



HAL
open science

Biological based Biosensor's Inception

Corentin Spriet, Angelina Kasprowicz, Jean-Francois Bodart

► **To cite this version:**

Corentin Spriet, Angelina Kasprowicz, Jean-Francois Bodart. Biological based Biosensor's Inception. Journal of Biosensors, Biomarkers and Diagnostics, 2016, 1 (1), pp.1-2. 10.15226/2575-6303/1/1/00103 . hal-03160206

HAL Id: hal-03160206

<https://hal.univ-lille.fr/hal-03160206>

Submitted on 5 Mar 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

Biological based Biosensor's Inception

 Corentin Spriet¹, Angelina Kasproicz^{1,2}, Jean-François Bodart^{2*}
¹University Lille, TIS Bio, UMR 8576 CNRS, F-59000 Lille, France,

²University Lille, Régulation des Signaux de Division Team, UMR 8576 CNRS, F-59000 Lille, France

Received: July 28, 2016; Accepted: August 02, 2016; Published: August 05, 2016

*Corresponding author: Jean-François Bodart, University Lille, Régulation des Signaux de Division Team, UMR 8576 CNRS, F-59000 Lille, France, Tel: +330320436867; E-mail: JeanFrancois.Bodart@univ-lille1.fr

As an incipit, one has to define the term biosensor. The term has been enclosing several views and concepts, which we will not review here. Nevertheless, biological based biosensors can be common only defined as biological items, whose properties modifications upon environmental modifications can be measured. Herein this opinion article we will refer only to biosensors as the biological based ones, which cover [1] molecules : among the best characterized biosensors are the FRET (Förster Resonance Energy Transfer)-based, genetically encoded Kinase Activity Reporter (KAR) [1,2], (2) cells : CBB (Cells Based Biosensors; [3] and (3) organisms, like *Xenopus* embryos, whose development is sensitive to external factors (FETAX), Frog Embryo Teratogenesis Assay *Xenopus* [4] (Figure 1A).

The untangling of complex signalling network is imperative both for understanding cells and organisms physiological and pathological contexts, and for isolating the ideal property modifications to measure that will reflect, for example, the deregulation of these networks. These modifications are the one sought for biosensors design or choice. Then, biosensors become mandatory for deciphering and characterizing molecular signatures associated with pathologies. The latter aspect is naturally tightly linked to prognosis and diagnosis.

Hub & Interplay

It is more or less consensual to assert that there are only a few molecules that can be taken as valuable for diagnosis, or to be considered as relevant for a signalling network's behaviour. Determining the ideal candidate for biosensors might be achieved, at the molecular level, by focusing on specific protein kinases or second messengers, which act as main effectors or contributors in many pathological contexts, like those which serve as converging hub or nodes for oncogenes. Among case-school enzymes are Protein Kinase A (PKA) [2] or Mitogen Activated Protein Kinases (MAPK) [5].

Nevertheless, is sensing one molecule for enzymatic activity enough? Indeed, network can be regulated by a plethora of post-translational modifications. The latter being able to impact each other in, for example, à yin-yang manner(O-GlcNAcversus phosphorylation [6], sulfhydrylation–nitrosylation [7]. Initial studies focused on one enzymatic activity, upon modification by

canonical regulators. Still, one has to keep in mind that a single enzymatic activity can be impacted by several post-translational modifications or yin yang balance. Main difficulty of this aspect is to anticipate the effects of combination and to seek for non-canonical pathways. As an example, preliminary studies enabled us to highlight the interplay between O-GlcNAc and phosphorylation on the regulation of the MAPK pathway, as seen by biosensors (Figure 1B). The latter has also been anticipated through classical approaches [8], but biosensing will provide a dynamical cell-by-cell view of this process.

Matriochka: the biosensor within the biosensor?

