



Elements of Didactic Innovation about Cellular Oxidative Stress for Health education in High School

Marina Minoli¹

Abstract

Oxidative process has a fundamental role in our organism. When there is an unbalance between the *oxidant and antioxidant species*, in our body appear pathological conditions called *oxidative stress* with production of free radicals. This conditions may also important for the insurgence of neurodegenerative diseases, like Parkinson's and Alzheimer's diseases.

The mission of this didactic project was to develop an interdisciplinary modern educational path with *STEM bioenglish activities* (chemistry, biology, medicine, biophysic and ICT) for conscious students about individual and general health. Scientific high school classes have worked as a scientific community relationship to the international modern research about cellular oxidative stress conditions: from the first researches to actually scientific international studies.

In this activity *biology teacher* has worked as an active and motivated *didactic – researcher*. An *inquire approach* using the model of the scientific inquiry is useful to promote curiosity, openness to new ideas, prepares students to think and like as real scientist.

The topic of oxidative stress is very interesting because integrate knowledge about different sciences sectors with STEM didactic strategies. These didactic activities are useful not only for learning important scientific concepts, but also to transmit in active way elements of *health education* about equilibrate life style for young people. Different phases of didactic work with students in which is important to analyze environmental sources of *oxidative stress conditions* and alimentation factors relationship homeostatic condition in our organism.

In this project it was possible to guide students in working as researchers analyzing biochemical and physiological dates, information, scientific figures about relationship between molecules, receptors and chemical messengers also about pathological mechanism as in Alzheimer's disease for innovative presentations about different aspects of oxidative stress during Miniworkshop students for students.

Keywords: *free chemical radicals; neurodegenerative diseases; inquire didactic project; ROS; cooperative learning; didactic – researcher biology teacher; interdisciplinary didactic activities;*

1. Theory Introduction

Oxidative stress a concept that has been formulated in 1985; the field of oxidative stress embraces chemistry, biochemistry, cell biology, physiology and pathophysiology, all the way to medicine and health and disease research. The concept of oxidative stress was updated to include the role of redox signalling and redox control, are redox reactions in living cells in which are utilized in fundamental processes of redox regulation. The updated definition of oxidative stress is "An imbalance between oxidants and antioxidants in favour of the oxidants, leading to a disruption of redox signalling and control and/or molecular damage". Oxidative stress is caused by overproduction of free radicals.

The two words oxidative and stress elicit a notion which focuses on an important sector of fundamental processes in biology. It is a challenge to combine the basic chemical notion of oxidation – reduction, including electron transfer, free radicals, oxygen metabolites with biological concept, that of stress.

- Antioxidant: molecule that inhibits the oxidation of other molecules
- Oxidation: chemical reaction that can produce free radicals that may damage cells

In the last years, the term oxidative stress has been overused and even missed outside scientific field. Also the term ROS, which stands for reactive oxygen species, is often incorrectly used: whenever the specific chemical entity of the oxidant is known, is often should be mentioned and discussed, not the generic ROS.

Oxidative process has a fundamental role in our organism indeed free radicals have a defence function against bacteria, and help transmission of information between neurons.

¹ High School Marconi, National Biologists Order, Italy - Royal Society of Biology, United Kingdom



However when there is an unbalance between the oxidant species and antioxidant species, in our body appear pathological conditions called oxidative stress. The excess of free radicals, like peroxide, so they tend to bind themselves to other radicals or substract an electron to the nearest molecules. This condition may also bring to the insurgence of neurodegenerative diseases, like Alzheimer' s and Parkinson' s disease.

2. Methods and Materials

2.1 Why Oxidative Stress in Classes with Students

The topic of oxidative stress is very interesting because integrate knowledge about different science sectors and so can be presented to students in the last years of the High school course.

From general analyse mass media presentation in advertising of oxidative stress condition for different commercial products to scientific research analyse of oxidative stress condition in human organism.

This didactic activities is useful not only for learning important scientific concepts but also to transmit in active way elements of education health about equilibrate life style for young people. With this thematic is possible also educate to complexity of the scientific knowledge and the limits of research activities and results so far obtained about some neurodegenerative processes. It is very interesting for students learn researching information also about antioxidant molecules in different plants.

2.2 Which Basical Concepts

In propedeutic phase of didactic activity of educational path is important to present some concepts about oxidative stress in the homeostasis of human body.

Oxidative stress is an **imbalance** between **oxidant** and **antioxidant chemical** species

- Oxidative stress is suspected to play an important role in neurodegenerative diseases
- Oxidative stress is thought to be linked to certain cardiovascular disease
- Oxidative stress is likely to be involved in age-related development of cancer
- Oxidative damage to DNA
- Oxidative damage to protein

Reactive oxygen species (ROS) are either free radicals, reactive anions containing oxygen atoms, or molecules containing oxygen atoms that can either produce free radicals or are chemically activated by them.

