OpenFreezer: a reagent information management software system

To the Editor: The rapid growth of large-scale reagent collections that are necessary for systems-level biological approaches has brought about a concomitant need for extensible and flexible tracking systems to manage such resources. To meet this need, we developed OpenFreezer, an open-source, web-based enterprise software application, which maintains detailed and standardized documentation on common laboratory reagents. OpenFreezer tracks both large-scale reagent collections and individual reagents in a laboratory via a centralized repository that allows for easy access, sharing and management of data across projects and research groups. As such, OpenFreezer will be of interest to researchers in a broad range of laboratories and institutes of varying magnitude.

OpenFreezer implements a three-layer client-server software architecture, comprising a normalized relational data layer (MySQL database), a domain logic layer written using object-oriented programming (PHP and Python programming languages), and a graphical user interface implemented in PHP, Python and dynamic HTML (**Supplementary Figs. 1** and **2**). With this setup, reagent data are permanently stored and securely archived at a single site while being simultaneously accessible to an unlimited number of users. The modular design of OpenFreezer's domain logic enables the future customization of existing features and implementation of new requirements with minimal effort.

There are three central modules in OpenFreezer (**Fig. 1a**). The 'administration' module tracks information on an unlimited number of laboratories, users and projects. Each user is granted access to the entire system, ranging from 'reader' who may only view specified reagents to 'administrator' who has full access to all components (**Supplementary Table 1**). Each reagent is assigned to a particular project, and the project owner defines which users can view or modify the associated reagents (**Supplementary Fig. 3**).

The 'reagent tracker' module is preset to track the uniform properties of four common reagent types in molecular biology: circular vectors, linear inserts, single-stranded oligonucleotides (oligos) and cell lines. These default reagent types can be modified, and new reagent types such as small molecule compounds, small interfering RNA or antibodies can be added via the web

