195. Terminology in Bacteriology, with Special Reference to Cell Body, Macromolecular Layer in the Cell Wall and its Substructure

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Introduction. In 1953 the "macromolecular layer" (MML) was firstly demonstrated in the cell wall of *Spirillum serpens* by Houwink.¹⁾ Since then, the existence of the MML has been recognized in the walls of various kinds of both Gram-positive and -negative bacteria by many workers, and the morphological properties of the MML, e.g. arrangement of the "unit structures" (US) in the MML, their shapes and sizes, and the subunit of the US have been described. Thus the anatomy of the wall was generally completed.²⁾ On the other hand, the morphological characteristics of the virus particle were discussed by Lwoff and co-workers³⁾ and the peculiar names such as *virion*, *capsid* and *capsomer* were also proposed by them for the virus particle and its substructures, respectively. Their considerations were proved to be true and their proposal was also accepted by the virologists after electron microscopy in the negative staining specimens initiated by Brenner and Horne.⁴⁾

Thus, the organization order of bacterial cells based upon the elementalism, especially the substructure system of the wall was recognized to be very similar to that of the *capsid* of virus particle.

Both systems are shown in parallel as follows:

* AML=amorphous layer, MML=macromolecular layer

As above mentioned, the virus particle and its substructures were given their peculiar names, whereas the bacterial cell body and its substructures have not yet been named. Therefore, the naming of the latters was discussed in comparison with the former and their peculiar names were proposed in this paper.

Organization of the bacterial cell, particularly of the sub-structures of the cell wall. It is considered that a bacterial cell body consists of some morphologically distinct structures, such as slime layer or capsule, cell wall, cytoplasmic membrane (CPM), cytoplasm and nucleus.

From the functional viewpoint, these structures are classified into two major groups. One is a group of an envelope or container and the other is a group of the contents which play the leading part of metabolism in the cell body.

The wall is thicker than the CPM and protects the contents as well as forming the shape of cell body with its higher degree of elasticity, ductility and rigidity. These properties of the wall were explained by the demonstration of the MML in the wall.⁷⁾ The MML is relatively preservable than the "amorphous layer" (AML), so that the former was also regarded as the skeleton structure of the wall.⁷⁾

The MML is constructed from the unit structures sometimes called "unit granule",⁵⁾ "unit particle",⁶⁾ or "unit cylinder".⁷⁾ The US varies in shape and size in the different bacteria. Four kinds of shapes, such as "spherical",⁸⁾ "doughnut-shaped",⁹⁾ "cylindrical"⁷⁾ and "cup-like",¹⁰⁾ were reported. The distribution of their diametric sizes ranges from about 50 to 200 Å. The existence of the subunits was observed in the US.^{11),12)}

The chemical composition of the subunits has not yet been clarified, however, they might be regarded as macromolecules because of their sizes.

The organization order of *Bacillus aneurinolyticus* is shown in Fig. 1 and of general bacteria is summarized in Fig. 2.

Fig. 1. Electron micrographs of a Bacterial cell body and its substructures based upon the elementalism.

It is explained that there are many differences between the virus particle and the bacterial cell in their morphological characteristics, e.g. the former is smaller, simpler and more primitive than the latter.

However, similarities and common characters also can be recognized between them. Especially, both the *capsid* and the MML represent the peculiar shape of each microorganism with the common order of organization (substructure system) respectively, and possess a function as the container for genetic materials and others. As a remarkable difference, the former is smaller with fewer number of the US than the latter. Therefore, it is considered that they hold the same rank in the organization order of each individual with the differences on the scale of whole body and in number of the US. The *capsomer* and the US of the MML resemble each other in shape (granular or cylindrical) and in size (around 100 Å).

Naming of the bacterial cell and its substructures. Each substructure in the bacterial cell organization, such as the cell body, the MML in the wall, and the US of the MML, does not have its own peculiar name now as above mentioned. Therefore, their peculiar names may be proposed with the discussions of naming procedures after the examples in virus by Lwoff and co-workers.³⁾

1) *The cell body.* A bacterial cell body is similar to a *virion* (virus particle) in the organization order, so that the imitation of the naming procedure of *virion* is reasonable. The *virion* must be a compound of two words, *virus* and *on*. The word of *on* is Greek which means "being", and is sometimes used as a suffix for the calling of the elementary particles and quantam such as electron, proton and ion in physics. Lwoff and co-workers³⁾ might have thought of the original meaning and customary usage of *on*. These discussions can be summarized as follows:

$$virus + on \longrightarrow virion$$

Bacterial cell bodies are larger than virus particles in general, however, they are still smaller than 10μ and each of them can be regarded as a kind of particle. In fact, they are usually treated as particles in suspension for several counting methods of cell bodies, e.g. the turbidimetry-nephelometry¹⁴⁾ and coulter count method.¹⁵⁾ Moreover, there is no size limit regarding the usage of *on*. Therefore, the following procedure in the naming of bacterial cell body can be admitted.

$$bacterium + on \longrightarrow bacterion$$

2) *The MML in the wall.* The MML is regarded as a similar structure to the *capsid* because of its morphological and physiological properties as above mentioned, consequently this structure can be

named in a way similar to that of the *capsid*. The *capsid* was induced from a Greek word "ΚΑΨΑ" (kapsa) by Lwoff and co-workers,³⁾ which means box or bag, and was regarded as a container of the genetic materials. They spelled *capside* in French and *capsid* in English.³⁾

The author would like to induce the peculiar name of the MML from a Greek word "ΤΕΙΧΟΣ" (teikhos) which means the wall, because the MML is the main structure of the wall as above mentioned. Consequently, the naming procedure is reasonable as follows:

Greek	Pronunciation	English style
ΤΕΙΧΟΣ	(teikhos)	<i>teichosid</i>

3) *The unit structure of the MML.* The name of *capsomer* was introduced from a compound of two Greek words as shown in Table II.³⁾

Table II. Naming procedure of "capsomer" by Lwoff *et al.*³⁾

	Origin	Spelling of peculiar name	
	Greek	French	English
Combination	ΚΑΨΑ+ΜΕΡΟΣ	<i>capsomeres</i>	<i>capsomer</i>
Pronunciation	(kapsa) (meros)	kapsomər	kəpsomə
Meaning	Box or bag Part	(Part of box)	(Part of box)

Accordingly, the name of *teichomer* can be given to the US of the MML in the sense of "part of *teichosid*" after the naming of *capsomer*, because the US is a constituent of the MML. The naming procedure of the *teichomer* is shown in Table III.

Table III. Naming procedure of "teichomer" by Yoshii (1974)

	Origin	Spelling of peculiar name	
	Greek	French style	English
Combination	ΤΕΙΧΟΣ+ΜΕΡΟΣ	<i>téichomeres</i>	<i>teichomer</i>
Pronunciation	(teikhos) (meros)	teifɔmər	teikhomə
Meaning	Wall Part	(Part of wall)	(Part of wall)

Conclusion. Because of similarities and common characteristics in the organization between the bacterial cell body and the virus particle (*virion*), the macromolecular layer (MML) in the cell wall and the *capsid*, and the unit structure (US) of the MML and the *capsomer*, the peculiar names were given to the cell body, the MML in the wall, and the US of the MML after the naming procedures of *virion*, *capsid* and *capsomer*.

Those peculiar names are "*bacterion*" (cell body), "*teichosid*" (MML in the wall), and "*teichomer*" (US of the MML), respectively.

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