

Encapsulation of bio-entities

Our goal



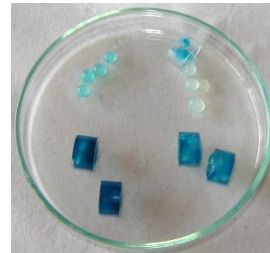
Design of multifunctional materials with biological activity

Bioreactors



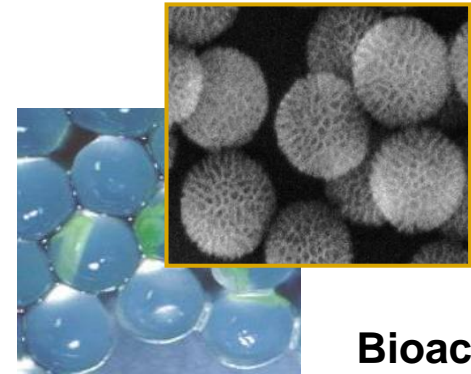
Tobacco BY2

Bioremediation



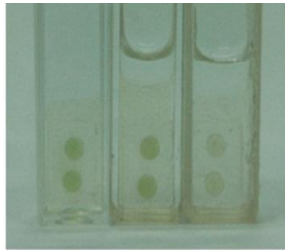
Fungi

Drug delivery

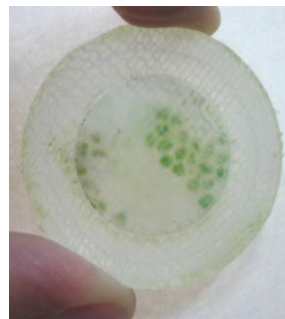


Bioactive molecules

Biosensors



Microalgi



Functional food

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Bio-entities

**Biomedical
appl.**

Biosensors
Early warning systems

Bioremediation

Biosensors
Ecotoxicity

**Antimicrobial
peptides**

Microalgi

Fungi

**Metazoan &
microalgi**

**Food
industry**

Artificial Biofilms

Bioreactors

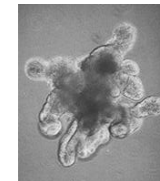
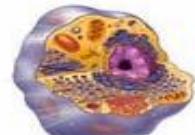
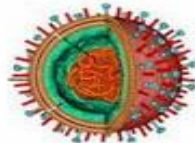
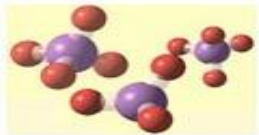
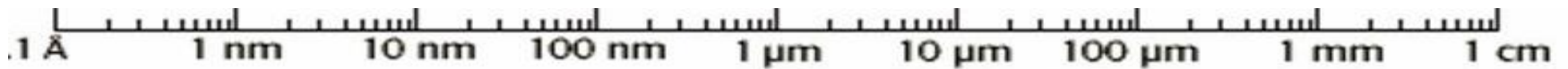
**Cerebral
organoids**

**Enzymes
bioactive
molecules**

microalgae

**Plant cells
(calli)**

**Mother
cells**

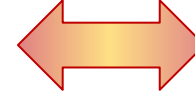


Design of functional materials

**Functionality
of the material**



**Biologic
functions**



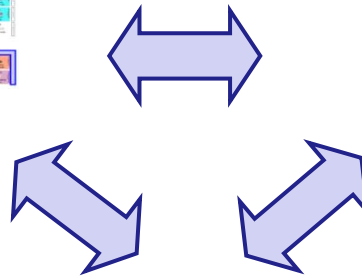
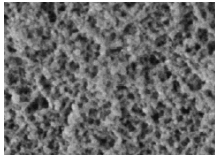
**Properties of
the matrix**

