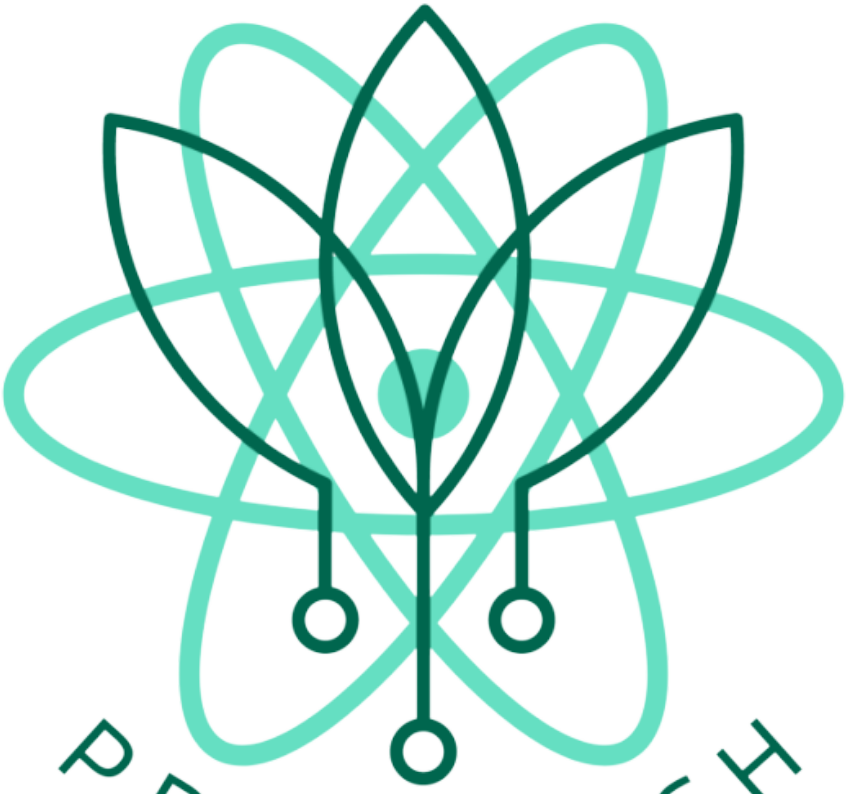


Literature Review

Basics of Scientific Research

Literature Review

How do you do proper literature review? Where do you start? Here we will break it down into multiple sections.

- Where to get started
- Interpreting scientific articles
- Building background knowledge

Literature review looks different for every field, and the literature cited by each project is a very good indicator of the level of the research project.

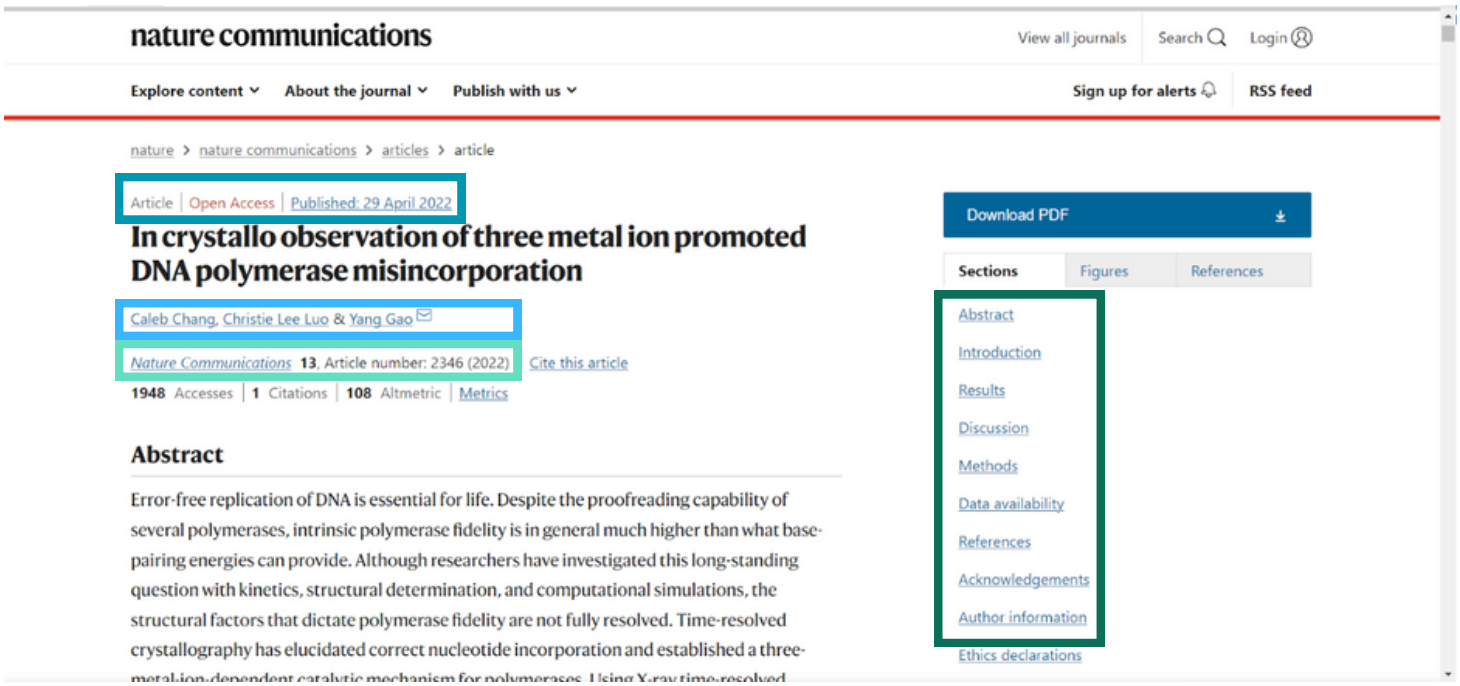
Often times, middle school and even high school science fair projects will cite web pages and web articles. These are often poor sources, and are not credible- including pages such as Wikipedia.

