

Paragraphing

Paragraphs should support the logic of your paper in both the way they follow one another and the way they are individually composed. Here we discuss four ways of organizing an individual paragraph.

Top-down Structure

In scientific writing, most paragraphs are written in a top-down style. The core idea appears as the first or second sentence—the *topic sentence*—and the remainder of the paragraph provides evidence and detail for that core idea.

Each of the **topic sentences** (in **bold**) introduces a single core idea for the whole the paragraph.

The rest of the paragraph provides evidence & detail in support of the topic sentence.

The paragraph transition connects something from the previous paragraph (“internal factors”) with the new core idea (“body size”).

Sample 1

Throughout the 1970s and mid 1980s, research [in insect biology] emphasized the internal factors within an individual that determine its task. The idea of a social insect colony as a factory with assembly-line workers, each performing a single task over and over, had widespread appeal. Such a view was consistent with contemporary thinking about analogous systems; examples were the ‘one gene, one protein’ view of gene action, and the idea that each neuron performs a single function. In social insects, a worker of a given behavioural ‘caste’ was thought to be intrinsically suited to a particular task, and to perform this task more or less exclusively.

One internal factor associated with task is body size. In some species of ants, colonies include adult workers of two or more sizes. Workers of a particular size might specialize in the task for which their size makes them most suited; smaller workers might forage, larger workers might define the nest, and so on. Empirical studies support this for a few species, but polymorphic species, which have more than one size of worker, occur in only a minority of ant genera (44 out of 263); bees and wasps have only one size of worker. [...] Other studies show that, regardless of body size, it is rare for individuals to specialize on a particular task throughout their lives. Although most researchers have moved beyond the idea of division of labour among innate, specialized castes, this idea provided a starting point for the study of task allocation.¹

The top-down structure is a way many scientists feel most comfortable explaining their subjects: in terms of main claims or findings (topic sentences) backed up by supporting evidence and detail. Each topic sentence provides a content milestone, allowing the reader to locate the main ideas efficiently.² The top-down structure is especially good for explaining ideas that the reader has some familiarity with. In the sample above, the reader can more or less understand each topic sentence on its own before reading the details.³

Bottom-up Structure

Sometimes your core ideas are too new, complex, or jargon laden for a reader to follow them in the top-down style above. Good writers address this challenge by using a bottom-up paragraph structure, especially in the first paragraphs of a section.

The paragraph begins with something every reader can relate to—for example, a scene, anecdote, or thought experiment. In this sample, it’s a scene of a fox chasing a rabbit.

The paragraph builds in complexity—here, connecting predator-prey dynamics in nature to a modern technological arms race.

The paragraph culminates in a new complex idea—a sort of **inverted topic sentence (in bold below)**—in this case, the term “arms race” as used by evolutionary biologists.

Sample 2

Foxes and rabbits race against each other in two senses. When an individual fox chases an individual rabbit the race occurs on the time scale of behaviour. It is an individual race, like that between a particular submarine and the ship it is trying to sink. But there is another kind of race, on a different time scale. Submarine designers learn from earlier failures. As technology progresses, later submarines are better equipped to detect and sink ships, and later-designed ships are better equipped to resist. This is an ‘arms race’ and it occurs over a historical time scale. Similarly, over the evolutionary time scale the fox lineage may evolve improved adaptations for catching rabbits, and the rabbit lineage improved adaptations for escaping. **Biologists often use the phrase ‘arms race’ to describe this kind of evolutionary escalation of ever more refined mutual counter-adaptations.**⁴

¹ Gordon, D. M. (1996). The organization of work in social insect colonies. *Nature*, 380(6570), 121.

² The top-down style is the structure prescribed in the famous (or infamous) “five-paragraph essay,” widely taught throughout the English-speaking world, especially in the United States.

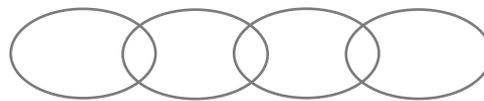
³ Perhaps the concept of “internal factors” is slightly vague at first, but it becomes clear quickly.

