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## Pleomorphism (microbiology)



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In microbiology, **pleomorphism** (from greek *πλέω*- more, and *-μορφή* form) is the ability of some micro-organisms to alter their morphology, biological functions, or reproductive modes in response to environmental conditions. Pleomorphism has been observed in some members of the [Deinococcaceae](#) family.<sup>[1]</sup> The modern definition of pleomorphism in the context of bacteriology is based on *variation* of morphology or functional methods of the cell, rather than a *change* of these characters as previously believed.<sup>[1]</sup>

## Bacteria

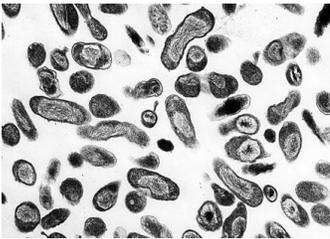
In the first decades of the 20th century, the term "pleomorphism" was used to refer to the idea that [bacteria](#) change morphology, biological systems, or reproductive methods dramatically according to environmental cues. This claim was controversial among [microbiologists](#) of the time, and split them into two schools: the monomorphists, who opposed the claim, and the pleomorphists such as [Antoine Béchamp](#), Ernst Almquist, [Günther Enderlein](#), [Albert Calmette](#),<sup>[2]</sup> Gastons Naessens, [Royal Raymond Rife](#), and Lida Mattman, who supported the posit. According to a 1997 journal article by [Milton Wainwright](#), a British microbiologist, pleomorphism of bacteria lacked wide acceptance among modern microbiologists of the time.<sup>[3]</sup>



*Helicobacter pylori* in curved rod form

Monomorphic theory, supported by [Louis Pasteur](#), [Rudolf Virchow](#), [Ferdinand Cohn](#), and [Robert Koch](#), emerged to become the dominant [paradigm](#) in modern medical science: it is now almost universally accepted that each bacterial cell is derived from a previously existing cell of practically the same size and shape. However it has recently been shown that certain bacteria are capable of dramatically changing shape.

[Sergei Winogradsky](#) took a middle-ground stance in the pleomorphism controversy. He agreed with the monomorphic school of thought, but disagreed with some of the foundational microbiological beliefs that the prominent monomorphists Cohn and Koch held.<sup>[4]</sup> Winogradsky published a literature review titled "The Doctrine of Pleomorphism in Bacteriology" in which he attempted to explicate the pleomorphic debate, identifying the fundamental errors within each side's argument.<sup>[5]</sup> Winogradsky posited that pleomorphists Naegli and Zopf were unable to perceive the existence of bacterial morphological classes, and that Cohn and Koch, within their own suppositions, ignore species of morphologically variant bacteria that are unable to grow within [axenic](#) cultures.<sup>[5]</sup> Winogradsky explained the perception of pleomorphic bacteria as bacteria progressing through different stages within a developmental cycle, thereby providing the fundamental structure for a theory of morphology based upon the concept of dynamic deviation from a morphological type, or [biotype](#).



*Coxiella burnetii* bacteria displaying pleomorphism

While the pleomorphic debate still exists in its original form to some extent, it has predominantly been altered to a discussion regarding the methods, evolutionary inception, and practical applications of pleomorphism.<sup>[6]</sup> Many modern scientists regard pleomorphism as either a bacterium's response to pressure exerted by environmental factors, such as bacteria that shed [antigenic](#) markers in the presence of [antibiotics](#), or as an occurrence in which bacteria evolve successively more complicated forms.<sup>[6]</sup> A hypothesis referred to as "Pleomorphic Provolution", a component of Stuart Grace's "Ambimorphic Paradigm", takes both of these theories into consideration.<sup>[6]</sup>

Although it has recently been shown that certain bacteria are capable of dramatically changing shape, pleomorphy remains a controversial concept. A well accepted example of pleomorphism is [Helicobacter pylori](#), which exists as both a helix-shaped form (classified as a curved rod) and a coccoid form.<sup>[7]</sup> [Legionella pneumophila](#), the species of intracellular bacteria parasite responsible for [Legionnaire's disease](#), has been seen to differentiate within a developmentally diverse network.<sup>[8]</sup> The genera [Corynebacterium](#)<sup>[9]</sup> and [Coccobacillus](#)<sup>[10]</sup> have been designated as a pleomorphic genera, diphtheroid [Bacilli](#) have been classified as pleomorphic [nosocomial](#) bacteria.<sup>[11]</sup> Additionally, in one study focused on agents involved in a non-infectious disease, pleomorphic bacteria were found to exist in the blood of healthy human subjects.<sup>[12]</sup>

One factor that affects the pleomorphism of some bacteria is their nutrition. For example, the bacterium [Deinococcus radiodurans](#) has been shown to exhibit pleomorphism in relation to differences in the nutrient contents of its environment.<sup>[1]</sup>

## Viruses

The [virions](#) of certain viruses sometimes exhibit pleomorphism, in the sense that their appearances can vary. However, this is not true pleomorphism, as individual virions are not changing shape, but being succeeded by virions with different shapes. One example is the [bacterial viruses](#) of the [Plasmaviridae](#) family.<sup>[13]</sup> A group of [haloarchaeal](#) viruses has been shown to exhibit pleomorphism as well.<sup>[14]</sup>

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