Disturbances in the normal redox state of cells can cause toxic effects through production of peroxides and free radicals that damage all components of the cell, including proteins, lipids and DNA.

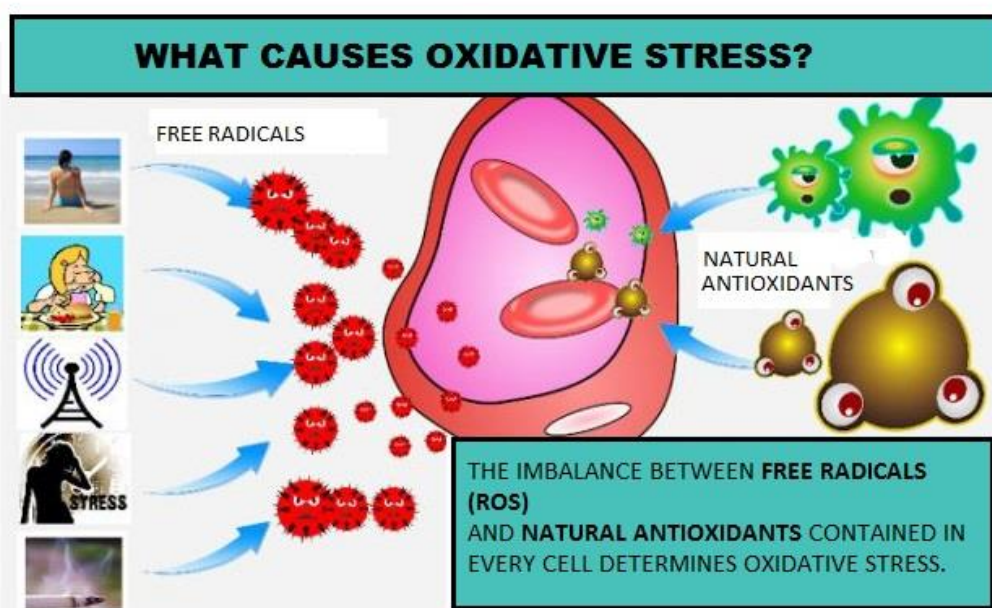


Fig. 1 – The effects of oxidative stress conditions



2.3 Cellular Sources

- Reactive oxygen species (ROS) are either free radicals, reactive anions containing oxygen atoms, or molecules containing oxygen atoms that can either produce free radicals or are chemically activated by them.
- Enzymes of the cellular respiration (**mitochondria**)
- Cytosolic enzymes (**cytosol**)
- Peroxisomal oxidase (**peroxisomes**)
- NADPH oxidase (**plasma membrane**)
- Cytochromes P450 (**endoplasmic reticulum**)

3. Phases of Didactic Project

3.1 First Phase

The first phase is important to analyze with students History of Oxidative Stress with Helmut Sies's studies (1985) and article with different links international researches. In little group students have analyzed discovers conditions and environmental sources of oxidative stress :

- Smoking
- Air pollution
- Excessive physical activity
- UV light
- Ionizing radiations

Antioxidants (as vitamins C and E) are molecules that inhibit the oxidation of other molecules.

3.2 Second Phase

The second phase is useful to analyze with students the biological effects of oxidative stress conditions in human organism as is possible to see in picture above (ROS)

3.3 Third Phase

Biology teacher presents to students microglial cells in the brain and effect of oxidative stress condition that is known to play an important role in the pathogenesis of a number of diseases. In particular, it is linked to the etiology of Alzheimer's disease.

Microglial Cells

They are specialized in defending cells that establish themselves permanently in the SNC; they remove damaged cells and foreign agents. Now neuroscientists are realizing that the cells of microglia not only represent the first line of defence of the Central Nervous System, but also can be implicated both in disorders in neurodegeneration diseases. In the sick brain, activated microglia cells look for damage neurons and disrupt their connections, their synapses.

