Logical Biology 6 (3): 62-64, 2006
http://logibio.com

PERSPECTIVE

CELL REPRODUCTION

Cell Division versus Cell Reproduction: No Evidence for Cell "Division"

Shi V. Liu

Eagle Institute of Molecular Medicine
Apex, NC 27502, USA

SVL@logibio.com

(Part 1 received 2006-08-15; accepted 2006-08-25; Part 2 received 2006-09-15, accepted 2006-0929; Both published 2006-09-30*)

HIGHLIGHT

A serious discussion on the problems and pitfalls of describing cell reproduction as a cell "division" was made. However, "top" scientific journals rejected to publish this discussion even in its short format.

ABSTRACT

Symmetric "cell division" has been a rooting concept for microbiology and cell biology that has contributed to a distorted view on microbial/cell life for centuries. A proposal is made here to replace "cell division" with "cell reproduction" to better capture the reality and to help unifying biology. This change in terminology should not be treated as a simple wording game but a fundamental revolution in microbiology/cell biology.

KEY WORDS

Cell reproduction, Cell "Division", Cell age, Cell life, Cell death, Cell "cycle", Cell Reproduction cycle

Part 1. Cell Division versus Cell Reproduction

"Cell division" is a very common term used in scientific researches and publications. The term might have taken its root from the early microscopic observations on some so-called "symmetric" microbes which form two "identical" cells from the previous one cell. To the early microbiologists/cell biologists, there was indeed no way to argue for any distinction between the two cells formed from the one cell. Thus, microbiologists or cell biologists have simply called these two cells formed from one cell as identical daughter cells. However, by doing so, microbiologists/cell biologists in fact have violated a basic life principle: reproduction means succession of generation which means there is a genuine chronological age difference between the old template and the new copy.

Perhaps microbiologists/cell biologists have realized the dichotomy they created for biology. Thus, instead of calling it as "cell reproduction" to conform to the normal scientific rule and logical pattern of classifying sub-level term/concept under its higher level term/concept, they used a new term "cell division" or "cell fission". By definition, division or fission does not intrinsically entail any mechanism of reproduction and thus it theoretically does not have a need to abide by any life principle related with reproduction.

Thus, ever since the beginning of microbiology/cell biology, the reproduction processes of microbes/cells have been described as some automatic cycling processes. "Cell cycle" has

even become a standard term for cell reproduction cycle. Even though the subject under study is really a reproduction process, many cell biologists (including microbiologists) have never taken any serious consideration over the very fact that the objects they are studying in the reproduction process should contain an old template and a new copy. Some microbiologists/cell biologists even became very upset when such possibility was pointed out. In the words of one such expert "The semantic metaphors of "mothers and babies" and "life cycles and immortality" may be of interest to philosophers but are not of any practical or theoretical value that I can see." (*Logical Biol.* 5: 254-271, 2005). An expert on "cell division cycle" even claimed that my alternative view on microbial/cell life (*Sci. China* 42: 644-654, 1999; *Logical Biol.* 1: 5-16 and 25-31, 2000; 4: 1-6, 7-15, 16-27 and 88-101, 2004; US patent 6767734B, 2004; *Trends Biotechnol.* 23:9-10, 2005) will cause "confusion as to the nature and study of the cell cycle" when he wrote in a Commentary that was initially accepted for publication by *Trends in Biotechnology* but later withdrawn from publication by that journal after the editor and board members read my reply to this Commentary (my reply was later published in *Logical Biol.* 5: 335-349, 2005 but that expert has refused repeated invitations to publish his Commentary in *Logical Biol.)*

However, increasing evidence has now shown that the so-called "symmetric" cell division is not "typical" at all and could not even serve as a representative for the diversified manners of cell reproduction. Many so-called "asymmetric" cells/microbes actually "divide" asymmetrically. More importantly, at the molecular level, even the so-called "symmetric" cells/microbes are not symmetric in their bodies and in their "divisions". Unfortunately, facing such an overwhelming amount of "inconsistent" data that contradict the dogmatic view of cell and cell division, microbiologists/cell biologists are not willing to reconsider the validity of their long-inherited "symmetry" assumption on cell body and the "equality" principle in cell division. Mainstream microbiologists/cell biologists are still closing their door tight to alternative views which in fact have provided much clearer insight to the underlying mechanisms of cell reproduction and cell aging (*Logical Biol.* 5: 51-55 and 109-116, 2005).

Furthermore, instead of correcting the fundamental mistakes in understanding cell reproduction, some microbiologists/cell biologists have come up with additional extreme claims. They called the two different cells formed from one cell as either non-identical daughters or daughters with different fates. To them, the difference between the two cells is not a reflection of the generation/age difference as a result of a normal reproduction but a result of the so-called "cell differentiation". Believe it or not, some microbiologists have even claimed that this "cell differentiation" has occurred even in some unicellular microbes (*Logical Biol.* 6: 31-32, 2006)!

However, my over twenty-years' search on the evidence for the "one mother two daughter" "cell division" concept has ended with an empty hand. To the contrary, I have found more recordings in literature (*Logical Biol.* 5: 350-355, 2005; *PloS Biol.* 3: 295-300, 2005) that actually accommodate my view of the microbial/cell life. In my view, whether a cell/microbe has a symmetric or an asymmetric body, its reproduction is always asymmetric in the sense that one cell still retains the old templates and existing materials (being it a strand of original DNA or else) and the other cell must form such molecules/structures (at least with some new materials). Thus, the differences in age between two cells formed from one cell are not limited to the cell level as one should be called as the mother the other as the daughter but are present at the deep underlying levels.