The literature review of all high level research, the research of professional academia, consists nearly completely of **peer reviewed journal publications**.

But what are peer reviewed journal publications? These are articles that have published by a credible research journal, and have been reviewed and approved by academic reviewers and editors, who are experts in the field.

Let's see what characteristics identify an article as a peer reviewed journal article, and what makes a source credible!

Literature Review



Nearly all peer reviewed journal articles will have the components of "Abstract, Introduction, Results, Discussion, Methods and References"

Here the name of the journal is mentioned, along with the volume number **13.** These show that the article was published in a peer reviewed research journal.

The term "Open Access" is a key indicator that the source is a credible research article. Many published research articles require paid access to view, and "open access" refers to an article being available with no charge. The publication date is a minimum requirement for a source to be credible

For a source to be a credible source, it should at a minimum have the names of the authors! In the image, the envelope by the author's name signifies that they are the corresponding author of the journal article, meaning that any questions about the article should be emailed to them.

Besides peer reviewed journal articles, most sources with a .edu domain are reliable sources, belonging to an educational institution.

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Where to get started?

Depending on your field, there are a few very good places to find articles for literature review, where you can find information and inspiration to develop your own project.

If you are seeking to develop a project in the biological sciences or with a health related application, then you are in luck! Scientific literature and resources in this field are well organized and well accessible. The **PubMed database by the United States National Library of Medicine** is where many of the literature and resources can be found. The usefulness of this database cannot be stressed further, it is the life sciences and biomedical researcher's best friend.

Projects in all fields can utilize **Google Scholar** to find academic publications (peer reviewed journal articles and books). Searching the keywords or key terms of the topic on Google could also yield results from accredited literature, and **ScienceDirect Topics** which has a compilation of academic literature on key terms is a good starting point for finding good sources. Though Wikipedia is not a good source, Wikipedia pages often cite peer reviewed journal articles in their citations, such as this one:

14. ^ Zhao, Z.; Gou, J. (2009). "Improved fire retardancy of thermoset composites modified with carbon nanofibers". *Sci. Technol. Adv. Mater.* **10** (1): 015005. Bibcode:2009STAdM..10a5005Z. doi:10.1088/1468-6996/10/1/015005. PMC 5109595. PMID 27877268.

We can identify this citation as peer reviewed journal article from its citation by the journal name in italics "*Sci. Technol. Adv. Mater.*" followed by the volume and issue numbers "**10** (1)". Other indicators that a reference is citing a peer reviewed journal article is the presence of a "doi", or Digital Object Identifier, and is used for identification and providing a link to its location on the internet.

Literature Review

Where to get started?

Once you have found one peer reviewed journal article, **you can use this article as a springboard** to find more relevant literature. Each article will have a references section, a list of articles that it cited, which are all credible literature to read through.

There are two common problems in starting literature review on peer reviewed journal articles for middle schoolers and high schoolers however:

- Being unable to access the article
- Being unable to understand the article

For the first problem, **Scihub.se** is a great resource for reading peer reviewed journal articles without having to pay a fee to read the paper or pay a subscription to the journal. For life sciences and biomedical researchers, many articles are also open access or available free of charge on the PubMed database.

As for the second problem, the next two sections of this guide will go over what to do.

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Interpreting Scientific Articles

As a middle schooler or high schooler just getting into research, it is extremely hard to understand research articles. The language and terminology may be completely beyond your current vocabulary, and it may feel like a completely foreign language. However, beyond the complex terminology is often a clear line of logic, and there are certain points that are more important than others. In order to understand an article, you have to be able to identify what is most important.

