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cytometric technologies in microbial single cell analytics  
((Forum contribution))**

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**Microbes' heterogeneousness – a focus issue on cytometric technologies in microbial single cell analytics ((Forum contribution))**

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((Forum contribution 1185 words – 2 pp))

**Microbes' heterogeneousness – a focus issue on cytometric technologies in microbial single cell analytics**

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Cytometry of microorganisms was introduced about 30 years ago [1]. Since those early times single cell techniques have found their way into many fields of application for microorganisms ranging from health to biotechnology. As we now understand, more than 98% [2] of the microbes in our environment cannot be kept in culture technologies that can precisely characterize them, yet these microbes are of imminent importance. Flow and image cytometry are the key technologies herein. High resolution Omics-approaches become add-ons for understanding intra- and interrelationships as well as for analyzing performances in bacterial production cultures or in natural communities [3, 4].

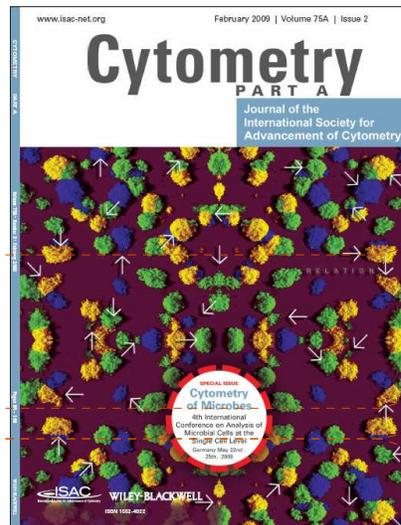
The February 2009 issue of *Cytometry Part A* focuses on the cytometry of microorganisms and provides a rich source of the newest approaches to the stoichiometric analysis of millions of individual microbial cells. This focus issue on microbiology contains a selection of manuscripts based on presentations at the 4<sup>th</sup> International Conference on the Analysis of Microbial Cells at the Single Cell Level which was organised on behalf of the Microbial Physiology Section of the European Federation of Biotechnology, and held in Bad Schandau, Germany in 2008 (<http://qbab.dbs.aber.ac.uk/sc2008>).

((quote))

**Newest approaches to the stoichiometric analysis of millions of individual microbial cells**

The issue contains concepts on how pathogens causing illness and death in humans, plants and animals may be sensed quickly and reliably. To address these problems, sophisticated single cell based techniques such as microfluidic surface plasmon resonance (SPR) are being developed to detect pathogens even at very low concentrations [5]. These negative features, however, should be considered to be one of the lesser impacts that microorganisms have on the existence of human society as microorganisms also have many beneficial effects.

For millennia microorganisms have been exploited in traditional biotechnologies such as brewing and bread making. A growing range of microorganisms are used in modern biotechnology industries for the synthesis of valuable materials such as pharmaceuticals, antibiotics, enzymes, metabolites and various other compounds. As was shown in the special issue, maintenance of viable and productive populations within the industrial environment is of paramount importance to the success and efficiency of these industries and these processes can be optimized by the use of flow cytometric analyses [6]. Understanding bacterial physiology, growth behaviour and



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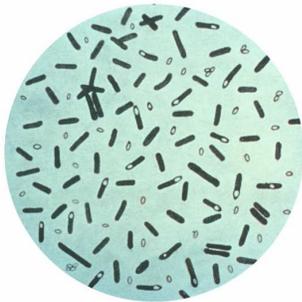
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2 survival strategies will open new ways to use, exploit or overcome bacteria on the basis  
3 of their inherent characteristics.

4 | Another matter that is often overlooked when we study microorganisms in the laboratory  
5 is the fact that many of them do not normally grow as planktonic single cells in nature.  
6 Structured communities known as biofilms are the most common state of many bacteria  
7 within the environment and this distinction has important consequences for the  
8 physiology and behaviour of the individual cells within these communities. Cells respond  
9 to local environments by placing stimuli which may arise both from, for example,  
10 nutritional local 'hot spots' but also from signalling from neighbouring cells. Biofilm  
11 structures offer protection against extrinsic stressors such as predators or toxic  
12 chemicals via the production of impenetrable extracellular matrices. Such multicellular  
13 biofilms are ubiquitous and play a well accepted role in stabilizing infection in human  
14 disease. As the special issue showed, scientists are on the way to resolve the  
15 interactions between individuals of *Pseudomonas* spp. in order to understand infection  
16 processes [7].



