JUMPCODE

Company Overview

IMPROVING NEXT GENERATION SEQUENCING WITH CRISPR POWERED TECHNOLOGY

Company Highlights

- **Founded:** 2016
- **History:** Spun out of iGenomX, Inc., with support from The Scripps Research Institute
- **Financial profile:** Backed by world-class private venture investors
- **Operations and laboratory facilities:** Located in La Jolla and Carlsbad, Calif.
- Strong IP portfolio
- **Capital raised:** $6.5M (equity)
- **Stage:** Commercial

Background

On December 3, 2019, the USPTO issued JumpCode claim allowance on our flagship technology utilizing CRISPR to improve performance of next-generation sequencing (NGS). This is a major achievement for JumpCode.

CRISPR stands for Clustered Regulatory Interspaced Short Palindromic Repeats, which are a hallmark of bacterial immune defense systems[1]. Our use of this technology is to remove overabundant nucleic acids from sequencing workflows to improve sensitivity and performance in many application areas. For example, human host DNA molecules can be removed from a sample of blood, allowing for a single universal infectious disease test for all viral, bacterial, and fungal pathogens — whether known or unknown. The technology was used by a team of researchers at UCSF[2] to diagnose a renal transplant patient for west nile virus, the cause of meningoencephalitis that eluded all traditional diagnostic testing. In this example, the technology was used to deplete human host RNA molecules that dominate a sample extracted from the patient's cerebrospinal fluid, allowing the team to detect the virus and successfully treat the patient.

Our patent claims cover broad use of the technology for many applications, including those described in these manuscripts. By removing ribosomal RNA, repetitive elements, or other abundant but scientifically undesirable molecules, JumpCode's products boost sequencing efficiency, increase sensitivity, and reduce overall sample costs.

In August 2019, JumpCode Genomics launched an early access program for our first commercial product. Initial feedback and results for the ribosomal RNA (rRNA) depletion product have been very positive. Users appreciate the simple workflow, greater sensitivity, higher throughput, ability to detect both known and unknown targets, and significant time and cost savings.

Early Access Customer Feedback

> Using JumpCode's accurate, efficient depletion techniques together with high-throughput sequencing has been a real turning point for my research. We can now generate data from enough low amount samples to have real statistical significance."

Laurey Steinke, PhD
Associate Professor, Nebraska Medical Center

> JumpCode's Human rRNA depletion kit is significantly more effective at reducing human rRNA contamination than RiboZero Gold in our pooled, 24 sample, stool associated RNA Tagseq libraries. JumpCode reduced human rRNA to ~.01% of all reads while RiboZero depleted less effectively at about ~.1%."

Julian Ponsford
Microbial Ecology Researcher, Broad Institute of Harvard and MIT

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Product Portfolio

For the past two years, JumpCode has been developing innovative products around its core technology. Initial applications include rRNA depletion, repetitive element depletion, removal of bacterial contaminants from saliva-derived DNA samples, removal of wild-type DNA from cancer samples, and removal of host DNA for infectious disease samples. The latter product replaces a multitude of technologies, reducing the time to results from weeks to days (potentially hours), which may literally be the difference between life and death in some scenarios (see figure below). In each example, removal of overabundant sequences enables workflow improvements, cost improvements, and most importantly a dramatic increase in sensitivity to detect rare events. One consultant described the technology as "enabling the ability to find the needle in the haystack… by removing the haystack."

Market Opportunity

Advances in technology have made CRISPR-powered sequencing more accessible and affordable for an increasing range of applications across end-markets with significant growth potential. JumpCode has eight patent filings covering a broad range of applications and products for genome interrogation, four of which are core to the business today. Based on the patented and patent-pending technology, we have the potential to develop products in four main verticals: basic research, infectious disease, molecular diagnostics, and oncology

Basic Research: $880M

Our current R&D program is focused on the basic research vertical; however, the components we are developing are fundamental to the products in all four

