

Organizing and Writing the Results Section

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What we'll cover

Organization of the results section

- As a whole
- Sub-sections and paragraphs

Guiding the reader

Creating coherence/flow between paragraphs

Organization as a whole

The results section **as a whole** sometimes begins with an opening paragraph to remind readers of:

- The overall research question/problem
- The overall approach taken to address that question or problem
- The main finding or bottom line

Or authors will dive right into their first result with no opening paragraph

Check out the journal you're targeting to see how it's done

Organization as a whole

Next, you need to decide how to order the results: Which to present first, next, last?

- Most relevant to your main question or message to least relevant
- Most important to least important
- Chronological*, especially if experiments build upon one another

**Don't just default to chronological, because you may lose readers who want to get to the most important results quickly*

Next: Organization of sub-sections and paragraphs

The opening of **each sub-section** of the results and **each paragraph** that introduces a new result usually contain:

1. A statement of the specific question/purpose (**why?**)
2. A brief description of the method (**how?**)

For example: Opening to sub- section

“**To detect variations within genomes** spanning the continuum of trophic strategies and **predict the lifestyle** of a bacterium from the genome sequence data, **we applied** the genomic markers to **a neural gas clustering method** based on self-organizing maps.” (Lauro, et al., 2009, PNAS)

Blue = Purpose

Green = Method

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Example: Opening to paragraph

“To confirm the presence of diverse cycloviruses and to characterize the genome of this novel group, **inverse PCR was used** to amplify and sequence complete viral genomes from human and chimpanzee stool samples. Each of the 15 sequenced circular genomes has two main open reading frames arranged in opposite directions, encoding the putative Rep and capsid (Cap) proteins, an arrangement typical of circoviruses (Fig. 2).” (*Journal of Virology*, Feb. 2010)

The purpose (blue) and method (green) set the context for understanding the result that follows

This first sentence is known as the topic sentence

“To confirm that the pancreas-derived cells were mesenchymal stem cells, we induced their differentiation into bone, fat, and cartilage under standard differentiation conditions. Consistent with mesenchymal stem cell behavior, original primary culture and clonally-derived pMSC showed the ability to undergo adipogenic, osteogenic, and chondrogenic differentiation (Fig. 2S). Results were reproducible with pMSCs from multiple male and female donors aged 21-65 years ($n = 12$). Further experiments were performed on islet depleted digest-derived pMSC.” (*Stem Cells*, Jan. 2010)

Topic sentences introduce the paragraph’s theme, tell the reader what the paragraph is about

Sometimes, you may even need to offer a little background

“The nucleocapsid protein protects the encapsidated genomic and antigenomic RNAs from nuclease digestion (references). **To determine whether the N protein mutations affected nuclease protection**, BHK cells were infected with vTF7-3 and subsequently transfected with a subgenomic replicon (Bgl-22) and plasmids encoding the P, L, and wild-type or mutant N proteins... **The data shown in Fig. 4A and B...**” (*J. Virology*, Feb. 2010)

Background (in blue) justifies the purpose (green), followed by the method (black) and the results (red)

You can also signal when one experiment leads to another

“Human ES cells (H9) were proliferated on the peptide-displaying SAMs, and the results were compared to those of cells cultured on Matrigel, the standard substrate employed in ES cell culture. Of the six peptide-modified SAMs that support NCCIT cell adhesion, all were effective at mediating human ES cell adhesion (over short time periods)...

These successes led us to evaluate the utility of the surfaces over longer time periods. Specifically, human ES cells were proliferated on LTTAPKLPKVTR- and TVKHRPDALHPQ-substituted monolayers in defined (TeSR-ROCK) media for 20 days (three passages)." (L. Kiessling, *JACS*, Jan. 2010)

To review...

Each sub-section and/or each paragraph that introduces a new result usually covers:

Why? (Purpose)

How? (Approach)

What? (Result)

How to describe your results

We recommend two essential steps in integrating visual and verbal information:

- Refer readers to the figure (graph) or table explicitly
- Tell them what patterns to notice (i.e., summarize, rather than rehashing all the details)

--from Writing in the Sciences, AM Penrose, SB Katz

Example: Summarizing your results

“To confirm the presence of diverse cycloviruses and to characterize the genome of this novel group, inverse PCR was used to amplify and sequence complete viral genomes from human and chimpanzee stool samples. **Each of the 15 sequenced circular genomes has two main open reading frames arranged in opposite directions, encoding the putative Rep and capsid (Cap) proteins,** an arrangement typical of circoviruses (Fig. 2).” (*Journal of Virology*, Feb. 2010)

Example: Summarizing your results

Un-summarized:

Bioassays showed that all 10 rotifers exposed to non-toxic green algae survived; all 10 exposed to dinoflagellates survived; all 10 exposed to both survived; 3 of the unfed group survived (Table 1).

Example: Summarizing your results

Summarized:

Bioassays with rotifers showed no mortality among any of the three algal food treatments (Table 1). In the un-fed treatment, 7 of 10 replicate animals died during the 9-day experiment.

*A summary in the topic sentence,
a.k.a. a preview*

“We predicted that most of the proteins related to CRP/FNR-type regulators fall into 8 major sub-families in α -proteobacterial species. The largest sub-family of proteins related to the CRP/FNR super-family is group A, which is composed of 152 uncharacterized proteins that are distributed in the genomes of 59 of the 87 α -proteobacterial species examined. The next largest sub-family, group C, contains 116 proteins...”