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28 The heterogeneity of cells within a population might be considered as an important  
29 factor in maintaining stability of a variety of systems. It is known from phylogenetic  
30 diversity analyses that an increase in species numbers leads to a concomitant increase  
31 in the stability of a system [8]. Additionally, heterogeneity of cells with regard to  
32 productivity within populations should be seen not only in terms of its impact on  
33 bioprocess yields, but also in terms of the revelation of information about cell response  
34 to a complex interaction of environmental stimuli. Currently our understanding of how  
35 and why an individual microbial cell reacts to its environment is often poorly understood.  
36 A recent approach that will improve our understanding of the mechanisms and triggers  
37 involved in heterogeneity of response is a single cell bioreactor [9]. Such devices will  
38 facilitate the acquisition of functional and structural information about individual cells. In  
39 addition it will permit analysis of the single cell fluxome – the quantification of metabolite  
40 turnover in the single cell, at least for larger microorganisms such as yeast cells.

41 | Of equal importance is the need to develop methods to administer the huge single cell  
42 data profiles in a form which can be understood and efficiently accessed by the user  
43 community – whether they are academics, clinicians or industrial scientists – a topic  
44 which was therefore intensively discussed at the 4<sup>th</sup> Conference in Bad Schandau. For  
45 example, in modelling applications, such data must be accessed and used to elucidate  
46 the behaviour of a cell in a community or population to improve our understanding of  
47 populations leading to process optimization and permitting accurate predictions [10].  
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Mathematical modelling helps to understand the behaviour of biochemical reaction networks, or the highly coordinated response of single cell populations to changing (micro)environmental conditions.

To gain a deeper understanding of these topics take a close look at the February Issue of Cytometry Part A which is exclusively dedicated to the world of the single microbial cell.

