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## Open life science research, open software and the open century

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### ABSTRACT

At the age of knowledge explosion and mass scientific information, I highlighted the importance of conducting open science in life and medical researches through the extensive usage of open software and documents. The proposal of conducting open science is to reduce the limited repeatability of researches in life science. I outlined the essential steps for conducting open life science and the necessary standards for creating, reusing and reproducing open materials. Different Creative Commons licenses were presented and compared of their usage scope and restriction. As a conclusion, I argued that open materials should be widely adopted in doing life and medical researches.

## 1. Introduction

One of the common issues in life science and medical researches is the repeatability of the results. Scientific repeatability had become a very important role in determining the reliability of the results and the significance of the conclusions. A good practice to increase the repeatability and the diffusion of outstanding discoveries in life science researches would be the promotion of open science by broadly using open software in the researches and making their original data in the papers become publicly available. In this review, I outline the development of open science movement and the standards implemented in open science with a focus on the introduction of open software.

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## 2. Open science movement

Open science is a movement to make scientific research, data and protocols accessible to the public[1]. In the researches of life sciences, one of the best ways for conducting open science is to develop and utilize open and/or free software when doing the researches for the purpose of increasing repeatability of the results and discoveries. Actually there are great progresses at this perspective[2]. For example, R[3] is free and open statistical software, while Python[4] is also free and open programming language that can be used to perform numerical calculation. The package repositories of R and Python developed by individual statisticians and researchers and can be utilized freely by the public under the Creative Commons licenses as well. Many journals required the authors to submit or publish their original data in online database and data repositories. For example, Data Dryad[5] is one of the ideal places for depositing the original materials for the papers published in life science and medical researches. Recently, rOpenSci[6] project

was launched for the purpose to create R packages for researchers to access public data repositories as well. All these promote the openness of scientific researches[2] at the perspective of open software. At last, citizen science[7], scientific research activities conducted by the public and nonprofessional amateur, could also promote the dissemination of scientific knowledge and become another important way to promote open science.

### 3. Licenses for publishing open materials

Development of open software or publishing open materials (e.g., journals or books) for open science in life sciences should follow some standards and rules. Creative Commons (CC) licenses provide standards for researchers to obey. Thus, it is necessary to present here some of the most important licenses commonly used in conducting open science. Here, different up-to-dated CC licenses were outlined and compared here, details of the license chapters and provisions should refer to the CC website[8]:

Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0)[9]: “Share - copy and redistribute the material in any medium or format; Adapt - remix, transform, and build upon the material. The licensor cannot revoke these freedoms as long as you follow the license terms.”

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As seen, the former licenses are basically nested with the later ones. The differences are: CC BY-NC 4.0 stated that the materials under this license may not be used for commercial purposes. In comparison, CC BY-SA 4.0 and CC BY 4.0 explicitly stated that the materials under these licenses can be used for any commercial and non-commercial purposes. Moreover, CC BY-SA 4.0 had additional statement that if one creates contributions upon the material under this license, one must distribute the contributions under the same license as the original one. Thus, CC BY-SA 4.0 is more restricted than CC BY 4.0.

Recognition of these licenses is a basic step for biologists to conduct open life science using open materials registered with CC licenses. Following these licenses and rules in open researches could ultimately promote the advances and successes of open science in this open century.

### 4. Conclusions

Open software plays a deterministic role in doing open science and citizen science. It is argued that for better broadcasting and re-using the open software, proper Creative Commons licenses should be followed.

### Conflict of interest statement

We declare that we have no conflict of interest.

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