This tutorial covers the following:

> Who writes about science
> The scientific peer review process
> Structure of a typical scientific research article
Introduction and context

This tutorial will introduce you to the scientific peer review process and how it contributes to the reliability of scientific knowledge. You will also learn to recognize the structure of typical scholarly scientific articles.

Who writes about science

The scientific peer review process

Structure of a typical scientific research article

This tutorial focuses on Information Literacy for General Education Area B2: Life Sciences
Who creates content?

There are many different kinds of creators, or authors, of information.

Individual authors/creators include:

- Scholars
- Novelists
- Journalists
- Bloggers
- Researchers

Journalists and bloggers write about science to report on significant advances and explain them for the general public, but it’s the research scientists themselves who write the serious research reports.

Now, let’s take a look at a resource that’s familiar to you and compare how its content is created with how scientific articles are written.
Who creates information?
Okay, now it’s your turn!

Click on the correct answer to the following:

1. Wikipedia articles are written by...
   - Researchers and academics
   - Hobbyists
   - People with a political agenda
   - All of the above

2. Wikipedia articles are written for...
   - The general public
   - School children
   - An educated layperson
   - All of the above

Submit responses
Who creates information?
Okay, now it’s your turn!

Below are the correct answers:

1. Wikipedia articles are written by...
   - Researchers and academics [Sure, lots of Wikipedia articles are written by experts in their discipline]
   - Hobbyists [Many Wikipedia articles come from individuals who have a personal interest in the topic they’re writing about]
   - People with a political agenda [Beware! Some articles on controversial topics may be written with a specific bias or may have been edited repeatedly by those on opposite sides of the issue]
   - All of the above [That’s right, anyone can sign up and author a Wikipedia article]

3. Wikipedia articles are written for...
   - The general public
   - School children
   - An educated layperson
   - All of the above [Correct, articles in Wikipedia cover the whole spectrum from extremely technical to very general and are intended to be read by anyone who’s interested in the topic]
What is a scholar?

According to the Merriam-Webster Dictionary, a scholar is “a person who has done advanced study in a special field; a learned person.”

Source: http://www.merriam-webster.com/dictionary

The avenues for formal communication among scholars vary by discipline, but in the life sciences they primarily take the form of peer-reviewed articles in scholarly journals.
What is a scholar?
OK, now it’s your turn!

Click on the correct answer to the following:

1. Scholarly publications are written by...
   - Researchers and academics
   - Professional journalists
   - Freelance bloggers

2. Scholarly publications are written primarily for...
   - The general public
   - School children
   - An educated lay person
   - Other scholars

Submit responses
What is a scholar?

OK, now it’s your turn!

Below are the correct answers:

<table>
<thead>
<tr>
<th>1. Scholarly publications are written by...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researchers and academics [Correct, those doing the research or formally studying the topic are the authors of articles that report the results of that research]</td>
</tr>
<tr>
<td>Professional journalists</td>
</tr>
<tr>
<td>Freelance bloggers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Scholarly publications are written primarily for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>The general public</td>
</tr>
<tr>
<td>School children</td>
</tr>
<tr>
<td>An educated lay person [Certainly, some scientific research is of interest to a generally educated person, but they are not the primary audience]</td>
</tr>
<tr>
<td>Other scholars [Correct, most scholarly publications are written to communicate research findings to other scholars and practitioners. They often use specialized jargon of the discipline that’s difficult to comprehend for those who are not scholars in the same field.]</td>
</tr>
</tbody>
</table>
**Definition of peer review**

“Scientific peer review is the evaluation of scientific research findings or proposals for competence, significance and originality, by qualified experts who research and submit work for publication in the same field (peers).”


Most scholarly publications in the sciences use the peer review process to control the quality of the content, weeding out weaker contributions and attempting to ensure that those accepted for publication contain solid science.
Your turn!

Take a few minutes to view the following video and read the brief overview of how the scientific peer review process works:

> Peer Review in 5 Minutes (video)
> How Science Works (brief overview)

As you can see, the process of producing and publishing an article that reports original scientific research results is fairly involved. It has built-in checkpoints to assure that editors, peer reviewers and authors combine efforts to produce the best possible content before it is formally published.

Source: How Science Works
Scientific peer review:
Let’s review!

Click on the correct answer to the following:

1. Who is selected to serve as peer reviewers?
   - Friends of the editor looking for favors
   - Other researchers in the same specialty
   - Scientists who hold the PhD degree

2. What key elements do reviewers look for and provide feedback on?
   - Potential importance as a new contribution to science
   - Thorough analysis of results in the context of work that’s come before
   - Valid and replicable methodology
   - All of the above

3. Which are the possible recommendations from reviewers to the editor?
   - Letter grades: A, B, C or fail
   - Adequate, commendable, outstanding
   - Reject, publish as is, publish after revision

Submit responses
Scientific peer review:
Let’s review!