**Synthesis
conditions**

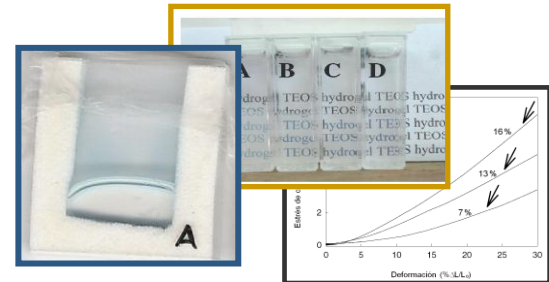


**Mechanical, optical, transport
properties**

Microstructure



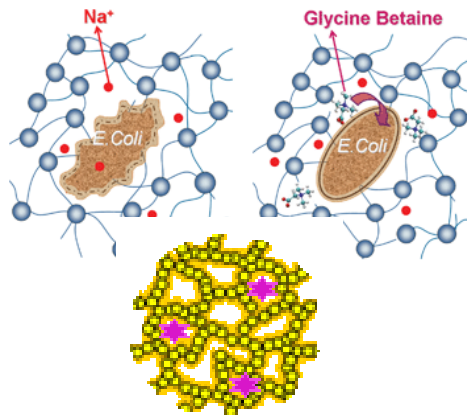
Biocompatibility



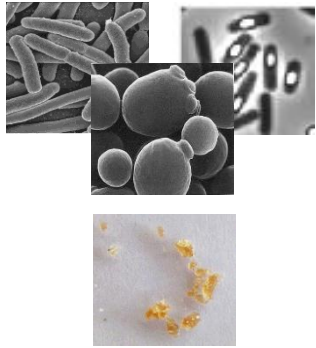
✓ **Viability**

✓ **Physiological state
(cell, organism)**

✓ **Biologic activity
(peptide, enzyme)**



Biotechnological applications



E. coli, B. subtilis
S. cerevisiae

N. tabacum, D. carota



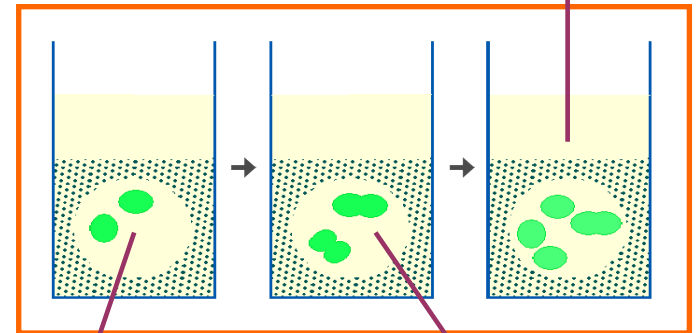
Disruptive innovation

Whole culture instead of
individual cell encapsulation

MODULAR BIOREACTORS
Cellular growth inside silica

Chem. Mater. **2005**, *17*, 3806-3808
J. Biotech. **2007**, *12*, 542-548

Recover of
bio products in the
culture media



Cavities created
inside the glass
matrix

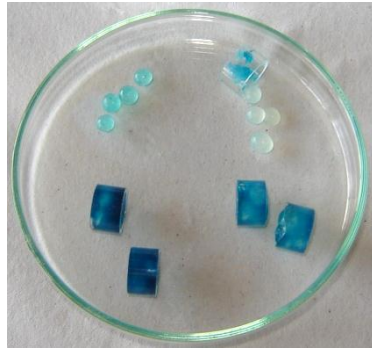
Cellular growth
and biosynthesis
of secondary
metabolites

Biotechnological applications



Stereum hirsutum
Trametes versicolor

Transport properties regulate the intake of contaminants and retain the enzymes inside the modules.



Reusable modules (6th months).

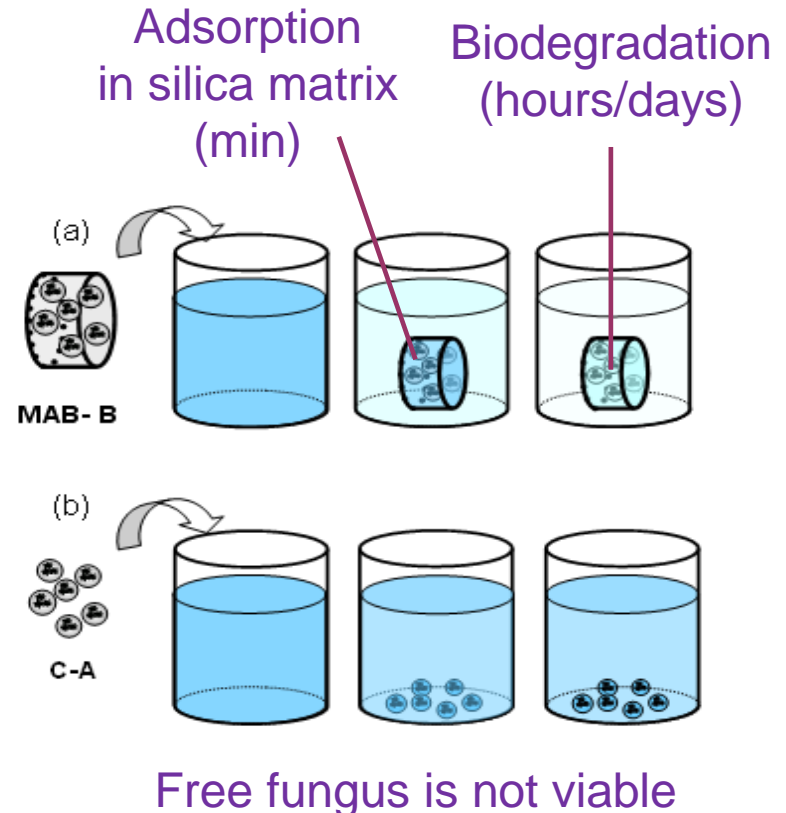
Treatment of industrial effluents to reduce its potential impact in the environment:

- bleached kraft pulp mill
J. Environ Sci Health 48, 166.

