SIMPLIFYING SCIENTIFIC WRITING

AN INTERACTIVE TUTORIAL ON WRITING A SCIENTIFIC PASSAGE FOR A LAY AUDIENCE

This tutorial is designed to be used in a classroom or workshop setting, and can also be used on an individual basis.

Learning objectives

Tips on writing for a lay audience:

- Shorten sentences
- Simplify wording
- Add explanation

Sample passage

The following passage on epigenetics was written for a professional audience. We will edit it, one half at a time, for a lay audience.

DNA in a mammalian genome, which consists of 3 billion nucleotides and has a length of approximately 2 meters yet must fit in a nucleus 10 microns across, is packaged into repeating units called nucleosomes that consist of two copies each of four histone proteins (H2A, H2B, H3 and H4) and about 147 nucleotides of DNA. Epigenetic modifications to histone proteins can alter the packing of nucleosomes. One type of epigenetic modification, histone acetylation, neutralizes the positive charge on lysine (K) residues at the amino terminus of histone proteins, which reduces the affinity of the histones for DNA and generally causes an increase in gene expression. (106 words)

Editing the first half

Step 1: Shorten Sentences

First half of original passage (a single sentence), reads:

DNA in a mammalian genome, which consists of 3 billion nucleotides and has a length of approximately 2 meters yet must fit in a nucleus 10 microns across, is packaged into repeating units called nucleosomes that consist of two copies each of four histone proteins (H2A, H2B, H3 and H4) and about 147 nucleotides of DNA.

The key facts are:

- DNA is long
- The nucleus is small
- DNA is packed into nucleosomes

Each fact should be in a separate sentence.

Before: The original sentence:

DNA in a mammalian genome, which consists of about 3 billion nucleotides and has a length of approximately 2 meters yet must fit in a nucleus 10 microns across, is packaged into repeating units called nucleosomes that consist of two copies each of four histone proteins (H2A, H2B, H3 and H4) and about 147 nucleotides of DNA.

After: Can be broken into four sentences:

A typical mammalian genome consists of about 3 billion nucleotides and has a length of approximately 2 meters. Yet [the entire genome] must fit in a nucleus 10 microns across. [DNA] is packaged into nucleosomes. [Each nucleosome] consists of two copies each of four histone proteins (H2A, H2B, H3 and H4) and about 147 nucleotides of DNA.

Passage with shortened sentences:

A typical mammalian genome consists of about 3 billion nucleotides and has a length of approximately 2 meters. Yet the entire genome must fit in a nucleus 10 microns across. DNA is packaged into repeating units called nucleosomes. Each nucleosome consists of two copies each of four histone proteins (H2A, H2B, H3 and H4) and about 147 nucleotides of DNA.

Step 2: Simplify wording

- What words is the reader unlikely to know?
- What words do they need to know?
- How can the content be simplified?

Words/concepts that can be simplified:

- "Genome" can be eliminated.
- "Nucleotides" can be changed to "bases".
- Units can be made consistent by converting "microns" to "meters".
- "Histone proteins" can be shortened to "histones".
- Histone names can be removed.

Before: Passage with shortened sentences:

A typical mammalian genome consists of about 3 billion nucleotides and has a length of approximately 2 meters. Yet the entire genome must fit in a nucleus 10 microns across. DNA is packaged into repeating units called nucleosomes. Each nucleosome consists of two copies each of four histone proteins (H2A, H2B, H3 and H4) and about 147 nucleotides of DNA.

After: Passage with shortened sentences & simplified words:

A typical mammalian cell has several DNA molecules that together contain about 3 billion bases and have a combined length of approximately 2 meters. Yet all the DNA must fit in a nucleus 0.0001 meters across. DNA is packaged into repeating units called nucleosomes. Each nucleosome consists of histones and about 147 bases of DNA.

Step 3: Add explanation

- What is the makeup of DNA?
- What is a nucleosome?

Add a sentence describing the makeup of DNA:

DNA is a very long molecule made from four bases, A, C, G and T. A typical mammalian cell has several DNA molecules that together contain about 3 billion bases and have a combined length of approximately 2 meters. Yet all the DNA must fit in a nucleus 0.00001 meters across. DNA is packaged into repeating units called nucleosomes. Each nucleosome consists of histones and about 147 bases of DNA.

Describe what a nucleosome is:

Before:

DNA is packaged into repeating units called nucleosomes. Each nucleosome consists of histones and about 147 bases of DNA.

After:

The DNA is packed tightly into repeating units called nucleosomes to make it more compact. The core of each nucleosome is a cluster of large molecules called histones. A strand of DNA about 147 bases in length wraps around the histone core like rope around a barrel.

Note that:

- In the original passage, the fact that nucleosomes make DNA more compact is inferred. In the edited passage, this fact is stated directly.
- An analogy is used to help the reader visualize a nucleosome.

First half of passage edited

DNA is a very long molecule made from four bases, A, C, G and T. A typical mammalian cell has several DNA molecules that together contain about 3 billion bases and have a combined length of approximately 2 meters. Yet all the DNA must fit in a nucleus 0.00001 meters across. The DNA is packed tightly into repeating units called nucleosomes to make it more compact. The core of each nucleosome is a cluster of large molecules called histones. A strand of DNA about 147 bases in length wraps around the histone core like rope around a barrel.

Editing the second half

Step 1: Shorten Sentences

First, note the key facts.

Before: End of original passage:

Epigenetic modifications to histone proteins can alter the packing of nucleosomes. One type of epigenetic modification, histone acetylation, neutralizes the positive charge on lysine (K) residues at the amino terminus of histone proteins, which reduces the affinity of the histones for DNA and generally causes an increase in gene expression.

