic component of these venoms is histamine.

References

Aparcio, Ayde. "Naturally Occurring Allergens that Cleave DNA," *Research Abstracts for Student Presentations* (September 24–27, 1992). National Science Foundation: Directorate for Education and Human Resources.

Bates, J. K., J. P. Bradley, A. Teetsov, C. R. Bradley, and M. B. Brink. "Colloid Formations during Waste Form Reaction: Implications for Nuclear Waste Disposal." *Science* 256 (1992).

Day, Robert A. *How To Write and Publish a Scientific Paper*. ISI Press, 1979.

Esteban, Everard Tesoro. "Components of Structural Matrices May Help Promote Neural Connectivity in the Brain." *Journal of Undergraduate Research in the Biological Sciences* 21 (1991).

Fuchs, Victor R., and Diane M. Reklis. "America's Children: Economic Perspectives and Policy Options." *Science* 255 (1992).

Mills, Gordon, and Walter, John. *Technical Writing*. Holt, Rinehart and Winston, 1978.

Olivido, Alexander E. Romualdez. "Larval Development as an Indirect Response Character of Imaginal Selection Regime." *Journal of Undergraduate Research in the Biological Sciences* 21 (1991).

Torres, Rebecca. "The Biology and Chemistry of Lepidoptera Venoms." *Journal of Undergraduate Research in the Biological Sciences* 21 (1991).

Wallace, Douglas C. "Mitochondrial Genetics: A Paradigm for Aging and Degenerative Disease?" *Science* 256 (1992).

Wang, Yung-Chia Melissa. "Summation Bandwidth at Threshold for Gåssler and Spiegel Experiment." *Journal of Undergraduate Research in the Biological Sciences* 21 (1991).

Notes

1. John C. Lane, "Digesting for a Multicompany Management Audience,"

Abstracts, 138th National Meeting of the American Chemical Society, September, 1960. Cited in Gordon H. Mills and John A. Walter, *Technical Writing*, 4th ed. (New York: Holt, Rinehart and Winston, 1978), p. 69.

2. *Science* 259 (1 Jan. 1993): 40. The emphasis is mine.
3. Ayde Aparcio, "Naturally Occurring Allergens that Cleave DNA," *Research Abstracts for Student Presentations* (September 24–27, 1992). Washington Hilton Hotel, Washington, D.C., National Science Foundation: Directorate for Education and Human Resources, p. 34.