Short Communication

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Is the eyespot a natural biosensor? observed from the perspective of a photoelectric sensor

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Natural biosensor

The ocular spot present in green algae is formed by granules that contain a carotenoid pigment inside, these granules detect the intensity and direction of the light that is redirected to a photoreceptor. The photoreceptor houses a protein that is activated by producing an electrical pulse, this pulse produces the flagellar movement and determines the movement of the cell. Can the eye spot be used as a light and electrical biosensor? What future possibilities will the biotechnological implementation of this organelle have? The eye spot or eyespot is an organelle present in green algae and mobile stages of non-mobile algae, is composed of osmophilic globules known as granules and inside is a carotenoid type pigment.[1] Their function is that they capture the direction of light intensity and redirect it towards a photoreceptor, which consists of a multilayer membrane structure of photoreceptor protein that, when photo activated, produces an electrical charge similar to nerve impulses in visual processes:[2] This charge determines the flagellar movement of the alga therefore its location in the water column in the optimal illumination area. Barsanti et al.,[3] define this ocular-photoreceptor-flagella stain configuration as a simple but complete visual system. What makes this system analogous to other types of more complex vision is the presence of this photoreceptor protein, "Rhodopsin", which consists of a protein part called opsin organized in 7 transmembrane helices and a light-absorbing group, the retinal (eg the chromophore).[4] This protein is very widely distributed in prokaryotes, eukaryotic algae,[4] humans and other invertebrate animals[5] and is responsible for converting photons into chemical signals that additionally stimulate biological processes in the nervous system of the latter two. In this case, the brain is the organ capable of translating these electrical signals into optical signals generating vision, because that is where all the images obtained that travel to different parts of it in the form of electrical impulses are generated[6] and although microorganisms do not possess this specialized organ, we can not deny the fact that they possess all the machinery necessary to generate a vision similar to animals.

To better understand this process, it should be mentioned that each Rhodopsin has a chromophore (11-cis retinal) covalently linked; When this absorbs light, this retinal form changes to its trans-retinal isomer, causing a conformational change in the Rhodopsin molecule activating it. Activated Rhodopsin binds to a trimeric G protein (transducing), causing the α subunit to dissociate and activate the GMP-cyclic-phosphodiesterase, which hydrolyzes cyclic GMP by dropping its concentration in the cytosol. With this fall, the GMP dissociates from the Na^+ channels of the membrane by closing them, thus leading the plasma membrane to a hyperpolarized state, in this way, the light signal is converted into an electrical signal, the electrical pulse or nervous pulse.[7] Optical sensors or light-dependent sensors (LDR), for their acronym in english, are treated with resistances that are inversely proportional to the intensity of light, so that when receiving a beam of light they allow the passage of an electric current through a circuit, and when this step is interrupted, the resistance is increased interrupting the passage of current, they are commonly used in robotics to regulate and stop their movement. These two systems have something in common and is the use of an electric current in order to send a signal, if the signal generated in the vision system of green algae could be transformed by a transducer, new technologies based on the minimization of biological systems. Several authors have successfully extracted and isolated the individual components that make up this system: the granules that make up the ocular spot present in Chlamydomonas reinhardtii[8] and Euglena gracilis,[9] the photoreceptors[3] and the photoreceptor protein[10] as well as the flagella.[11] It is only a matter of time for the eye spot and all this simple vision system used by the algae for new possibilities for research and technological developments.[12–14]

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Conflict of interest

The authors declare there is no conflict of interest.

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