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Biosensor for measuring stress in cells

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Cancer, nervous system disorders such as Parkinson's disease, cardiovascular disorders and old age have one thing in common: Both in afflicted tissue and in aging cells, scientists have observed oxidative changes in important biomolecules. These are caused by reactive oxygen molecules, including the notorious "free radicals" that are formed as a by-product of cellular respiration and attack cellular proteins, nucleic and fatty acids.

Today, reactive oxygen molecules are no longer regarded by and large as culprits, since it has turned out that they are also involved in regulating major life processes such as growth and cell death. The right balance between oxidation and the reverse reaction, reduction, makes the difference between health and disease. "Oxidative stress" arises when this balance shifts towards oxidation-promoting processes.

So far, it has hardly been possible for scientists to measure the level of oxidation and, thus, the stress status of living cells. This will now be feasible thanks to a highly sensitive biomarker presented in the journal Nature Methods by Dr. Tobias Dick and co-workers of the German Cancer Research Center, jointly with colleagues from the University of Heidelberg.

The biosensor specifically measures the oxidation state of glutathione. This is an important protection molecule that captures a large portion of reactive oxygen molecules within a cell by oxidation. If much of a cell's glutathione is present in an oxidized state, this is an important indicator of the cell's overall oxidation level. The investigators equipped test cells

with a fluorescent protein that reacts to changes in oxidation level by releasing light signals. Since the fluorescent protein on its own is not sensitive enough, it was coupled with an enzyme called glutaredoxin. This enzyme “measures” the oxidation state of glutathione and transmits the value to the fluorescent protein.

The stress biosensor developed by Dick and colleagues measures the slightest changes in the oxidation state of glutathione without destroying the cell. Even more relevant, however, is its precise time resolution, as Tobias Dick explains: “In order to measure short-term variations of oxidation state, the systems needs to react instantly and dynamically. This is guaranteed with our biosensor, which works down to the scale of seconds.”

The measuring system allows researchers to determine those short-term variations that occur when reactive oxygen compounds are released as signaling molecules. However, the biosensor is equally suitable for use in pharmaceutical research, for example, to determine the effect of new substances or plant food constituents on oxidative processes and, thus, on the stress status of cells.

Source: Helmholtz Association of German Research Centres