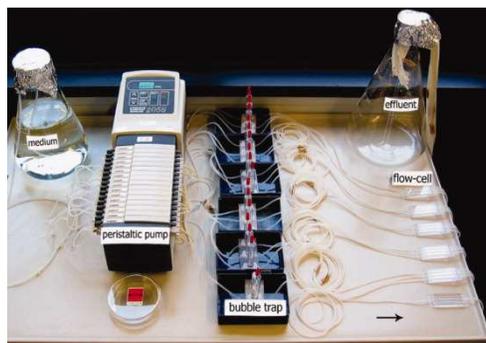
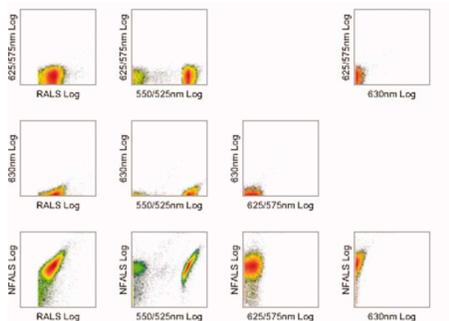
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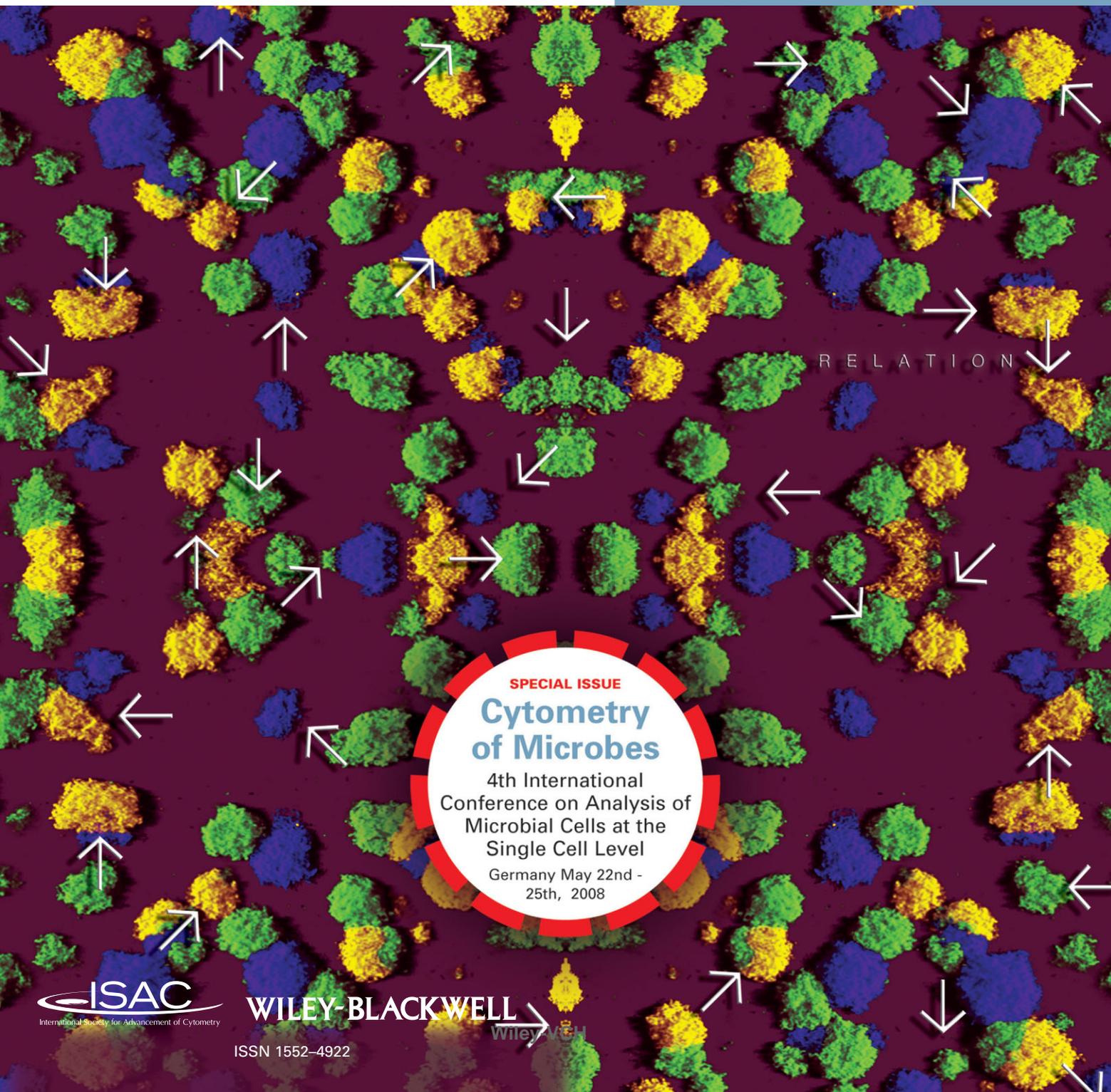
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# Cytometry

## PART A

Journal of the  
International Society for  
Advancement of Cytometry

CYTOMETRY  
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RELATION

**SPECIAL ISSUE**

### Cytometry of Microbes

4th International Conference on Analysis of Microbial Cells at the Single Cell Level  
Germany May 22nd - 25th, 2008



