



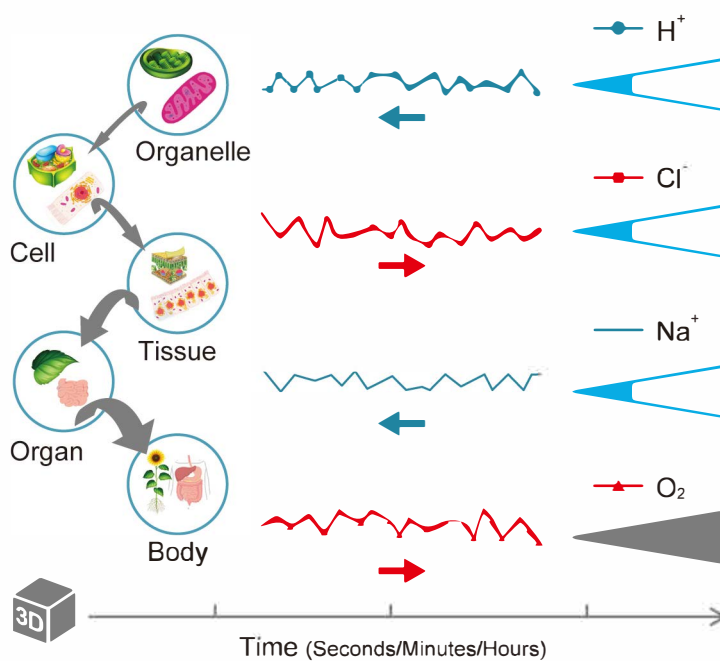
Life  Environment

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NMT & Its Applications

Non-invasive Micro-test Technology in Life Sciences



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Abstract

Life is an irreversible dynamic equilibrium in which ions and molecules are constantly exchanging between its internal and external environments. NMT: Non-invasive Micro-test Technology can detect this dynamic process by measuring concentration gradients, namely ionic/molecular fluxes, in multi-dimensions in real time and in situ with live samples. NMT has a super sensitivity capable of detecting Ca^{2+} fluxes of a single cell, e.g. a pollen grain, which has been making it an invaluable tool for scientists in many scientific fields. In this life science version, applications from biomedical research to plant and crop sciences, animal science, environmental science, microbiology to marine biology et al. have been covered. Brief NMT history and some new features integrated with current AI capabilities as well as NMT for higher education are also introduced hoping to inspire young scientists to explore this exciting area in the future. Standardization in terms of SOPs stemmed from pioneer NMT scientists, commercialization and industrialization of NMT are also introduced as references for both ambitious bio-entrepreneurs and new people who just came across this technology. The promising imOmics and its related projects, such as Bio-imOmics Project are explained with intention to guide people to fully appreciate the integration capabilities of NMT in the upcoming multi-omics age.



Keywords

NMT, Non-invasive Micro-test Technology, Ions, Molecules, Fluxes, Sensors, Microelectrodes, Transmembrane transport, Microenvironment, Life Sciences, imOmics, BiP, Bio-imOmics Project

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1 Introduction

Ions and molecules are not only the basic particles that make up all things in the world, but also an important medium for information exchange and energy conversion between living and non-living substances and their external environments. From Ion and Molecule Homeostasis (IMH) perspective, it is essential to study ionic/molecular activities in life sciences¹⁻⁹. Diseases of humans, animals, crops, insects and microbes et al. are usually accompanied by abnormal IMHs. Excessive H^+ accumulations, for instance, is the result from lactate formation even in the presence of O_2 in tumor cells demonstrated by Nobel laureate Warburg nearly a century ago¹⁰⁻¹⁴. It is also well known that a plant will not grow properly if the supply of NH_4^+ , NO_3^- , PO_4^{3-} , K^+ among other ions/molecules are out of balance¹⁵⁻¹⁸.

However, it has been a daunting challenge for biologists to fully comprehend the IMHs due to:

a) ionic and molecular information related to IMH have to be collected with live samples in order to make reliable and practical sense of those data;

b) multiple ions/molecules are preferably measured simultaneously in order to construct the relationship network among relevant ion(s)/molecule(s) to a specific physiological process;

c) ionic/molecular data in different levels, i.e. cell, tissue to organ, has to be collected due to the increasing evidence that there are dramatic differences of ionic/molecular transmembrane activities from cellular to tissue and/or organ levels;

d) since biological materials are 3-dimensional per se, 1D or 2D form of data is no longer accurate enough to reflect the biological real 3D world¹⁹⁻²³.

In the last 20+ years, Non-invasive Micro-test Technology (NMT) has been proved to be able to tackle these challenges mentioned above^{9,24}.