The author uses the topic sentence to preview for readers where they're headed

Another example: Previewing

“Well-known clades of marine copiotrophs, mostly belonging to the gamma-proteobacterial orders Vibrionales and Alteromonadales, were grouped within two clusters at **one extreme of the spectrum** (Fig. 2). **At the other end of the spectrum**, the genome sequences of the two strains of the ubiquitous marine bacterium *Candidatus Pelagibacter ubique* clustered with *S. alaskensis*.” (oligotrophs) (Lauro et al., 2009, *PNAS*)

This is a preview of an entire sub-section of results; it provides a framework for all the details that follow

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At the end of the paragraph: A conclusion

To investigate the effect of ET, 5-week-old plants were treated with 0.1 mM MeJA and either 0.25, 1.0, or 2.5 mM ACC... SA strongly suppressed MeJA-induced PDF1.2 transcription in the presence of up to 1 mM ACC (Fig. 3B). However, when 2.5 mM ACC was applied, the antagonistic effect of SA on MeJA-induced PDF1.2 expression was strongly reduced. **These data support the genetic evidence provided in Figure 2 that, under conditions in which JA- and ET-dependent responses are simultaneously expressed, ET is predominantly responsible for neutralizing the antagonistic effect of SA on JA-responsive gene expression.** (*Molecular Plant-Microbe Interactions*, Feb. 2010)

*Purpose (blue), method (green), result (black), conclusion (red).
The last sentence is also called the stress position; it contains the information you want to stress.*

I.e., Don't make readers guess what's important to notice: Tell them

...“We focused on the two other specific members of the e-CENP-A complex, HJURP, and nucleophosmin (NPM1), two proteins found associated with the CENP-A nucleosome. Immunoblotting of the purified complexes offered additional evidence that both proteins were present in the e-CENP-A complex, but not in the e-H3.1 complex (Fig. 1D). In vitro experiments showed that NPM1 could bind equally well to the CENP-A/H4 and H3/H4 tetramers, strongly suggesting that it cannot be a bona fide chaperone specific for CENP-A. **Consequently, the best candidate for a specific CENP-A chaperone remained HJURP.**” (PNAS, Jan. 2010)

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Another example of a conclusion

“To confirm the presence of diverse cycloviruses and to characterize the genome of this novel group, inverse PCR was used to amplify and sequence complete viral genomes from human and chimpanzee stool samples. Each of the 15 sequenced circular genomes has two main open reading frames arranged in opposite directions, encoding the putative Rep and capsid (Cap) proteins, **an arrangement typical of circoviruses** (Fig. 2).” (*Journal of Virology*, Feb. 2010)

To review again...

Each paragraph that introduces a new result usually covers:

Why? (Purpose)

How? (Approach)

What? (Result)

So What? (Conclusion)

Now that you have your paragraphs, how do you tie them together?

Transitions: Transitions are words, phrases or sentences that create coherence and flow by showing how ideas, sentences, and paragraphs are connected.

Example: Transitions

In vitro experiments showed that NPM1 was able to bind equally well to the CENP-A/H4 and H3/H4 tetramers, strongly suggesting that it cannot be a bona fide chaperone specific for CENP-A.

Consequently, the best candidate for a specific CENP-A chaperone remained HJURP.

If HJURP was a CENP-A chaperone*, it should exhibit a cell cycle dependent association with CENP-A chromatin, because the incorporation of CENP-A is cell cycle dependent and its deposition occurs at G1. And indeed, we found that in G1, in contrast to S and M phases, the quasi-totality of HJURP was tightly associated with CENP-A chromatin.

**This phrase (blue) connects back to the conclusion in green; i.e., it ties the ideas presented in the two paragraphs together*

Example: Transitions

In vitro experiments showed that NPM1 was able to bind equally well to the CENP-A/H4 and H3/H4 tetramers, strongly suggesting that it cannot be a bona fide chaperone specific for CENP-A. **Consequently, the best candidate for a specific CENP-A chaperone remained HJURP.**

If HJURP was a CENP-A chaperone, it should exhibit a cell cycle dependent association with CENP-A chromatin, because the incorporation of CENP-A is cell cycle dependent and its deposition occurs at G1. And indeed, we found that in G1, in contrast to S and M phases, the quasi-totality of HJURP was tightly associated with CENP-A chromatin.

We **next*** conducted experiments to **further*** confirm the presence of HJURP in the e-CENP-A prenucleosomal complex. Thus, we established a stable HeLa cell line expressing a N-terminal FLAG-HA epitope tagged HJURP.

**In the third paragraph, the authors use the simple words “next” and “further” to indicate how this paragraphs relates to the one before*

Another example: Repetition creates the bridge

“...We found that α -proteobacteria from the genera *Rickettsia*, *Ehrlichia*, *Wolbachia*, and *Bartonella* do not possess proteins in the CRP/FNR super-family. These genera were ignored for the rest of our analysis. Among the remaining genera, we selected 87 representative α -proteobacterial species that contain altogether **697 proteins** in the CRP/FNR super-family.

To assemble these **697 proteins** into functionally related groups, we took a clustering approach similar to the one employed by the ORTHOMCL algorithm.”

Transitions can also signal when one experiment leads to another

“Human ES cells (H9) were proliferated on the peptide-displaying SAMs, and the results were compared to those of cells cultured on Matrigel, the standard substrate employed in ES cell culture. Of the six peptide-modified SAMs that support NCCIT cell adhesion, all were effective at mediating human ES cell adhesion (over short time periods)...

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Remember: Writing is like giving directions to the reader

This means:

- Including each step in your thinking
- Showing how ideas are connected to one another
- Offering context when needed
- Reminding readers where they are and what is most important to notice
- Telling readers where they're headed