ISSN 1552-4922



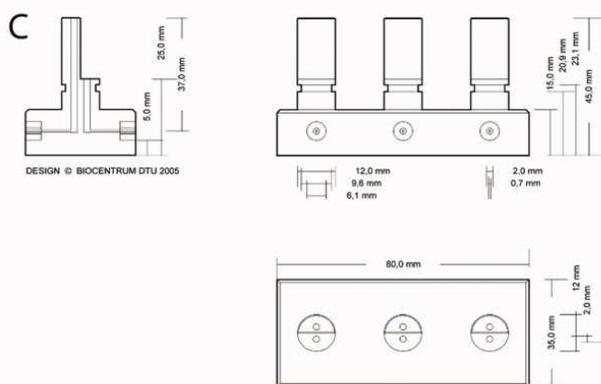
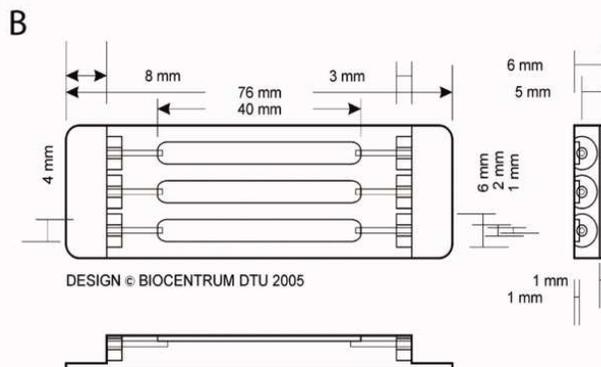
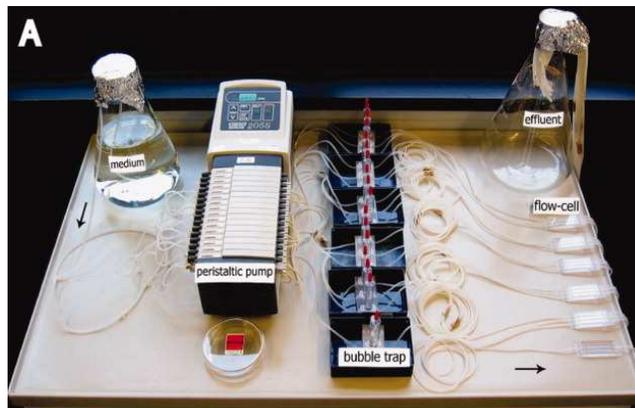
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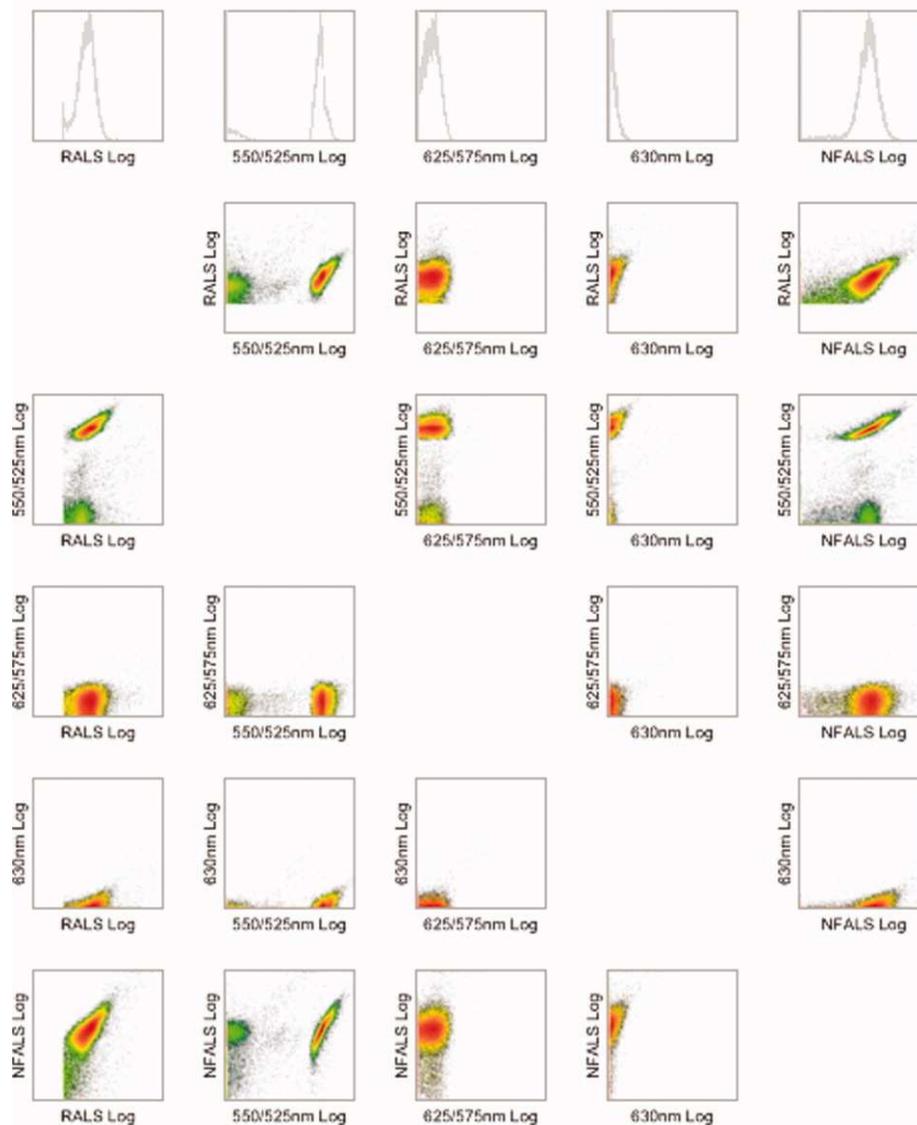


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