

Addgene: a global scientific resource

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Abstract

Addgene (<http://www.addgene.org>) is a nonprofit organization whose mission is to accelerate research and biomedical discovery by facilitating access to useful research materials and information. To fulfill this mission, Addgene maintains a repository that distributes >50,000 plasmids contributed by scientists coming from more than 3,000 different labs all over the world. The repository stores, quality controls, and annotates the data associated with the plasmids. Addgene also recently started providing ready-to-use viral particles produced from select plasmids in the repository. Researchers can use these viral particles directly in their experiments, thereby skipping the viral production process and accelerating their research. All plasmid data is made freely available to the public at Addgene.org. Members of the academic and nonprofit research community can request plasmids from the repository for a small fee. In addition, the organization creates useful educational materials covering topics from basic biology to the therapeutic applications of CRISPR for an audience ranging from undergraduate biologists to tenured professors. Every month Addgene distributes ~11,000 plasmids, provides hundreds of viral particles, and publishes posts on a blog receiving >60,000 views per month. Addgene is an essential and global resource for the academic life sciences.

Introduction

Plasmids (also called vectors) were first described by Joshua Lederberg in the early 1950s as extra-chromosomal, heritable, small, circular, double stranded DNA units capable of replicating autonomously (1). The birth of molecular genetics in the 1970s pushed plasmids to the forefront of molecular biological research. The discovery of restriction enzymes, ligases and gel electrophoresis, allowed scientists to move fragments of DNA from chromosomes to plasmids facilitating their amplification in bacteria and subsequent analysis. Since then, plasmids have served as an ubiquitous tool playing a decisive role in science progress and discovery. For example, plasmids have been essential to getting CRISPR working quickly and easily in a variety of biological systems.

Currently, in order to make it easier for other scientists to reproduce results and save

resources, most journals and grant agencies require authors to make their published reagents available to the scientific community (2-3). However, many scientists find it difficult to keep up with this best practice when they have many requests, when they have to find the materials and the associated data created by former lab members, or when they have to ship the materials to countries with custom restrictions. A very important role in overcoming these obstacles is played by repositories for biological resources (4-6).

In 2004, Addgene was founded with the goal of providing scientists easy access to research materials used in publications (Figure 1). Its creation was inspired by the frustratingly common experience of not getting a response, or getting the wrong material, when requesting published reagents. So far, the organization has archived more than 50,000 plasmids and distributed more than 750,000 plasmids on

behalf of more than 3,000 depositing labs. Addgene is continuously developing and implementing new plasmid and molecular biology related projects like their new Viral Service that provides academic researchers with ready-to-use viral particles (Lentivirus and AAV). The organization also creates useful educational materials like blog posts, protocols, articles, videos, and more. These materials help

scientists understand and use plasmids as well as new technologies and techniques used in molecular biology. In addition, many scientists, especially students and postdocs, benefit from professional development advice featured on the Addgene blog as well as career talks and conference/travel/distinction awards sponsored by Addgene.

In this article, you will learn about the benefits of becoming a part of the Addgene community.

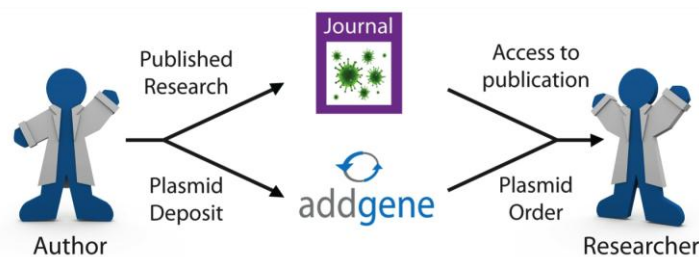


Figure 1. Addgene provides and easy access to published research materials

Benefits for depositing scientists

Dealing with plasmid requests can be a tedious and time consuming burden for many labs (7). Many scientists don't have time to dig through their freezers and notebooks to find the requested samples and their associated data. Shipping preparation, confusing customs regulations, and the need to adhere to the rules found in materials transfer agreements (MTAs) further complicate the process (8). Once they deposit their plasmids with Addgene, labs do not have to deal with plasmids requests, instead they can focus on their research. Addgene propagates, stores, and ships any deposited plasmids and works directly with TTOs at both the depositing and requesting institutions to distribute plasmids under the UBMTA. The steps required to deposit plasmids are very simple and can be found in **Figure 2**.

