Back in the 1870s, opinion was divided on whether microbes could arise in growth media from nowhere. **Gavin Thomas** describes how this theory was disproved by an Irish physicist and science popularizer called John Tyndall.

Microbes in the air: John Tyndall and the spontaneous generation debate
anticipated. He then demonstrated, using his light scattering assay, that air filtered by cotton wool was ‘optically empty’, meaning that the path of the beam appeared black, which he also saw with air that had been left to settle for long periods of time in a sealed glass chamber. Finally, he reported that his own breath, especially the end of his expiration, was remarkably free of particulate matter. He opened half of them in a hayloft near his cottage on the Bel Alp. Tyndall had demonstrated that upon opening these flasks there was a brief inrush of air, but that the shape of the neck prevented any further entry of particulate matter. He opened half of them in a hayloft near his cottage and the other half on a ledge overlooking the Aletsch glacier, making sure he was himself downwind of the flasks and wearing a spirit lamp to sterilize the neck pliers that were used to break off the top of the flask. Tyndall then incubated all his opened flasks over his kitchen stove for 3 days and found that all but two of the flasks opened in the hayloft were ‘invaded by organisms’, while not one opened in the ‘cleaner surrounding mountain air’ had any growth. Tyndall hence demonstrated that air from the mountain top was largely free from organic material and no life was produced in the flasks, while the flasks opened in the closed environment of the hayloft, in the presence of an abundance of organic material, almost always had growth. This particular experiment was a precursor in an earlier demonstration by Pasteur that air from the Mer de Glace was cleaner than that from the town below, but was presented as part of the many experiments Tyndall performed during the 1870s to provide convincing quantitative evidence supporting the spread of microbes in the air.

A bale of hay

Tyndall’s experiments hit difficulties in 1876 when, for a reason that eluded him, he could no longer keep his infusions sterile. He only managed to reproduce his experiments again after moving his lab to Kew Gardens. Earlier in 1876 Tyndall had met the German botanist Ferdinand Cohn, who discussed his recent description of spores in the life-cycle of the hay bacillus (Bacillus subtilis) and also mentioned Robert Koch's observations of spore formation in B anthracis. Tyndall had brought a bale of hay into the Royal Institution at about the time that his experiments became contaminated and he reasoned that spores from the hay were now in the air of his lab and were able to survive the heating process he used to sterilize his infusions. It is of interest to note that this had been observed previously by Bastian, who had used these data to support his ideas of spontaneous generation. Now, however, Tyndall had a potential explanation and investigated the heat resistance of spores in more detail. After a few months of work he discovered that a series of boiling and cooling steps in the treatment of his growth medium could completely prevent any growth in his flasks. By heating and cooling the spores were germinating and were then being killed during the next exposure to boiling. This process of fractional sterilization, sometimes known as Tyndallization, is still used today to sterilize certain diagnostic, growth media that cannot tolerate autoclaving.

By 1880 the debate was effectively over due to the hard work of Tyndall and others, including the Englishmen William Dallinger and John Drysdale, who had demonstrated that Bastian’s experiments could be explained simply by improved knowledge of microbiology and did not need to imply continual de novo creation. Spontaneous generation was removed from the frontlines of science into the history books – all started by a chance observation made while pursuing a completely different field of science.

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Further reading


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Tyndall’s tubes and chamber will be available for general viewing at the Royal Institution after a major redevelopment due to be completed by the end of 2007. The author would like to thank Prof. Frank James and Katharine St Paul for locating the chamber and for allowing it to be photographed, and Prof. James Strick for comments on this article.