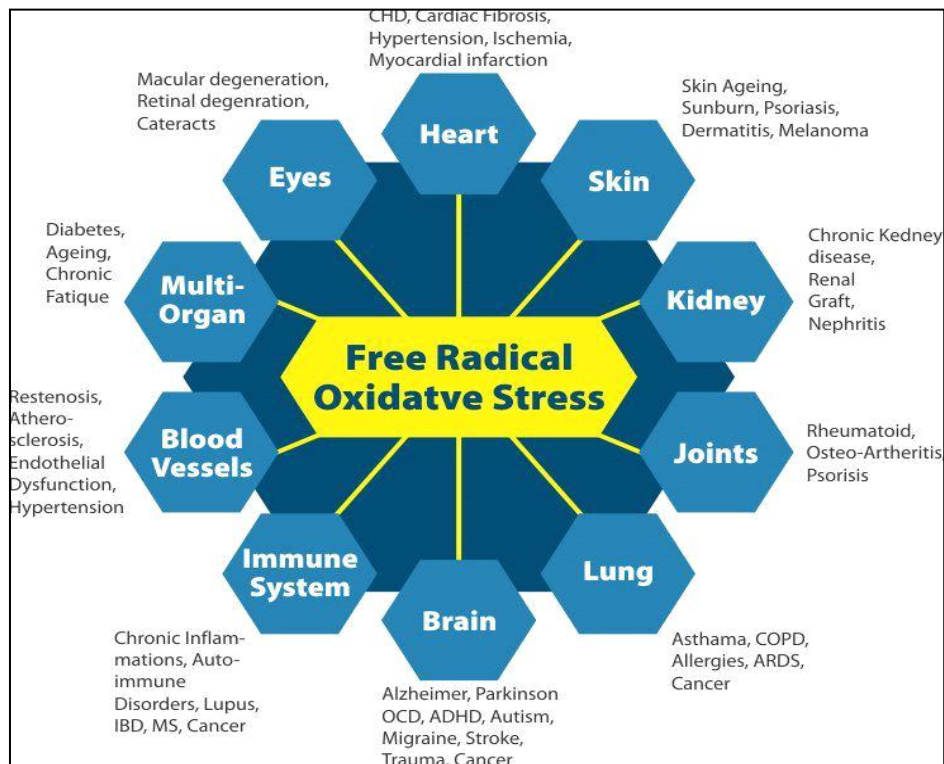


Fig. 2 – Oxidative stress conditions and pathology in human organisms

Alimentation as possible factor for cellular oxidative stress

Phytochemical are naturally occurring chemical compounds in plants.

- Phytochemicals and their main cell targets involved in ENERGY HOMEOSTASIS, CELL SURVIVAL and STRESS RESPONSE.
- Fundamental Phytochemicals work as either PROMOTERS or INHIBITORS.
- Polyphenol and Flavonoid as possible antioxidant

These molecules are also recalled antioxidant substances but they induce an initial mild prooxidant action. The problem is that often scientists lacking a deep molecular and cellular explanation of their actions.

4. Didactic Activities

1. To analyze basically chemical and biological concepts for understanding stress oxidative conditions with students (oxidation and reduction chemical process): elements of biochemistry cellular respiration an phosphorylation process in mytocondria
2. To present some concepts about nervous system for neurodegenerative diseases
3. To guide lectures of different modern articles about oxidative stress and neurodegeneration diseases
4. To involve neuroscientist for coprojected seminary about learning this topic
5. To work post seminary with students: each student present informatics elaborations about one of different aspect of seminary with integrations consulting other international sources
6. To present in the class community in 10 slides by each student,elaboration with valuation by Biology teacher
7. To realize with students an interactive Stress oxidative Poster, a creative and interesting work: important to chose scientific images and the short bioenglish text for different parts of poster
8. To organize with students of two different classes leading by Biology teacher a Miniworkshop Students for Students for other students not Clil classes



5. Discussion Action's Project

5.1 What Biology Teachers Do – Didactic Researchers

- a. write itinerary of educational path about oxidative stress in which students are protagonist in relaboreted activities
- b. present to the classes fundamental biochemical and physiological concepts about cellular metabolism
- c. contact neuroscientist for collaboration in coprojected seminary about oxidative stress condition for health
- d. create a scientific lecture itinerary of all or parts actually (2016 – 2017) research articles in web about oxidative stress (factors implicated and possible prevention)
- e. communicate to students characteristic of each informatics presentations about different aspects of seminary activity; which way of evaluation of works realized and presented to the class
- f. organize with students Scientific Miniworkshop Students for Students
- g. reanalyze with students the results after Miniworkshop

5.2 What Students Do as Protagonists

- a. realize concepts and phases of neuroscientist seminary and write bioenglish short reports;
- b. read scientific articles of scientific magazine divided by teacher in different parts and organized verbal presentations in groups with original informatics applications
- c. organize ,coordinated by biology teacher, a scientific Miniworkshop as researchers students for not Clil students of others classes of high school

6. Conclusions

In this activities is possible to guide students in working as researchers analyzing biochemical and physiological dates, informations, scientific figure about relationship between molecules, receptors and chemical messengers also about pathological mechanism as in Alzheimer' disease. In the second time all students have to chose figure, dates, all important elements to rielaborations a personal informatics presentation for other students for the class about one aspect of oxidative stress.

Different didactic strategies of this work are finalized to present also some limits of science research about this topics. Learning science in relevant context is important to transfer scientific knowledge to authentic situation. An inquire approach in which is useful model of the scientific inquiry, as curiosity, openness to new ideas, prepare the students to think and act like a real scientists, ask questions, hypothesize, and presents results using standard science practise.

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