The true growth and development of you and your project in literature review starts by piecing together the information that you can understand, and figuring out what terms mean and how concepts work.

Peer reviewed journal articles always start with an abstract. Read through the abstract first! It is a summary of the most important ideas in the entire article. After reading the abstract, try to figure out what the article is about.

Let's do an example with the most term heavy field: Molecular Biology

ABSTRACT Go to: ▸

S100 proteins comprise a multigene family of EF-hand calcium binding proteins that engage in multiple functions in response to cellular stress. In one case, the S100B protein has been implicated in oligodendrocyte progenitor cell (OPC) regeneration in response to demyelinating insult. In this example, we report that the mitochondrial ATAD3A protein is a major, high-affinity, and calcium-dependent S100B target protein in OPC. In OPC, ATAD3A is required for cell growth and differentiation. Molecular characterization of the S100B binding domain on ATAD3A by nuclear magnetic resonance (NMR) spectroscopy techniques defined a consensus calcium-dependent S100B binding motif. This S100B binding motif is conserved in several other S100B target proteins, including the p53 protein. Cellular studies using a truncated ATAD3A mutant that is deficient for mitochondrial import revealed that S100B prevents cytoplasmic ATAD3A mutant aggregation and restored its mitochondrial localization. With these results in mind, we propose that S100B could assist the newly synthesized ATAD3A protein, which harbors the consensus S100B binding domain for proper folding and subcellular localization. Such a function for S100B might also help to explain the rescue of nuclear translocation and activation of the temperature-sensitive p53val135 mutant by S100B at nonpermissive temperatures.

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Interpreting Scientific Articles

First read through the abstract a couple times on your own, and see if you understand what is going on.

Let's break it down. Through interpreting this abstract, we'll see some strategies to develop understanding in scientific articles.

The first strategy to understanding, is to **follow the logic** of each sentence: Understand what is the point of the sentence, and what it is doing.

The first sentence of the abstract is typically a general statement of background information. Here it says that "S100 proteins comprise a multigene family of EF-hand calcium binding proteins that engage in multiple functions in response to cellular stress".

Already a lot of terminology, but we can figure out the gist. The subject of the article must involve **S100 proteins**, and we are told that S100 proteins are a **family of EF-hand calcium binding proteins**. Importantly, **we are told what they do**: engage in multiple functions in response to cellular stress. Some things we can understand without digging into terminology:

- S100 proteins bind calcium
- S100 proteins do things in response to cellular stress

The second line says: "In one case, the S100B protein has been implicated in oligodendrocyte progenitor cell (OPC) regeneration in response to demyelinating insult."

The phrase "In one case" indicates that this line further narrows the focus of the study from the broad background, and the mention of a specific protein "**S100B**" narrows the subject. Without understanding what "oligodendrocyte progenitor cell regeneration" or "demyelinating insult" is, we can understand that:

- S100B has a role in OPC regeneration when:
  - S100B reacts to demyelinating insult

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Interpreting Scientific Articles

The third and fourth line say: "In this example, we report that the mitochondrial ATAD3A protein is a major, high-affinity, and calcium-dependent S100B target protein in OPC. In OPC, ATAD3A is required for cell growth and differentiation."

Once again, the focus of this study is narrowed and identified with the phrase "In this example". "we report" indicates what this study found. The lines identify a new subject, **the ATAD3A protein**, and **how it is related to S100B,** as well as **what it does in OPC.** Essentially, the gist we get from these lines is that S100B targets ATAD3A and has a role in ATAD3A function, as well as the fact that ATAD3A has a role in OPC. This identifies the **role of S100B in OPC as an indirect one**, one that involves **acting upon ATAD3A, which has a direct role** in OPC.

We can connect some dots here though. Note the fact that the third line mentions that ATAD3A is "**calcium-dependent**". We also know that S100B targets ATAD3A and that S100 proteins are a family of "**EF-hand calcium binding proteins**". The link here is **calcium**. This is the **strategy of connecting dots**- often times, understanding comes from **piecing information around the same keyword** together.

From this reasoning, we can infer that S100B binds calcium and brings it to ATAD3A, which allows ATAD3A to function and perform its roles in OPC.

The next three lines explain what was done in the study: "Molecular characterization of the S100B binding domain on ATAD3A by nuclear magnetic resonance (NMR) spectroscopy techniques defined a consensus calcium-dependent S100B binding motif. This S100B binding motif is conserved in several other S100B target proteins, including the p53 protein. Cellular studies using a truncated ATAD3A mutant that is deficient for mitochondrial import revealed that S100B prevents cytoplasmic ATAD3A mutant aggregation and restored its mitochondrial localization."