The key facts are:

- Histone modifications can alter the packing of nucleosomes.
- One type of modification reduces the attraction of histones to DNA.
- This modification also generally increases gene expression.

After: Passage with shortened sentences:

Epigenetic modifications to histone proteins can alter the packing of nucleosomes. One type of epigenetic modification, called histone acetylation, neutralizes the positive charge on lysine (K) residues at the amino terminus of histone proteins. [This modification] reduces the affinity of histones for DNA. [This modification] generally increases gene expression.

Step 2: Simplify wording

- What words is the reader unlikely to know?
- What words do they need to know?
- How can the content be simplified?

Words/concepts that can be simplified:

- “Histone proteins” can be simplified to “histones”.
- “Histone acetylation” can be eliminated.
- “lysine (K) residues at the amino terminus” can be eliminated.
- “Affinity” can be simplified to “attraction”.

Passage with shortened sentences, simplified words:

Epigenetic modifications to histones can alter the spacing of nucleosomes. One type of epigenetic modification neutralizes the positive charge on histones. This modification reduces the attraction of histones to DNA. This modification reduces the attraction of histones for DNA. This modification generally increases gene expression.

Step 3: Add explanation

Passage with shortened sentences, simplified words:

Epigenetic modifications to histones can alter the spacing of nucleosomes. One type of epigenetic modification neutralizes the positive charge on histones. This modification reduces the attraction of histones to DNA. This modification reduces the attraction of histones for DNA. This modification generally increases gene expression.

Words/concepts that require explanation:

- What is gene expression?
- Why does nucleosome packing affect gene expression?
- Why do histone modifications affect the attraction of histones to DNA?

The concept “gene expression increases”, which can be described in 3 words to a scientist, takes an entire paragraph to explain to a non-scientist. The same paragraph can explain why nucleosome spacing affects gene expression.

New paragraph explaining what is meant by “gene expression increases”:

DNA contains instructions for making large molecules called proteins. There are many types of protein that each perform a particular function. Histones are a type of protein, and so are enzymes that digest foods. The amount of each protein made must be carefully regulated, and one way this is accomplished is through alterations in the packing of nucleosomes. If DNA is packed loosely, cellular machinery can bind and read the genetic instructions, which allows protein synthesis to occur. If DNA is packed tightly, cellular machinery cannot bind and protein synthesis does not occur.

Note that:

- The definition of proteins includes examples.
- The fact that histones are proteins, which was omitted earlier, is added here, after proteins are defined.
- The passage now explains <u>why</u> nucleosome packing affects gene expression.
- The passage explains the concept “gene expression” without using the actual phrase.

Why does affinity of histones for DNA change? This optional explanation can be added to the final portion of the passage:

Before:

Epigenetic modifications to histones can alter the spacing of nucleosomes. One type of epigenetic modification neutralizes the positive charge on histones. This modification reduces the attraction of histones to DNA. This modification reduces the attraction of histones for DNA. This modification generally increases gene expression.

After: Passage with shortened sentences, simplified words & explanation added:

Packing of nucleosomes depends, in part, on modifications to histone proteins called epigenetic modifications. Unmodified histones have positive charges that are attracted to DNA, which is negatively charged. Certain histone modifications neutralize these positive charges, thereby weakening the attraction of the histones to DNA. As a result, the DNA packs more loosely around the nucleosome. Modifications that neutralized charges on histones generally cause an increase in protein synthesis.

Note that the original passage assumes the reader knows that DNA negatively charged, a fact the reader will need to know to understand why positive charges on histones interact with DNA. Such assumptions, which are very common in writing for a professional audience, cannot be made for a lay audience.

Final

DNA is a very long molecule made from four bases, A, C, G and T. A typical mammalian cell has several DNA molecules that together contain about 3 billion bases and have a combined length of approximately 2 meters. Yet all the DNA must fit in a nucleus 0.00001 meters across. The DNA is packed tightly into repeating units called nucleosomes to make it more compact. The core of each nucleosome is a cluster of large molecules called histones. A strand of DNA about 147 bases in length wraps around the histone core like rope around a barrel.

DNA contains instructions for making large molecules called proteins. There are many types of protein that each perform a particular function. Histones are a type of protein, and so are enzymes that digest foods. The amount of each protein made must be carefully regulated, and one way this is accomplished is through alterations in the packing of nucleosomes. If DNA is packed loosely, cellular machinery can bind and read the genetic instructions, which allows protein synthesis to occur. If DNA is packed tightly, cellular machinery cannot bind and protein synthesis does not occur.

Packing of nucleosomes depends, in part, on modifications to histone proteins called epigenetic modifications. Unmodified histones have positive charges that are attracted to DNA, which is negatively charged. Certain histone modifications neutralize these positive charges, thereby weakening the attraction of the histones to DNA. As a result, the DNA packs more loosely around the nucleosome. Modifications that neutralized charges on histones generally cause an increase in protein synthesis. (*259 words)*

Notes on science writing for a lay audience:

- Simpler does not mean shorter. Many concepts that would be understood by a scientist must be explained to a non-scientist.
- Scientific writing should always explain why things happen.
- Always consider:
    - What is the reader likely to know?
    - What does the reader need to know?
    - How can the content be simplified?
- As a writer, you need to understand the material you are presenting. The writer always needs to know more than the reader.
- Shorten sentences
    - Unrelated ideas should be in separate sentences.
- Simplify words
    - Avoid jargon and acronyms
    - Identify & explain key terms
- Add explanation
    - Use analogies & examples

These steps do not need to be followed in order, but they should always be considered.

Final note to the reader:

Respect your audience: Simplify the language. Don't simplify the science.

About the author

Dr. Andrea Hazard has 15 years of experience writing scientific communications for lay and professional audiences. To learn more about her freelance writing services visit her website: www.biocommunicase.com.