Below are the correct answers:

1. Who is selected to serve as peer reviewers?
   a. Friends of the editor looking for favors
   b. Other researchers in the same specialty [Correct, the reviewers are chosen because they also do related research in the same area of specialization as the author]
   c. Scientists who hold the PhD degree [Most research scientists do have a doctoral degree, but unless they’re working in the same discipline as the author, they wouldn’t be in a position to assess the quality of the article]

2. What key elements do reviewers look for and provide feedback on?
   a. Potential importance as a new contribution to science
   b. Thorough analysis of results in the context of work that’s come before
   c. Valid and replicable methodology
   d. All of the above [Correct, all of these elements and more are appraised by the peer reviewers]

3. Which are the possible recommendations from reviewers to the editor?
   a. Letter grades: A, B, C or fail
   b. Average, commendable, outstanding
   c. Reject, publish as is, publish after revision [Correct, some journals reject a large percentage of submitted articles even before sending them out for peer review, but after review most are returned to the author for revision before final acceptance for publication.]
Structure of a typical scientific research article

Most scholarly, peer-reviewed articles have similar organization:
- Title
- Author(s) and affiliation
- Abstract
- Introduction
- Methodology
- Results
- Discussion
- References

The next few pages show an example of each component...

**Abstract:** Brief comprehensive summary of the article. Use to determine if the article is relevant to your topic.
Structure of a typical scientific research article

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Introduction & Background:
States the reason for the research, background about the issue being studied, and reviews the literature on the topic.

In recent years, cocoa and dark chocolate have been promoted as health foods due to the high levels of antioxidants found in cocoa beans (Theobroma cacao L) and their products (Jamison, 2004; Borchers et al., 2000; Rusconi and Conti, 2010), but they also contain moderate to high levels of oxalates (Zarembski and Hodgkinson, 1962; Weissberger et al., 1971; Kasidas and Rose, 1980; Brinckley et al., 1981; Ogawa et al., 1984; Aremu et al., 1995), which can cause some health concerns.

Oxalic acid is an antinutrient present in many plant foods where it is found in the highest concentrations in the seeds and leaves (Noonan and Savage, 1999). It is found either as the free acid, the soluble salt or bound to bivalent ions. The soluble salt can be absorbed by the human body and contributes to the oxalic acid concentration in the urine (Holmes et al., 1995) while insoluble oxalate is directly excreted in the faeces. Once the urine becomes supersaturated oxalate may crystallise as an insoluble salt, calcium oxalate, in the soft tissues, i.e. the kidneys, and form kidney stones (Massey, 2007). Some people either suffer from an increased endogenous oxalate production or have a higher oxalate absorption from food and, hence, a higher urinary oxalate output.

As chocolate is considered as a high oxalate food (Williams and Wilson, 1990; Massey et al., 1993; Noonan and Savage, 1999; Mendoña et al., 2003), The Oxalosis & Hyperoxaluria Foundation (OHF, 2004) recommends that affected persons should avoid eating chocolate. Apart from forming kidney stones, oxalate can bind to minerals, such as calcium, magnesium and iron, rendering these less available for absorption. The contribution of oxalate from chocolate to urinary oxalate excretion also depends on oxalate bioavailability which is likely to be dependent on a number of factors including the proportion of soluble oxalate in the food and the composition of the food, for instance and the fat and fibre content of the foods consumed at the same time as the chocolate.

Some of previously used methods to determine the oxalate content in cocoa and chocolate are now considered antiquated and unreliable (Hinow and Hesse, 2002). The previously used methods concentrate on total oxalate while the soluble oxalate content, which contributes to human urinary oxalate excretion, is disregarded. Furthermore, it was shown for other plants that the oxalate content can vary among different cultivars and during processing (Noonan and Savage, 1999). Aremu et al. (1995) found, for example, a decrease in the oxalate content of cocoa beans during fermentation, an essential step in processing the cocoa beans to initiate the development of a strong chocolate flavour.

Cocoa beans for most cocoa products and chocolate bars come mainly from two different cultivars of Theobroma cacao L var. Criollo, which is grown in South and Central America and var. Forastero, which is grown in the Amazon region. So far, there has been no study that compares cocoa powders and chocolates with the cocoa beans originating from different cultivars.
Structure of a typical scientific research article

Most scholarly, peer-reviewed articles have similar organization:
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- Abstract
- Introduction
- **Methodology**
- Results
- Discussion
- References

### Methodology:
- Describes what or who is being studied
- Methods used to gather the data
- Methods used to analyze the data