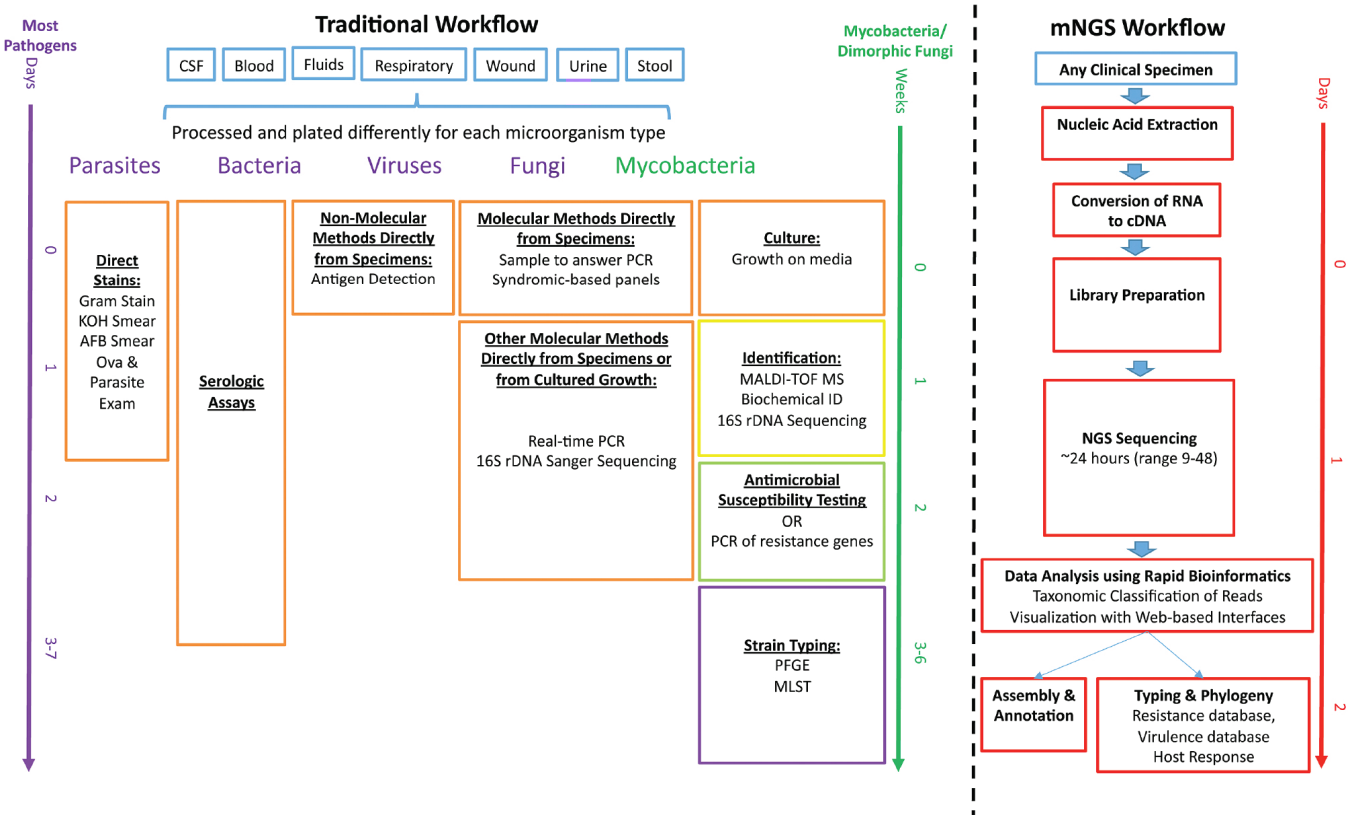


Figure 1. Summary of the traditional timeline and workflow in diagnostic medical microbiology laboratories and the future state with the incorporation of metagenomic next-generation sequencing (mNGS) methodologies.[4] Current organism detection techniques (orange), identification (yellow), antimicrobial susceptibility testing (green), and strain typing (purple) can take up to a week or longer from specimen collection (blue) to strain typing results. mNGS has the capability of greatly reducing turnaround times and providing all the data summarized in current methods in a single modality (red) and could potentially provide all of these within 24-48 hours of specimen receipt.

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verticals. There are currently more than 11,000 Illumina sequencers installed globally, with an average throughput of more than 100 flow cells (the disposable sequencing chips) per instrument. We estimate that based on the application usage of Illumina sequencers, one out of every four flow cells could use JumpCode products to improve results. This results in a current opportunity of $880M based on an ASP of $800 per flow cell using JumpCode products. Available products include rRNA depletion for human, pan-bacterial, and meta-transcriptomics. Repeat element removal products for human, wheat, and corn are in various stages of development. Additional products for mitochondrial depletion, chlorophyll depletion, and bacterial depletion from saliva-derived samples have been proposed in collaboration with strategic partners.

