

## Punctuation

Written by Tim Inglis

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**Punctuation.** **Punctuation.** n. the use of periods and other marks in sentences. From Latin *punctus*  
point or prick,  
*punctuare*  
to mark with points or dots; related to punctual, prompt; punctuality, exactness or precision; less closely to punctilio n. detail of honour, conduct or ceremony.

In the

[language of infection](#)

punctuation is concerned only with the written form i.e. the genome, its corresponding proteome and their identifiable functions. These belong to the emerging field of omics (genome, transcriptome, proteome, metabolome etc) which is awash with linguistic metaphors notably including translational science.

Narrowing that field to manageable proportions, punctuation is a very practical and often neglected component of written language. There are plenty of celebrated examples of misplaced punctuation fundamentally changing the meaning of a phrase (e.g. an amphibology as in

[Eats shoots and leaves](#)

, Truss, 2003), and entire websites devote their space on the web highlighting the abuse of the humble

[apostrophe](#)

## Pausing for breath

The period mark or full stop is the simplest of punctuation marks. It indicates the point at which you, the reader, need to pause for breath and possibly a little reflection, before proceeding to the next sentence. Convention has it that an additional blank character space should be placed immediately after the period mark. The full stop-space-upper case package is the

[stop codon](#)

of written English. In Germ terms, it signifies the end of the gene. Transcription of the genetic code into messenger RNA stops here, pauses and prepares to start the next part of the message at the following word commencing with an upper case letter.

The comma is used to denote a shorter pause in the linear generation of message, often ending

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the end of a phrase or clause within a full sentence. Examples include breaks between items in a list, numbers or prior to starting quoted speech. Think of it as a

[premature stop codon](#)

. At the opposite end of the scale are paragraphs and, in the case of lengthy documents, chapters. These start and end with the punctuation described above, but add whole blank lines or even start overleaf in the case of chapters.

Phrases, sentences, paragraphs and chapters contribute to a narrative at different levels in a hierarchy of scale. The infectious disease outcomes of human encounters with microbes can be classified into a similar hierarchy of scale, starting with the molecular level, through cellular, tissue, organs, organ system, to whole being and human communities. At the granular end full stops and commas punctuate the genetic code of a specific microbial species. At the human health end of the scale, paragraphs, papers, chapters and books detail the cases, outbreaks and pandemics. Literally.

## Dialogue

Engagement and interaction between different parties is often more interesting than plain narrative text. A series of specialist punctuation marks and conventions is used to change the measured pace of uninterrupted, objective narrative.

“I disagree,” said the

[Micrognome](#)

, choking on an apostrophe as he ended the sentence with a final stroke of his pen.

Many microorganisms borrow heavily from the genetic material of close relatives, whether they are members of the same species, near neighbours or not even remotely related. There is a huge range of methods used to gain new genetic material that might help in the struggle for survival, and it is not always clearly identified as an insertion sequence, transposon or plasmid with quotation marks. However, a simple search function (

[BLAST](#)

) similar in concept to a

[Google text search](#)

will quickly show you whether a gene sequence you think belongs in quotation marks has been encountered before.

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There are special punctuation conventions that invite a dialogue with the reader. These are question and exclamation marks. Questions usually begin with a strong cue that this is about to happen, notably who, what where, when, why words. These are the words used to start an analysis of outbreaks or

[epidemics](#)

, and should therefore be familiar to anyone with an interest in public, community or international health. But the same process occurs at the molecular and cell biology end of the scale, the difference being that the microorganisms are doing the asking and the corresponding non-specific and immune defences provide the answers to the who, what where, when why of the molecular/cellular encounter. Exclamation marks have become sadly overused in recent time, but still have a proper use after imperatives (commands), expletives (profane language), calls for help and the like. We can thus imagine an exchange of blows between a priobe, P1 (influenza virus) and a person, P2 (the Micrognome):

P1: "Who inhaled me?", said the influenza virus

P2: "I did," said the Micrognome

P1: "What did you inhale?"

P2: "An unidentified aerosol. I'm working on it."

P1: "How far do you think I can go?"

P2: "Bring it on!"

P1: "When will you learn to keep a lid on it?"

P2: "I'll teach you to replicate. Take that, and that, and that!"

P1: "Why not pour a bit of petrol on the flames?"

P2: "Help! I've started a cytokine storm."

## Subtleties

The imagined exchange between the Micrognome and influenza virus lacks the detail or subtlety that produces such a wide variety of infection outcomes. There is still so much to learn

from the

[omics of infection](#)

. Even at a whole microbial genome level, the growing collection of annotated genomes has yet to yield its deeper secrets. Much less is known of the functional details of transcription and translation, let alone the expression of gene function in a range of cellular and tissue contexts. Some of the subtler aspects of functional biology reflect the economic manner in which microbial genomes and proteomes are organised to combine necessary repetition without wasteful reduplication. As in our written language, it is possible to denote a wider range of functional vowel sounds than there are vowels by using letter combinations known as diphthongs, as in bacteraemia. Simplified English loses the ability to represent this level of language texture. At the public health end of the scale, the message that different combinations result in a rich variety of different outcomes can be seen in the results of combined or synergistic infections e.g. epidemic

[influenza and secondary bacterial infection](#)

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Another type of text marking seen very little in English, but used more commonly in Latin-based languages, are the accents. These marks change the sounding and emphasis of specific syllables and are most commonly seen over or under vowels. Once again, the range of sounds produced is increased without increasing the number of letters in the alphabet. Since vowels are sounded directly from the larynx with little if any interference by lips or tongue, but have to be grouped with other vowels and consonants to make the building blocks of polysyllabic speech, accents are one way to mark up what in microbial genetic terms would be post-transcriptional regulation.

The converse of subtlety is the blunt, whole-word emphasis seen as upper case, bold or underlining. Underlining is sometimes used as an alternative to italics to denote proper biological names in their Linnean binomial (

[Genus and species](#)

) form. Just as the written language recognises a biological entity with a degree of formality, so too does the Microbiological world (a) by attribution of properties to a new species when accepted by international scientific consensus, and (b) when encountered by a more complex life form through its specific defences. Indeed, when immunological epitopes are first processed by the human immune system, it takes time to mount an effective immune response. On subsequent encounters, the anamnestic response ensures a much faster recognition. This would be like progressing from (1)

*Staphylococcus aureus*

, to (2)

*S. aureus*

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### Editorial prerogative

Editors; those policemen of the written word, use a much maligned and significantly extended set of punctuation marks borrowed from the typesetter's handbook. Readers of the printed word need not encumber their brains with the marginalia of the editorial landscape. Just be aware that full stops, commas, quotation-, question- and exclamation marks, em dashes, apostrophes, colons, semi-colons, accents (foreign borrow words) and diphthongs (European English) are the tip of the iceberg on which many a would-be author has foundered. But consider this; what unseen editorial processes are in action behind the scenes to realign errors of transcription and translation in the microbial world in order to assist the humblest of

[priobes](#)

survive each outing into a hostile environment? Turning the tables; what editorial processes operate to ensure any subsequent encounter with a hostile priobe is relegated to the pages of immunological history?

Both perspectives on infection are told as an extended narrative. The tale often becomes a complex dialogue functioning simultaneously at several levels of biological complexity. No matter how long it may take to develop a mechanistic explanation of biological process, tell the story and get it into print, the editor has the final word on how much text will be tolerated between the first and last words. His is therefore the all important decision on where to put the last full stop.

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