#### 2. Materials and methods

2.1. Sample material

Representative samples of different cocoa powders and chocolate bars, all labelled as either dark chocolate or bitter chocolate (Tables 1 and 2) were purchased at either local health food shops or supermarkets in Australia, Belgium, Denmark, Ecuador, Germany, Italy, Malaysia, New Zealand (NZ), France, Sweden, Switzerland, the United Kingdom (UK) and the United States of America (USA) between April and July 2010. Baking cocoa powder was either purchased in plastic bags inside a box or paper bag (3, 5, 7, 8, 9, 12 and 13) or in re-sealable paperboard boxes (6 and 10). All of the chocolate bars were wrapped in proprietary-branded foil and paper. The cocoa powders were kept at room temperature in desiccators and the chocolate was stored at 4°C. In preparation for analysis the chocolate bars were stored at -20°C before grinding in a knife mill (Grindomix GM 200, Retsch; Haan, Germany).

2.2. Dry matter determination

Each sample of cocoa or chocolate bar was sub-sampled and dry matter (DM) was determined by drying in an oven (Watox, Watson Victor Ltd, NZ) set at 105°C to a constant weight (AOAC, 1980). All determinations were performed in triplicate.

2.3. Extraction of total and soluble oxalate and analysis

The measurement of total and soluble oxalate was performed following the method outlined by Savage et al. (2000). Triplicate samples of chocolate or cocoa powder were extracted with 50 ml nanopure water and incubated in a water bath at 80°C for 15 min to extract soluble oxalates. Total oxalates were extracted using 24. Bioavailability assay

Fourteen female volunteers aged from 21 to 35 were recruited from students at Lincoln University, Canterbury, NZ, to participate in the study. All participants were asked to maintain their normal diet throughout the experimental period, but to avoid high levels of foods and drinks known to contain high levels of total and soluble oxalate for the week proceeding and during the experimental period (a list was given to each participant). Each volunteer was also instructed not to have breakfast on the day the test meal was served. The volunteers were encouraged to drink half a cup of water every hour during the test period to ensure an adequate urine production. Participants ate a light lunch during the collection periods avoiding oxalate containing foods.

Each participant consumed approximately 65 g (12 pieces) of Whittaker’s dark Ghana chocolate, containing 72% cocoa (J.H. Whittaker & Sons Ltd, Porirua, NZ) as a test meal served as breakfast (9 am) after overnight fasting. Starting from the time when the test meal was consumed, total urine output was collected for 6 h in an individual plastic container. A urinary control sample was collected from each volunteer on a separate day in the week when the test meal was consumed. The volunteers ate a normal breakfast avoiding known high oxalate containing foods. The urine sample was collected for 6 h and was used as the reference blank for each person.

2.5. Urine analyses

Total urine output was recorded and 10 ml of 35.4% HCl (Aristar BDH Chemicals, Ltd, Poole, UK) was added. The samples were then mixed thoroughly to prevent the precipitation of oxalate as well as the conversion of ascorbic acid to oxalate and to inhibit microbial growth. The total oxalate content of the urine collected over 6 h was determined using a Trinity Oxalate Kit (no 391) (Trinity Biotech Plc, Wicklow, Ireland). Oxalate was determined using an oxalate
Structure of a typical scientific research article

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Results: Summarizes the results and findings using text, tables, charts, and graphs.

Discussion: Analyzes results, explains the significance, and discusses further research. (The Discussion section often comes after Results with its own header).
Structure of a typical scientific research article

Most scholarly, peer-reviewed articles have similar organization:

- Title
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- References

References: List of the works cited and used to support the research.
Comparison: popular or peer-reviewed

Popular magazine articles

Popular magazine articles are written by journalists and are for the general public. Magazines, like journals and newspapers, are published at regular intervals throughout the year. You can find print magazines at newsstands and in libraries. Some are published only on the web as electronic magazines.

Use a Magazine:
- to find information or opinions about popular science
- to find information about recent discoveries
- to find general articles written for people who are not necessarily specialists in the topic area

Take a look at the first page of the article to the right, which covers the health effects of chocolate. Note the prominent illustration. Also note the tone of the first few sentences quoted below. This is a common example of a popular magazine article written for a general audience.

“The cocoa bean formally belongs to the genus Theobroma, or food of the Gods. Not many mortals would disagree. And science now rewards their taste...”
A peer-reviewed journal article is written by researchers who are experts in the field. By comparison, you can readily see that this article on the same topic is from a scientific research journal and has the classic structure of a peer-reviewed research article (as noted beginning on page 13):

- Author names and affiliations
- An abstract summarizing the key points of the article
- An Introduction reviewing earlier literature on the topic

You should now have a good sense of what a scholarly, peer-reviewed scientific research article looks like and how to tell it apart from a popular article from a magazine.
That’s it.
You’ve finished the third information literacy tutorial!

Links to suggested additional readings:
- How Scientific Peer Review Works
- Peer Review Process
- Peer Review at Science Publications