Infectious Disease: $20B opportunity[5]

Submarkets: Transplantation[6]= $2B (US only) and blood screening=$1.3B[7] (US only).

Pathogen detection for infectious diseases remains a critical aspect of human healthcare. The ability to make crucial decisions faster, cheaper, or at the point-of-care allows for more effective responses.[8] As an example, in the US alone, 1 million patients are hospitalized for pneumonia each year at a cost of ~$10 billion. Infected patients exhibit symptoms that are highly similar, requiring a battery of tests to be performed, yet 20%-60% of the cases remain undiagnosed, resulting in delayed or ineffective treatments, increased costs, and even death.[9]

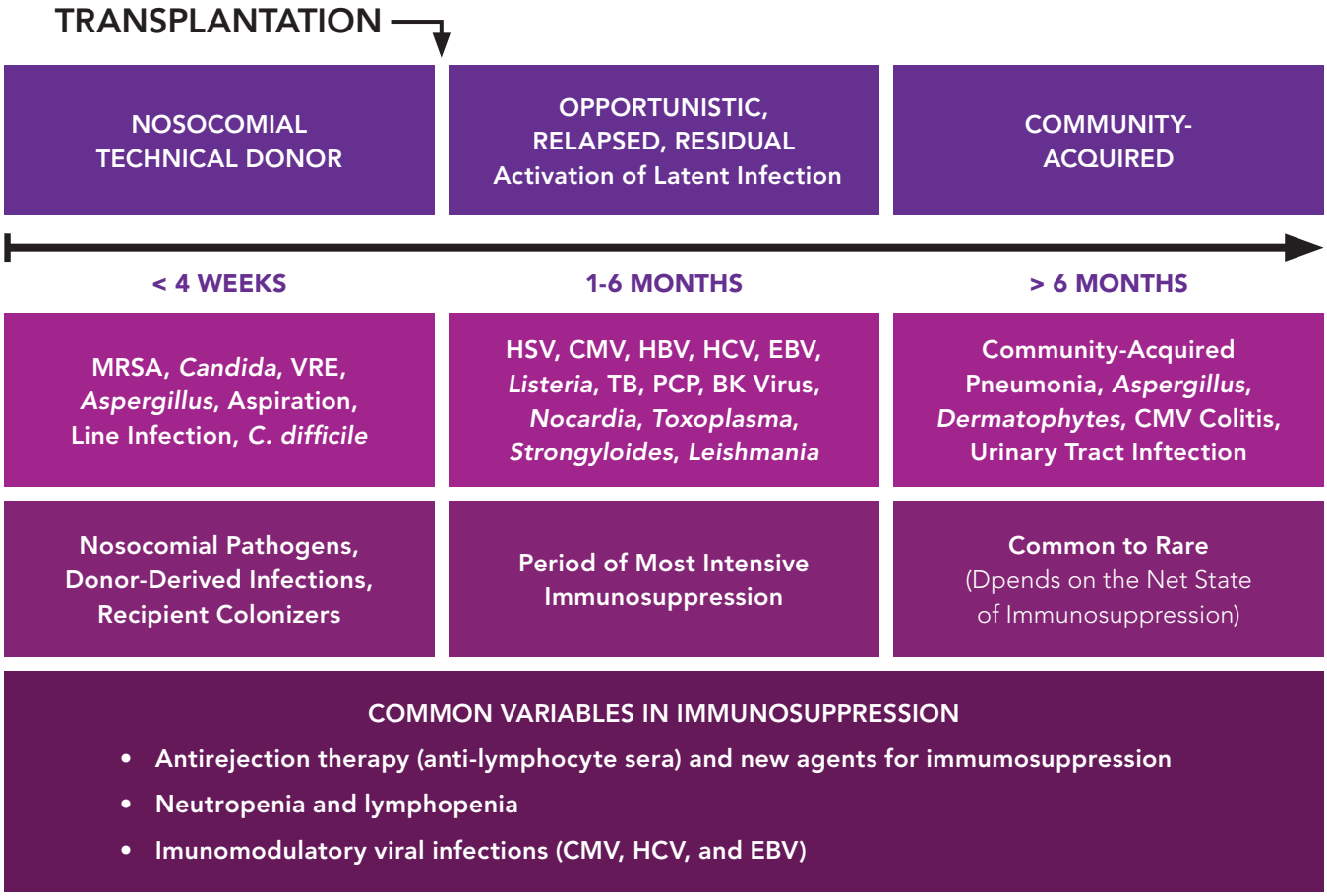


Figure 1: Timeline of posttransplant infections.[10]