Sometimes, **the strategy is to understand things in context**. For example, you may not understand anything within the first line, other than that something (Molecular characterization) was done by some experimental technique (NMR)

Literature Review

Interpreting Scientific Articles

which found something (consensus calcium-dependent S100B binding motifs).

Looking at line 1 alone, it doesn't tell you much if you don't understand the terminology. However, if you look at the second line, it tells you that the **S100B binding motif is conserved in several other S100B target proteins.** This allows you to **connect the dots** through looking at context. This allows you to deduce certain things:

- Regardless of what "conserved" means in this context and also seeing that this binding motif was referred to as "consensus", we can deduce that the S100B binding motif on ATAD3A is also found elsewhere.
- Our previous deduction stated that S100B **binds calcium** and brings it to ATAD3A. Now it is said that ATAD3A has **calcium dependent S100B binding motifs.** Thus we can deduce that the calcium S100B binds to also plays a role in ATAD3A-S100B binding.
- Finally, the **meaning of the word "motif"** can be figured through context of the above deductions. If you generally understand what a motif is, a short sequence that is repeated, you can infer that **"S100B binding motif"** is essentially an area/site that is seen on many proteins that binds to S100B.

Line 3 tells you about what was done in the experiment of the study and what was found as a result. Here is what we can deduce with the strategies described above:

- As the ATAD3A "mutant" was unable to be imported into the mitochondria, we can assume that **"mutant" means an altered version of ATAD3A**, and "truncated" means altered in a certain way (if you know the word, yes it means shortened).
- **Why intentionally make ATAD3A "deficient for mitochondrial import"?** That means two things:
  - Scientists want to see ATAD3A outside the mitochondria
  - **S100B binds to ATAD3A outside the mitochondria**
- By observing this ATAD3A mutant interact with S100B outside the mitochondria, scientists saw that S100B prevents cytoplasmic ATAD3A mutant aggregation and restored mitochondrial localization.
  - While we can't really understand "prevents cytoplasmic ATAD3A mutant aggregation" without knowing the terminology, **we can deduce that mitochondrial localization** means that ATAD3A is assisted by S100B to reach its location in the mitochondria.

Literature Review

Interpreting Scientific Articles

The last two lines of the abstract are the **discussion part of the article**, where the researchers analyze what their findings tell us. This is indicated with the "With these results in mind".

"With these results in mind, we propose that S100B could assist the newly synthesized ATAD3A protein, which harbors the consensus S100B binding domain for proper folding and subcellular localization. Such a function for S100B might also help to explain the rescue of nuclear translocation and activation of the temperature-sensitive p53val135 mutant by S100B at nonpermissive temperatures."

In the first line, we can understand nearly all of it based on our previous conclusions, except for what "**proper folding**" means. This is a concept that we have no context for in the previous lines of the abstract, and takes background knowledge to understand.

However, we can guess the meaning based on the words used. **"Proper" indicates that the "folding" of ATAD3A is correct when S100B binds to it**. Though without knowing what "protein folding" is, we can't be entirely sure of what it is, but it is reasonable to estimate that **it has to do with the structure or function** of ATAD3A, either way indicating that **ATAD3A will not be "correct" or maybe "not work" without S100B binding**.

Finally, the second line strays away from the case of this study, and expands the conclusions of this study to another case, which we cannot understand without reading the article.

Through **following the logic, connecting the dots and utilizing context,** we were able to deduce a lot about this study from reading an abstract with many terms we do not know. However, this is not always the case, and which is why building background knowledge, the next section, is also extremely important!

Literature Review

Building Background Knowledge

Being able to interpret scientific articles when you do not know the terminology is difficult, even with the strategies we utilized above. Thus, **building your background knowledge on the field of the topic you are researching is critical for the progress of your project.**

For example, it is advised that you **look up every term you do not understand** and attempt to figure out each concept you do not understand. Often times, the explanation for high level concepts is one that you won't understand either, so you will have to look up what you don't understand within the explanation until you reach a level of explanation that you can understand with your existing scientific knowledge. It isn't easy to pick up chemistry when you haven't taken a designated chemistry class, or understand forces when you haven't taken a physics class, but there are resources out there for you to understand the basics and allow you to gain an understanding of concepts that allow you to build higher level research.

For every science, most notably biology, chemistry and physics, **Khan Academy** covers the entire AP course on each of these subjects. These courses teach college introductory level content, and are easy to understand without much previous knowledge. Look for the topics that are relevant to your research topic and learn the concepts.

With the basics understood from Khan Academy, **higher level concepts** that are built upon these basics can be learned through **Wikipedia or articles from college websites that end with a .edu**. Additionally, methodology in research articles **reference the journal article that published that specific procedure**, and common experimental procedures can be learned from reading those articles. With some grasp on higher level concepts, you can better process scientific literature on your topic and begin developing a high level research project.