Beyond making it easier for researchers to fulfill plasmid requests, Addgene also serves as a safe archive/backup storage space for depositor's important constructs. Depositors do not have to worry about possible plasmid loss due to the turnover of lab members, accidental manipulations, or other unwanted situations like freezer meltdowns. Depositing is also an excellent option for scientists that are changing institutions or are about to retire and don't want their materials to be lost at the bottom of a freezer.

Scientists that foresee many plasmid requests before publishing a paper have the option of depositing plasmids before publication. These scientists can then include the Addgene plasmid identification numbers and links to the plasmids' webpages in their manuscripts. Future manuscript readers then have easy access to the plasmids and their associated

sequences and maps. The plasmids and their paper is published data will only appear on the website when the

Step 1: Provide Addgene with the plasmid information. Use the online application or fill out the deposit spreadsheet both of which can be found here - <https://www.addgene.org/depositing/start-deposit/>

Step 2: Provide Addgene with the samples (~10 microlitres of miniprep quality DNA or bacterial streaks on plates). Addgene will provide you with a "deposit kit" with prepaid shipping and instructions on how to package your materials.

Step 3: Addgene conducts quality control (QC) on your samples. New plasmids are sequenced using next generation sequencing.

Step 4: Addgene handles the MTA. The Institution and the PI agree that Addgene distributes the deposited materials on their behalf.

Step 5: Addgene stores the plasmids. The constructs are stored as bacterial glycerol stocks in triplicate (2 onsite in Cambridge MA, 1 offsite).

Step 6: Addgene makes the plasmids available. Academic scientists and nonprofit researchers have access to the deposited materials.

Figure 2. Steps to deposit materials with Addgene.

Once Addgene makes the deposited plasmids available, the depositor (usually a PI) is given a PI page on the Addgene website. This page organizes the depositor's plasmids by publication and makes it easy for the depositor to refer requesters to their lab's plasmid collection. Depositors appreciate that Addgene sends periodic reports indicating who has requested their plasmids. This feature can be used to foster collaborations between depositors and those who are using their constructs.

Addgene also takes a variety of steps to increase depositors' visibility. Labs that use requested plasmids in their experiments are instructed to reference the publication where the plasmids were originally described. Addgene also promotes new deposits on social media and features some plasmids in its quarterly newsletter. Particularly popular

plasmids are demarcated by yellow (>20 requests), red (>50 requests), and blue (>100 requests) flames. In 2016, Addgene started distributing the "Blue Flame Award" to depositors with blue flame plasmids. These awards highlight the work of these great scientists and help further promote their plasmids to the scientific community. These are some testimonials from Addgene's depositors:

"Addgene has done a first class job and has, at the same time, taken an enormous burden off my back and my budget. Almost all of [my] requests are forwarded to Addgene and I've heard repeatedly that they are doing an excellent job!" Dr. Robert Weinberg, Whitehead Institute for Biomedical Research and the Massachusetts Institute of Technology (Cambridge, MA)

“Addgene not only reduces significant time spent handling plasmids requests, it allows all researchers involved to get on with the science.”

Dr. Reuben Shaw, Salk Institute for Biological Studies (San Diego, CA)

For more information on the deposit process check out the deposit page at Addgene (<https://www.addgene.org/deposit/>).

Benefits for requesting scientists:

Addgene gives scientists the opportunity to speed up their research by facilitating access to a broad variety of quality controlled and published materials present in its collection (<https://www.addgene.org/search/>). The collection (>50,000 plasmids) is always growing

and includes constructs to carry out all kinds of experiments (gene expression, gene knockdown, tagging, editing, etc.) in many model organisms (human, mouse, rat, bacteria, yeast, worms, flies, fish, plants, etc). The repository contains popular CRISPR plasmids, empty backbones, viral vectors, fluorescent reporters, stem cell factors, cloning tools, and much more. Addgene curates these plasmids into convenient collections with the objective of helping requesting scientists easily find the materials they need for their next experiments (<https://www.addgene.org/special-collections/>). Once scientists find the materials they need, it is very easy to place an order online and get the materials within days (**Figure 3**).



Figure 3. Steps to request materials via Addgene.

Since September 2016, requesting scientists can also benefit from Addgene’s viral service. Viral production is a common step after requesting plasmids from the repository. With the new Viral Service, Addgene lets scientists skip this step and get their results faster. On the viral service page (<https://www.addgene.org/viral-service/>), researchers can find the plasmids that are currently available in lentiviral or AVV format.