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This is particularly true in immune-compromised individuals such as transplant recipients or patients on immunosuppressive chemotherapy. In 2018, there were greater than 36,000 solid organ transplants in the United States; there have been more than 750,000 transplant surgeries since 1988 (the first year these stats were recorded). The five-year survival rate is 50%-75% (depending on organ type).[11] Using these statistics, we estimate a minimum of 16 tests per transplant over a five-year window at a proposed cost per test of $3500. This results in a $2B annual TAM for the transplantation sub-sector of the infectious disease market to replace a battery of existing tests that result in a diagnostic determinant less than 50% of the time[12] (see Figure 2 on the previous page).

There are more than 13 million blood donations per year in the US.[13] Here we assume an ASP per test of $100 to replace the current testing regimen of greater than 20 viral and bacterial tests, which still result in dozens of donor-derived fatalities per year. In 2016, the FDA issued guidance for Zika testing of the US blood supply.[14] The following quotation from the paper describes the initial evaluation of the program to implement Zika virus testing, which took approximately 12 months from the FDA guidance to implementation in all US blood banks: "On the basis of industry-reported costs of testing and the yield of the tests in our study, the cost of identifying eight mosquito-borne ZIKV infections through individual-unit nucleic acid testing was $5.3 million per ZIKV RNA-positive donation." JumpCode's unbiased approach allows for a single test of all viral and bacterial contaminants of the blood supply (including today's recommended tests and tomorrow's outbreaks) at a cost equivalent to or less than today's combined testing regimens with limited diagnostic yield.

Oncology: $2.9B (US)

Our oncology products focus on an unmet need in clinical research programs: the ability to target retro-viral and endogenous mobile element components that characterize more than 50% of cancers. The development of cost-effective, long-read sequencing technology, along with our growing understanding of mobile element biology, and a growing NCI and investor focus on new cancer biomarkers make the timing right for accurate, sensitive, and practical tools. The US will have an estimated 1.5 million new cancer diagnoses in 2019, resulting in a $2.9B market for NGS-based testing (average cost per test of $1,300).[15]

Molecular Diagnostics: $1B (US)

Pharmacogenomic (PGx) and repeat expansion disorders represent a greater than $1B market in the US today.[15] JumpCode technology will address gaps in current technology for existing genetic disease testing markets. Identified near-term opportunities include PGx testing (e.g.: CYP2D6) and repeat expansion disorders (e.g.: Fragile X, Huntington's disease). For example, our technology enables detection of repeat expansion length, methylation, and mosaicism in a single assay. This replaces three separate technologies to address important questions.

Capital Requirements

JumpCode is currently seeking financing to expand our R&D team and commercial operations as well as to explore the regulatory path to *in vitro* diagnostic products using our technology.

Leadership Team

- **Keith Brown**, Chief Executive Officer and Chief Technology Officer
- **Decky Goodrich**, Chief Commercial Officer
- **Azeem Siddique, PhD**, Vice President of Research
- **Steve Head**, Director of Laboratory Operations
- **Phil Ordoukhanian, PhD**, Director of Assay Development

Scientific Advisors

- **Shawn Levy, PhD**, Chief Scientific Officer, Genomics at Discovery Life Sciences
- **Kirk Malloy, PhD**, Founder and Principal, BioAdvisors, LLC
- **Gene Yeo, PhD**, Professor of Cellular and Molecular Medicine, University of California, San Diego
- **Nik Schork, PhD**, Director of Research at Scripps Genomic Medicine
- **Andrew Su, PhD**, Professor of Integrative Structural and Computational Biology, The Scripps Research Institute

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Board of Directors

- **Kirk Malloy, PhD**, Founder and Principal, BioAdvisors, LLC
- **Kevin Li, PhD**, Partner at LYZZ Capital, LLC
- **Eugene Chen**, Director, CWC Healthtech
- **Joel Rotroff**, Partner, American Industrial Partners
- **Keith Brown**, Chief Executive Officer

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