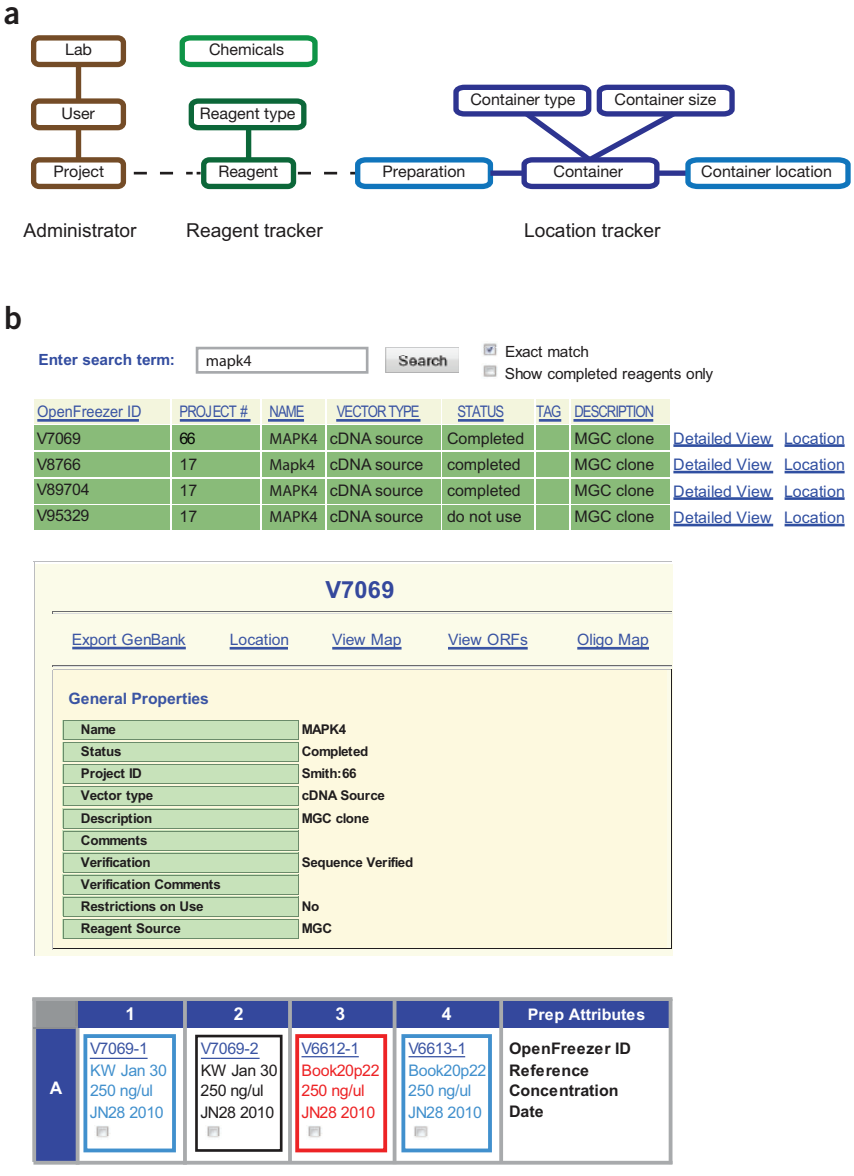

Figure 1 | Overview of OpenFreezer. (**a**) Schematic of modules. (**b**) Screenshots illustrating navigation of OpenFreezer. After entering a query at the reagent search page, reagents matching the query are displayed with links to their detailed views and locations (top). On the reagent detail view, properties are presented, separated by categories (middle). The location link leads to a container detailed view where information specific to physical preparations of the reagents is displayed (bottom). ul, microliter.

interface by an administrator (**Supplementary Figs. 4** and **5**). Addition is done using a standardized form, where reagent properties are defined and organized into categories (**Supplementary Table 2**). A hierarchy of reagent types (parent-child relationships) is also established, enabling ancestral tracking and transmission of annotations from parents to children. Upon saving, OpenFreezer automatically generates templates for entering, searching or modifying information for reagents of this type. OpenFreezer also tracks chemicals, including their safety classification and links to material safety data sheets for safety reporting (**Supplementary Fig. 6**).

Reagents are added through the web interface (**Supplementary Fig. 7**) or parsed directly into the database with programmer's support. Associated data for every reagent include general information such as name, reagent type–specific information and sequence, if applicable. Sequences can be annotated by region so that features such as tags or promoters can be easily identified. All entered information is saved in the database, and can be searched and updated (**Fig. 1b** and **Supplementary Fig. 8**).

OpenFreezer automates workflow processes such as primer selection (**Supplementary Fig. 9**). The interactive 'primer design' tool helps users design a PCR product from a cDNA template stored as an 'insert' in OpenFreezer. The generated primers can be saved as new oligos and the PCR product as a new insert. The user can then enter the resulting insert into a cloning workflow (**Supplementary Fig. 10**) for which OpenFreezer automates vector creation arising from either standard restriction endonuclease digestion and ligation techniques or recombination systems (Gateway[1] and Creator[2]). Additional bioinformatics tools including export to GenBank are available (**Supplementary Fig. 11**).

For any reagent, the locations of its physical preparations are tracked through the 'location tracker' module, which provides a detailed inventory of containers and preparations stored within them (**Supplementary Figs. 12–15**).

Currently OpenFreezer is tracking over 150,000 reagents accessed by more than 150 users from 13 different laboratories at the Samuel Lunenfeld Research Institute. OpenFreezer provides a foundation for researchers who wish to build specific workflow applications within an enterprise application framework. OpenFreezer is freely available as an open-source software package, making it an affordable and adaptable solution for other laboratories or institutes.

The source code, database archive, documentation and system demonstration are available on the OpenFreezer website (http://www.openfreezer.org/).

Note: Supplementary information is available on the Nature Methods website.

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COMPETING FINANCIAL INTERESTS

The authors declare no competing financial interests.

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