Requesting scientists consistently thank Addgene for facilitating an easy access to high quality research materials.

Benefits for all of the scientific community

Addgene is considered a useful resource not just for the materials in the repository, but also for its many useful and publically available educational resources. By reading Addgene’s blog (<http://blog.addgene.org/>) scientists can learn about CRISPR, fluorescent proteins, cloning techniques, and more (**Figure 4A**). They can also access interesting information about science careers and related topics such as management and mentoring (**Figure 4B**). Addgene also recently introduced protocol videos into its repertoire of resources (<https://www.youtube.com/user/addgenemedi>). These videos are intended to teach new researchers common lab techniques. Some of Addgene’s most popular resources include the Plasmids 101, CRISPR 101, and the Mentoring

for Scientists eBooks. The CRISPR 101 eBook

alone has been downloaded >18,000 times.

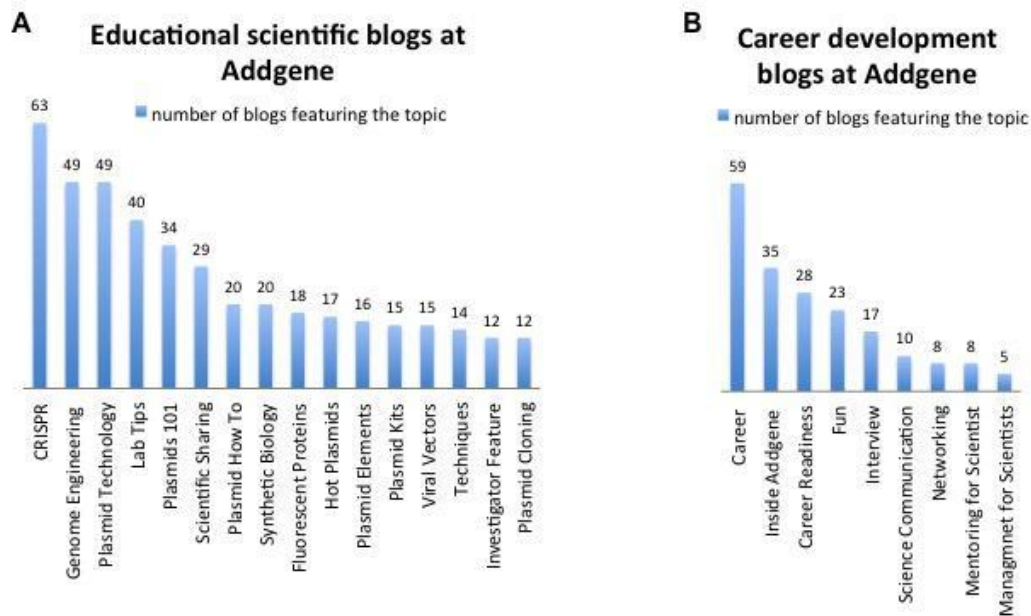


Figure 4. Scientific (A) and career (B) blogs created by Addgene. Note, topics are not necessarily mutually exclusive.

Academic scientists can benefit from Addgene starting early in their careers. PhD students and postdocs not only use Addgene's constructs in their daily experiments, but can also find useful resources on addgene.org to advance their experiments and their career goals. Scientists have access to podcasts (<http://blog.addgene.org/topic/podcast> or <https://itunes.apple.com/us/podcast/addgene-s-podcast/id1151454253?mt=2>) and have the opportunity to watch free mentoring and career development talks presented by Addgene's Executive Director and career expert Joanne Kamens (https://www.youtube.com/watch?v=nxSl6KicD_s4&t=243s0). In addition, Addgene sponsors initiatives that benefit young scientist like the Michael Davidson and Roger Tsien travel award (<http://blog.addgene.org/michael-davidson-and-roger-tsien-commemorative-travel-awards>)

and the "Postdoc of the Year Award". Many Scientists that use Addgene as Postdocs are keen to strengthen their bonds to this community when they become PIs by contributing to the repository as depositors.

Conclusions

Addgene's unique repository gives researchers the means to widely distribute their materials at an ensured level of quality while also providing them with a safe way to archive past work. The growing use of repositories like Addgene may help enhance productivity in the biological sciences and is already making it easier for researchers to find and obtain the materials they need to get more accurate results faster.

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