⁴ Dawkins, R., & Krebs, J. R. (1979). Arms races between and within species. *Proceedings of the Royal Society of London. Series B. Biological Sciences*, 205(1161), 489-511.

This author could have started with the topic sentence (with slight modifications) and written a top-down paragraph with the same content. But many readers would have had trouble understanding this because of three key complex terms: “arms race,” “evolutionary escalation,” and “mutual counter-adaptations.” With the bottom-up strategy, the author first give a taste of these complex concepts through concrete examples of foxes, rabbits, and submarine designers. Then upon this basis, the reader can easily grasp the concluding topic sentence, jargon and all.

Sequence Structure

A third structure can be used to depict a sequence—for example, the history of a field, the evolution of a body of literature, or the steps in an experiment. This chain-like structure has no need for an overarching theoretical message in the form of a topic sentence. It may especially fit in parts of your introduction and methods section.



It may especially fit in parts of your introduction and methods section.

Sample 3

More than 70 years ago, Landau and Peierls argued that strictly 2D crystals were thermodynamically unstable and could not exist. Their theory pointed out that a divergent contribution of thermal fluctuations in low-dimensional crystal lattices should lead to such displacements of atoms that they become comparable to interatomic distances at any finite temperature. Indeed, the melting temperature of thin films rapidly decreases with decreasing thickness [...]. For this reason, atomic monolayers have so far been known only as an integral part of larger 3D structures [...]. Without such a 3D base, 2D materials were presumed not to exist, until 2004, when the common wisdom was [flouted] by the experimental discovery of graphene and other free-standing 2D atomic crystals [...]. These crystals could be obtained on top of non-crystalline substrates, in liquid suspension and as suspended membranes.⁵

Sample 4

Gels were cast between glass plates. The plates were separated by Perspex side pieces 3 mm thick and along one edge was placed a "comb" of Perspex, which moulded the sample wells in the gel. The Perspex pieces were sealed to the glass plates with silicone grease and the plates clamped together with Bulldog clips. The assembly was stood with the comb along the lower edge. [...]⁶

Although these two samples have no need for topic sentences, notice how they still follow the essential familiar-to-new principle of paragraph cohesion (see the EWC's *Cohesion* handout).

Mixed Structure

You might find that none of these templates fits your needs perfectly and you would rather combine a few different features. Look how Sample 5 mixes structures: it starts with a strong top-down topic sentence, but then largely follows the bottom-up structure.



Sample 5

How does the normative theory [of consumer choice] hold up in more complicated situations? Consider the famous birthday problem in statistics: if 25 people are in a room what is the probability that at least one pair will share a birthday? This problem is famous because everyone guesses wrong when he first hears it. Furthermore, the errors are systematic—nearly everyone guesses too low. [...] For most people the problem is a form of mental illusion. Research on judgment and decision making under uncertainty, especially by Daniel Kahneman and Amos Tversky, has shown that such mental illusions should be considered the rule rather than the exception. **Systematic, predictable differences between normative models of behavior and actual behavior occur because of what Herbert Simson (1957, p. 198) called 'bounded rationality'**[.]⁷

In this sample, you could consider the first sentence to be a teaser for the full topic sentence that comes at the end of the paragraph. Without this teaser, the reader might wonder why they should follow the birthday party thought experiment. The teaser is a placeholder for the reader, signaling where the bottom-up paragraph is going. And indeed, by the end of the paragraph, the reader can decipher the complex, jargon-heavy sentence that wraps up the whole passage.

⁵ Geim, A. K., & Novoselov, K. S. (2007). The rise of graphene. *Nature Materials*, 6, 183-191. [citations removed for readability]

⁶ Southern, E. M. (1975). Detection of specific sequences among DNA fragments separated by gel electrophoresis. *Journal of Molecular Biology*, 98(3), 503-517. [citations removed for readability]

⁷ Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior & Organization*, 1(1), 39-60.