- olive oil mill
Water Air Soil Pollut 223, 4307.

BIOREMEDIATION DEVICES Degradation of textile dyes

J. Mater. Chem. **2010**, 20, 6479-6483
Clean-Soil and Water **2016**, 44 (2), 180-188



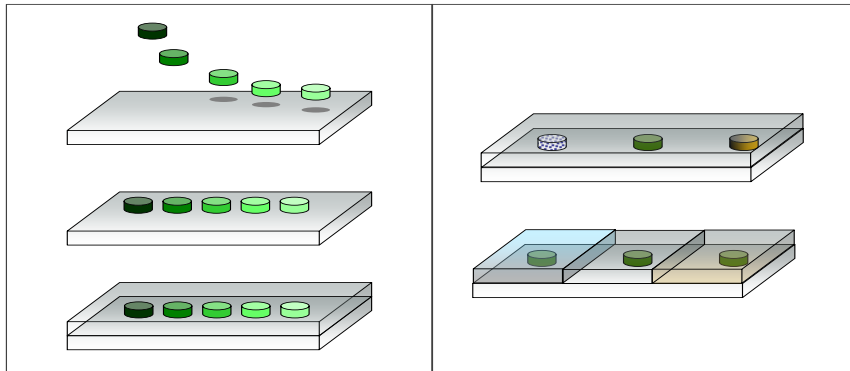
Biotechnological applications



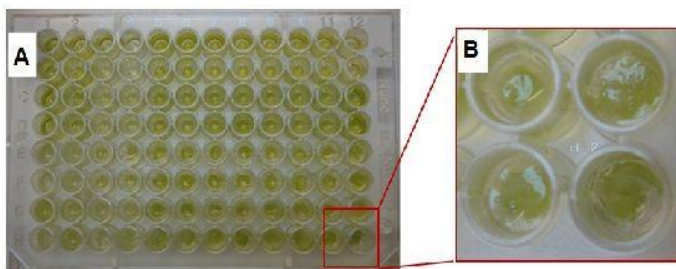
Chlorella vulgaris
& other microalgi

Different organisms
modulate sensitivity
to contaminants

Different matrices
regulate transport
of contaminants



Design of Biosensor Array
Early Warning



BIOSENSORS

Detection of contaminants in water

Chem. Mater., **2011**, 23, 1374-1378

Sensors **2012**, 12, 16879-16891

J. Biotechnol. **2014**, 179 (1), 65-70

Table 2 Organic composition of samples collected after different rainfalls in the Chassieu and Ecully basins. The lowest and highest concentrations measured are presented

Chemical (ng/L)	Chassieu	Ecully
Atrazine	1.7–2.5	<–2
Diuron	20–43	12.2–238
Hexachlorocyclohexane	<–7.2	<
Isoproturon	1.7–2.7	<

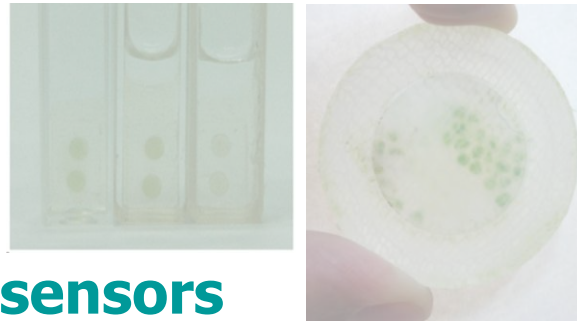
Environ. Sci. Pollut. Res. **2016**, 23, 9-13



Daphnia magna

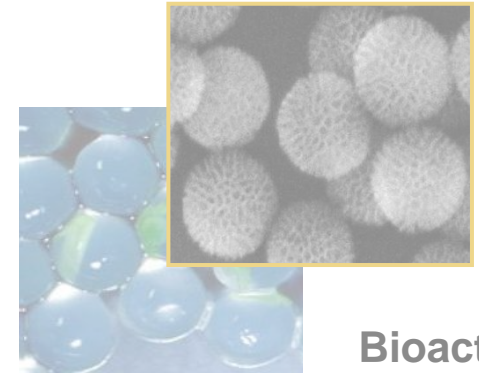
Biotechnology Reports,
2014, 4, 147-150

Microalgae



Biosensors

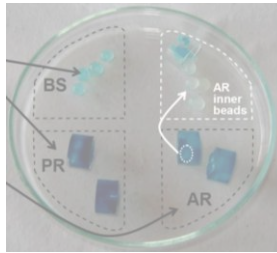
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Bioactive molecules

Bioremediation

Fungi



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Bioreactors



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