Thus, for the correctness of reflecting a reality and the consistence of organizing scientific knowledge, I appeal to use "cell reproduction" instead of "cell division" and "cell reproduction cycle" instead of "cell division cycle". I strongly denounce the short form "cell cycle" because it is even more problematic than the long form "cell division cycle". This ambiguous term may create an illusion that cells (as living individuals) are actually being cycled. In fact, this situation has been reflected in the "immortality" view on cells when the "cell cycling" is considered as something that will continue indefinitely unless external environment does not provide supporting living conditions.

I should point out that the proposed terminology change is not simply a naming game. No matter how trivial this change appears in the surface of words it indeed has far-reaching implications. For example, it not only paves a way for unifying biology under truly common life principles but also provides some conceptual frameworks to understand cell-based biology. For instance, the popular proposal of the so-called "immortal strand DNA" hypothesis for stem cell may just be a misunderstanding of the cell aging process and the so-called "self-renewal" property of stem cells may simply a reflection that these cells may just stay alive longer than the so-called one "cell cycle" or, as often the case, simply called the "life cycle".

Logically speaking, "cell cycle" is not an equivalent term for "life cycle". Just as we should not simplify human life cycle into human cycle, we should not simplify cell (as an individual not a process) as "cell cycle". However, we can perfectly say reproduction cycle as a way to describe the common process repeated in many different individuals or even species.

I must confess that I am not optimistic with the even a slow acceptance of my proposed terminology change. "Cell cycle" has become such a popular "sound-bite" that any alternative saying would be heard as awkward if not awful. To eradicate its strong impact that has been buried deeply in people's minds some thorough brain washes are necessary. Fortunately some washing solutions are already shelved in *Logical Biology* (http://logibio.com) and more are coming from different parts of the world.

Part 2. No Evidence for Cell "Division"

Cell "division" represents a fundamental concept and even a cardinal principle in cell biology and microbiology (*Cell* 100: 71-78, 2000). By choosing the word "division" cell biologists/microbiologists have satisfied their need for explaining why two "identical" or "similar" cells can be "found" (perceived) as a result of the "growth" of one cell and avoided a criticism for their artificial creation of a dichotomous biology where microorganisms/cells do not follow the basic life principle – reproduction means generation of a chronologically young body from a chronologically old body.

However, careful literature examination (*Logical Biol.* 1: 5-16 and 32-49, 2000; US patent 6767734B, 2004) has not yet revealed a single piece of evidence that demonstrates cell "division" – dividing *existing* cell structure and content. Early observations on cell "division" have emphasized its "symmetric" nature. However, more and more later studies have showed that not only many cells' "divisions" are morphologically asymmetric but also many "symmetrically divided" cells are unequal in their cellular contents or behaviors (*Sci. China* 42: 644-654, 1999; *Logical Biol.* 4: 7-15, 16-27, 2004). Unfortunately, these asymmetric observations have not been truly understood by mainstream cell biologists/microbiologists. Sometimes, these differences were just simply attributed to the so-called "cell differentiation". Believe it or not, "cell differentiation" has even been claimed for unicellular microbes (*Logical Biol.* 6: 31-32, 2006)!

It turned out that cell biologists/microbiologists' mistake in falsely characterizing cell *reproduction* as cell "division" was not only due to some deficiencies in experimental observations in the early studies but also some fallacies in logical reasoning (*Logical Biol.* 1: 17-20 and 25-31, 2000). This conceptual mistake in fact has installed a much stronger constraint on the thinking of cell biologists/microbiologists that prevented them from objectively and correctly interpreting any new findings that are contradictory to their established dogma (*Trends Biotechnol.* 23:9-10, 2005; *Microbe* 1: 1, 2006).

However, with enough experimental evidence (*Sci. China* 42: 644-654, 1999; *Logical Biol.* 4: 7-15 and 16-27 2004; 5: 350-355, 2005) to light up the center stage of cell research – cell reproduction mechanisms and implications – and, more importantly, with the existence of a new alternative cell life theory (*Sci. China* 42: 644-654, 1999; *Logical Biol.* 5: 51-55 and 109-116, 2005), it is time to move across the cell "division" barrier in understanding cell biology/microbiology. Let's say the process of forming two cells from one cell is a *reproduction* process and the two cells so-formed are not of any twin daughter relationship but a true parent-child relationship!

So I appeal cell biologists/microbiologists to use the more truthful and universal terms "cell reproduction" and "cell reproduction cycle" and get ride of the untruthful and idiosyncratic terms "cell division" and "cell division cycle". I believe that this terminology change and, more importantly, this conceptual brain wash will benefit cell biologists/microbiologists for long run in their future efforts of understanding the true life of cells/microorganisms.

* This publication contains two parts which address the same issue but were written for different submission purposes. The longer version (first part here) was first submitted to *Cell* on 2006-08-15 and was rejected on 2006-08-17. Then it was submitted to *Science* on 2006-08-21 but was rejected 2006-08-25. A much shorter version (second part here) was submitted to *Science* on 2006-09-15 but again was rejected on 2006-09-29. The publication here contains the original content as submitted to *Science* except with added highlight and keywords.