To get beyond the molecular aspects and its single angled focus, one can take advantage of the biosensors diversity, as above-mentioned, and compatibility. The family of the biologically based biosensors is quite large, multiscale, but molecular biosensors might be integrated in cells or embryos, being themselves used as biosensing elements of their environment. Difficulties at this level

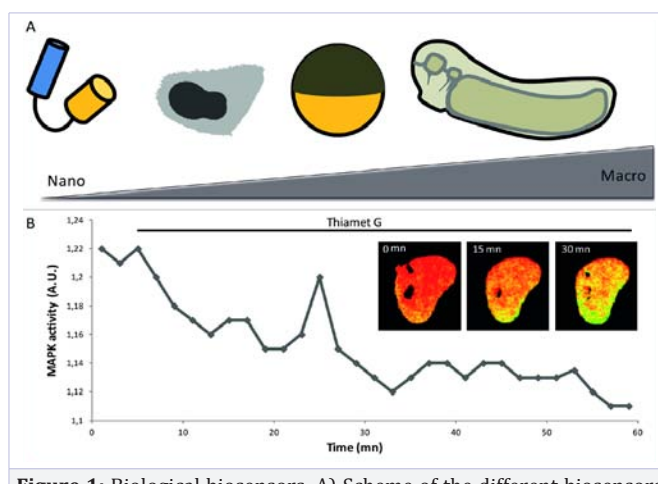


Figure 1: Biological biosensors. A) Scheme of the different biosensors scales, ranging from molecules (genetically encoded biosensor), cells and oocytes (CBB) to embryo. B) Representative MAPK activity measurement in living cell after maximum MAPK activation and OGA inhibition (Thiamet G) the reduced O-GlcN Acylation level induces a reduced MAPK activity. Images represent MAPK activity in cell nucleus between 0 and 30mn (picture size 12µm, the hottest colours correspond to the highest activity). For details about acquisition and analysis procedure, see [1,2].

are no longer technical. Many molecular biosensors have been successfully expressed and measured in various physiological environments, but not in the perspective to use both molecular and cells or organisms hosting them as biosensors. In such way, one might access to a more complete fingerprint and integrated signature of physiological or path physiological contexts. An added benefit of biosensors towards -omics approaches remain in their intrinsic ability to measure dynamic processes and not to provide single snapshots.

Acknowledgement

JFB is affiliated to the Site de Recherche Intégrée en Cancérologie (siric oncolille). We thank the personal of the TIS Bio Facility for access to the microscopy systems and technical advices. We are indebted to the Research Federation FRA Bio for providing the scientific and technical environment conducive to achieving this work.

References

1. Vandame P, Spriet C, Riquet F, Trinel D, Cailliau-Maggio K, Bodart JF. Optimization of ERK Activity Biosensors for both Ratiometric and Lifetime FRET Measurements. *Sensors (Basel)*. 2014;14(1):1140-54. doi:10.3390/s140101140.
2. Vandame P, Spriet C, Trinel D, Gelaude A, Caillau C, Bompard C, Biondi E, et al. The spatio-temporal dynamics of PKA activity profile during mitosis and its correlation to chromosome segregation. *Cell Cycle*. 2014;13(20):3232-40. doi: 10.4161/15384101.2014.950907.
3. Banerjee P, Kintzios S, Prabhakarandian B. Biotxin detection using cell-based sensors. *Toxins (Basel)* 2013;5(12): 2366-2383 doi: 10.3390/toxins5122366.
4. Boga A, Erdogan S, Sertdemir Y. Effects of Specific Dosages of Magnesium and Zinc on the Teratogenicity of Cadmium, Nickel, and Cobalt in *Xenopus* Embryos, as Assessed by the Fetax Test. *Dose Response*. 2007;6(1):16-29. doi: 10.2203/dose-response.05-027.Boga.
5. Bodart JF. Extracellular-regulated kinase-mitogen-activated protein kinase cascade: unsolved issues| *Cell Biochem*. 2010;109(5):850-7. doi: 10.1002/jcb.22477.
6. Lefebvre T, Issad T. 30 Years Old: O-GlcNAc Reaches the Age of Reason -Regulation of Cell Signaling and Metabolism by O-GlcNAcylation. *Front Endocrinol (Lausanne)*.2015;6:17. doi: 10.3389/fendo.2015.00017. eCollection 2015.
7. Nevoraj J, Bodart JF, Petr J. Gasotransmitters in Gametogenesis and Early Development: Holy Trinity for Assisted Reproductive Technology—A Review. *Oxidative Medicine and Cellular Longevity*. In press.
8. Olivier-Van Stichelen S, Drougat L, Dehennaut V, El Yazidi-Belkoura I, Guinez C, Mir AM, Michalski JC, et al. Serum-stimulated cell cycle entry promotes ncOGT synthesis required for cyclin D expression Oncogenesis. 2012;1(12): doi: 10.1038/oncsis.2012.36.