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Summary

What does "plasmid biology" currently mean? Summary of the Plasmid Biology 2004 Meeting

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Abstract

Almost 200 scientists from America, Europe, Asia, Australia, and Africa participated in the Plasmid Biology 2004 meeting, which was organized between 15th and 21st September 2004 in Kanoni (Corfu island), Greece. Various aspects of biology of plasmids and other mobile genetic elements were discussed during the meeting, including problems of replication, transfer, stable inheritance, and evolution. Medical and veterinary aspects of plasmids were highlighted as well as other applications of these replicons. It appears that plasmids and other mobile genetic elements are still excellent models in studies of basic biological problems at the molecular level, and their role in medicine and genetic engineering can be enormous. Moreover, studies on ecology of plasmids provide extremely important data that can be used in environment protection as well as in biotechnology. Understanding the importance of studies on plasmids and other mobile genetic elements, participants of the meeting decided to establish the International Society for Plasmid Biology.

1. What is plasmid?

Surrounded by beautiful scenery, bathed in warm hospitality of our hosts, and plied with excellent food, the Plasmid Biology meeting took place in Kanoni (Corfu), Greece. Almost 200 scientists from around the world presented results of their recent research on plasmids and other mobile genetic elements during lecture and poster sessions. The program of the meeting was divided into several sessions, but similarly to functions of many genes and proteins, overlaps between various artificially classified "boxes" had to appear.

The nomenclature problem was addressed by David Romero (Morelos, Mexico), who—in his excellent talk—clearly depicted the equivocal nature of artificial classifications. He discussed the problems of classifying megaplasmids and minichromosomes. By standard definition, a chromosome

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contains the main genetic information of the cell, including essential genes, while a plasmid is a small, autonomously replicating genetic element bearing genes that may be useful under certain environmental conditions but is not essential for growth of the host in standard microbiological media. However, sometimes DNA molecules that bear no essential genes (i.e., plasmids by definition) are not small, consisting of several hundred kilobases or even more than one million base pairs. Such replicons are called megaplasmids. On the other hand, when some chromosomes (i.e., DNA molecules bearing many essential genes) are significantly smaller than megaplasmids—they are called minichromosomes. Still, this classification is based on the presence of essential genes on DNA molecules, and such a method of distinguishing between chromosomes and plasmids may appear logical and simple. Nevertheless, even accepting this simple rule, sometimes it is difficult to classify particular replicons. For example, there are "plasmids" bearing no truly essential genes, but after elimination of these replicons or their certain genes, host cell generation time increases dramatically. Should they be called plasmids or chromosomes? The same question may be asked about replicons that bear just one essential gene. Additional problems may arise, for example, if the structure of the replication *origin* is also considered while classifying a replicon (i.e., whether the *origin* region resembles *oriC* of *Escherichia coli* or another model organism or that of any known plasmid).

Discussions like that presented above reminds me of a situation that occurred after a dinner in one of Corfu's restaurants. A group of the meeting participants wanted to order coffee, and saw "Greek coffee" in the menu. We had no idea what kind of coffee was that and had to ask a waiter: what is Greek coffee? This was a very strange question to him—I assume he was sure that everybody must know what this kind of coffee is. So, we asked: could you compare Greek coffee with, for example, cappuccino? His answer was: "Greek coffee is Greek coffee, and cappuccino is different." It appears that he had an excellent feeling about diffrent kinds of coffee. The analogy is that people working in the field of plasmid biology have a good feeling about what plasmid is, thus one could say: "plasmid is plasmid, and chromosome is different." However, I would suggest to accept David Romero's conclusion that actually it is not important how a DNA molecule is classified if we know how it works.

2. Replication

Replication is a very basic function of each plasmid. In fact, so called cryptic plasmids do not reveal any other detectable function but replication. Thus, it is not surprising that the first session of the meeting was devoted to mechanisms of DNA replication.

Although most communications concerned bacterial plasmids, the session was opened by Deepak Bastia's (Charleston, USA) presentation on replication termination in yeast. It is important to keep in mind that plasmids are genetic elements occurring not only in bacteria, but also in eukaryotic cells, which is often forgotten when discussing general problems of plasmid biology. In his talk, Deepak Bastia focused on characterization of the Fob1 protein, which binds to Ter sites. The very important message was that replication termination is coupled to several other cellular processes, including cell aging, gene silencing, exit from mitosis, and cohesion of DNA molecules. Interestingly, some proteins are involved in all these processes.

Another group of organisms, separated from eubacteria and thus often omitted in general discussions concerning plasmids, are archaea. There are archaeal plasmids, and one of them was discussed by Georg Lipps (Bayreuth, Germany). The pRN1 plasmid from *Sulfolobus islandicus* is not related to any bacterial plasmid, and codes for unusual proteins. One of them is a 110 kDa product of *orf904*, which possesses activities of helicase, DNA polymerase, and primase. Surprisingly, the primase prefers dNTPs over rNTPs.

Among eubacterial plasmids, there are two major modes of their replication: circle-to-circle (theta) and rolling-circle (sigma). It appears that theta replication predominates in plasmids from Gram-negative bacteria. Plasmids replicating by the rolling-circle mode were first discovered in