

Genomic Data Mining Unraveled Potential Biocompass in Fruit Flies and Current Status of Magneto Genetics

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Commentary

Some animals have the extraordinary ability to sense the Earth's magnetic field allowing them to navigate and migrate between different locations. It is essential that these animals detect weak magnetic fields with great precision to ensure that they do not become lost during migrations that can, on occasions, cover distances of several thousand kilometers. The mechanisms that allow animals to sense magnetic fields have been a topic of hot debate for decades. However, our lack of understanding of the magnetic receptor and its functions has hampered our understanding of magneto-perception.

Recently, a large-scale genomic screening by Siying Qin and colleagues from several research institutions in China reported their discovery of a multimeric magneto sensing cylindrical protein complex that is composed of two proteins-namely a putative magnetic receptor protein, known as MagR, and a photosensitive protein and biochemical magnetoreceptor, Cryptochrome (Cry) in the fly, *Drosophila melanogaster* [1]. Certain metals (like iron) can form magnets through a mechanism known as ferromagnetism and previous studies have hinted that either iron-binding proteins or complexes that include iron-binding proteins are critical for further characterization of the biological magnet. Hence, the authors used genome-wide screening coupled with an extensive search of the research literature of putative iron-binding proteins in a bid to identify potential magneto sensing proteins [1] as summarized in (Figure 1).

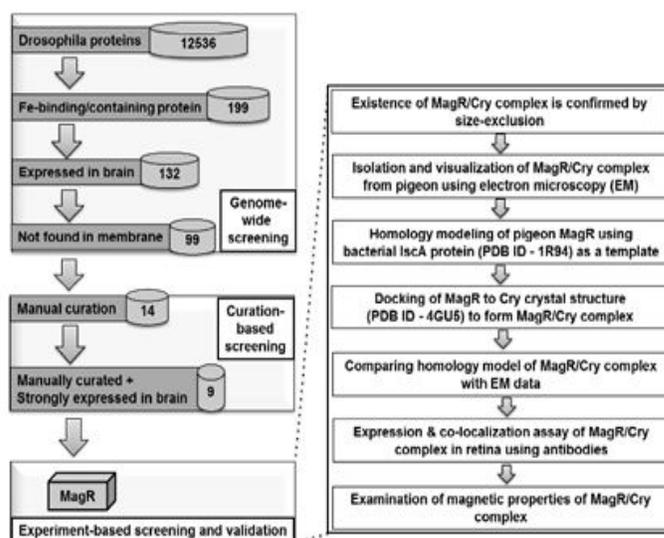


Figure 1: Overview of Screen Approaches and Experimental Validation for Discovery Potential Animal Biocompass, which Starts with Genomic Data Mining and Data Curation based on Literature and Expression Parameters. Furthermore, Various Experiments were Performed to Declare that MagR/Cry Complex Can Serve as Potential Biocompass.

Initially, the team identified 199 putative iron-binding proteins, which they then narrowed down to 98 by selecting only those that were not located in the membranes expressed of head of the fly. The team then purified fourteen of the fly iron-binding pro-

teins in order to find out which, if any, of the ion-binding proteins could form a stable and functional complex with the cryptochrome protein, Cry. Using careful manual inspection, chromatography and electron microscopy, the team found that only one of the putative 14 iron-binding proteins—a protein known as CG8198, which the authors renamed as Magnetoreceptor (MagR)—was capable of forming a stable complex with the cryptochrome to form protein rods that could function as a viable biocompass. And when the team viewed rods of the protein complex in a magnetic field using an electron microscope, the rods aligned with the magnetic field, suggesting that they could function as a biocompass.

This MagR/Cry complex could serve as biocompass as both proteins are conserved in several animals from flies to birds and human [1,2] and the complex is co-localized in retina of the pigeon. These two genes forming this complex is conserved across several animal genomes [1] from insects to human. For example, zebrafish has a one copy of MagR and 7 copies of cry genes due to several duplications of cry1 gene [3].

However, as of now, there is no direct evidence that the MagR/Cry complex functions as a biocompass in living animals. In addition, cryptochrome proteins are known to be key regulators of circadian rhythms, raising the possibility that magnetoreception and circadian rhythms could be linked, with potential implications for migrating animals that time their migrations according to a variety of factors. However, without a complete understanding of the mechanisms linking magnetoreception and circadian regulation, the answer to this question remains a puzzle.

These finds are important because of two major points

- For clear picture on the magnetogenetics and its application in migration of several animal species.
- For roles in the developments of biomedical tools using magnets.

Additionally, others have use potentials of biomagnetism using genetically regulated hybrid protein assemblies that possesses iron-storage protein ferritin conjugated with Transient Receptor Potential Vanilloid 1 (TRPV1, [4]) and 4 (TRPV4, [5]). In the first study, Stanley, et al. 2015 created hybrid of TRPV1-ferritin for applying an oscillating magnetic field that assist heating of the ferritin and in turn, higher temperature would open TRPV1 channel and stimulating insulin release in insulin-secreting cells. Authors demonstrated that TRPV1 channel was activated by oscillating magnetic fields in mice. In the second example, TRPV4 was coupled the ferritin to unravel behavioral and cellular changes in a magnetic field. Authors reported observed electrophysiological and behavioral changes when they applied magnetic field gradients to various experimental systems including live mouse.

All these three examples if true hold, are violations of basic laws in physics since all these systems have very a low amount of

iron atoms, to be affected by magnetic fields [6]. There is disparity of between 5 to 10 orders of magnitude [6]. Therefore, I suggest careful look into these studies and any further studies on related to the biocompass.

However, discovery of MagR in *Drosophila* demonstrates how genomic data mining assist in finding long lasting biological problems. Being a genome analyst, my interests are clear on the applications of genomic data mining with several publications in the area of genomic scanning [7-20] and also on transient receptor potential channels [21-25]. Notably, I recommend a word of caution on over claiming any results when topic is highly interdisciplinary. I strongly recommend considering suggestions from several areas of sciences if a study is interdisciplinary in nature to avoid doubts like in these cases biophysical experts were not consulted.

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