

Example 3: Bioscience & Healthcare

1. Team

The PI is a Professor of Biological Sciences at Vanderbilt University.

2. Technology/Innovation Description

The technology includes a series of novel compounds that interact with insect odorant receptors to interfere with cues that direct insects to sources of food. These compounds were originally designed to interrupt the detection of humans by mosquitoes but are now understood to affect broad classes of insects.

The technology also includes compounds for disruption of insect host sensing. Potential uses as human and animal insect repellent and pest control agent for agriculture. The PI has patents filed on methods of use and compounds to include both receptor agonists and antagonists, which represent multiple insect control strategies.

3. Predicted Outcome

The aim of the project is to characterize the chemical properties and overt toxicity of these compounds, which appears to be the minimum requirement to entice a licensee for further development. This funding is designed to quickly identify highly toxic compounds, so that further development efforts can be focused on candidates most likely to succeed.

A successful outcome will bolster the chance of new Gates Foundation funding, perhaps US Army Deployed Warfighter Protection Research (DWFP) funding, and angel/VC investment. GearJump will have more data to engage with ag companies. The results also will answer an important commercialization (and patent) gating question.

4. Commercial Targets

The Total Addressable Market (TAM) for the mosquito market is expected to grow from 6.51 billion USD in 2022 to 9.30 billion USD by 2029, exhibiting a Compound Annual Growth Rate (CAGR) of 5.23% during the forecast period.

Microban, Tech Accel, Elanco, and other labs have indicated a desire to do testing of compounds on nuisance insects and specific ag pests but are reluctant without having toxicology information. We had a path forward on the tox front with Barr Brands, but they withdrew.

The ideal commercial target would be a partnership among agricultural/consumer product/chemical manufacturer companies. These constructed relationships are typical for insecticide product development.

A chemical manufacturer that specializes in insecticides and has expressed interest in the Vanderbilt compounds. The PI and chemists recently traveled to a manufacturing site to discuss a partnership. The company is eager to partner with us if we can engage another partner that could formulate a final product.

SC Johnson is a consumer product company that has also expressed interest in the compounds but is hesitant to pursue formulation studies until we can provide more data on the physical chemistry characteristics and toxicity of the compounds. We are currently marketing this technology to agricultural companies.

GearJump Technologies is a Singapore-based engineering and life sciences company that develops disruptive technologies to solve complex global problems in healthcare, vector control, and plant protection. GearJump's technology platforms focus on the synergy of electronics, bionanotechnology, and novel biomaterials. These platforms operate at multiple scales for multiple applications ranging from nanoparticles to wearable and field use devices.

5. Scope of Work

Phase I

Three compounds (two agonists and one antagonist) will be synthesized using Vanderbilt's Chemical Synthesis core. Compounds will be tested for solubility in up to fifteen vehicle solvents to identify one suitable for administration in the toxicity test. Twenty grams of each compound will be sent to an outside contractor, Product Safety Labs, to measure and provide a report on the acute oral toxicity range of each compound. The test is structured to begin as a Limit Up/Down test that converts, if needed, to an LD50 test (lethal dose of 50% of animals). The acute oral toxicity test design is standard and modeled upon one of the requirements for the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Product Safety Labs is a world leader in animal toxicity testing for EPA regulatory approval. Compounds that exhibit acute oral toxicity at > 500 mg/kg would be in the same class as the widely used pesticide DEET and deemed acceptable for further development.

Phase II

We will provide compound to external toxicology testing lab to perform "six pack" toxicity tests in animals, mutagenicity (Ames), and one environmental biodegradation test.

We will also obtain chemical property tests first or in addition to the tox test. Some properties are estimated by the team, such as vapor pressure, boiling point, and melting point. However, many others are unknown and may need to be performed by an outside test lab, depending on the minimal requirements. The team will consult with vendors to identify the minimal requirements in a typical Safety Data Sheet (SDS).

Limited efficacy testing on two insect species has previously been done in the PI's labs and by Citadel Protectants. However, additional studies both here and elsewhere have been suspended on an ethical basis, pending additional information on toxicity and compound properties. A single preliminary oral toxicity study was conducted in 2013 for three compounds resulting in no toxicity detected at that time in the single test.

6. Schedule

9-12 months.

7. Deliverables

Phase I

Basic solubility determination, 20 g synthesis of the three selected compounds, preliminary oral toxicity report, and classification.

Phase II

Written reports illustrating (i) results of toxicology tests and (ii) results of chemical property tests.

8. Budget

Phase I

Synthesis of compound 1 by VICB chemical synthesis core	\$6,980
Synthesis of compound 2 by VICB chemical synthesis core	\$6,155
Synthesis of compound 3 by VICB chemical synthesis core	\$6,822
Acute Oral Toxicity Study, performed by Product Safety Labs, for three chemical compounds	\$8,910
Cost to return any unused chemical compounds from Product Safety Labs	\$915
Total Phase I	\$29,782
Phase II	
"Six Pack" tox tests	\$9,500
Ames Assay	\$1,000
1 Environmental Test	\$22,300
Total Phase II	<u>\$32,800</u>

Total Project

\$62,582

9. Significant Interim Milestones

Milestones are punctuated by the project phases. Successful completion of Phase I activities (*i.e.*, chemical synthesis, preliminary toxicity test) will enable completion of Phase II activities (*i.e.*, chemical characterization, “six pack” toxicity tests).

10. Intended Populations of Impact

Compounds are expected to have broad applications, ranging from controlling agricultural pests (both crop and animal husbandry markets), nuisance pests (commercial, household and personal uses), and disease vectors caused by the mosquito, including Malaria, Dengue Fever, and Zika virus.

11. Competitive Landscape and Advantage

Some of the main competitors in this market include:

- Ecolab: Ecolab is a global leader in water, hygiene, and energy technologies and services. The company offers a variety of mosquito control products and services, including larvicides, adulticides, and mosquito traps.
- Mosquito Shield: Mosquito Shield is a leading provider of mosquito control services. The company uses a variety of methods to control mosquitoes, including spraying, fogging, and using mosquito traps.
- Rollins: Rollins is a pest control company that offers a variety of services, including mosquito control. The company uses a variety of methods to control mosquitoes, including spraying, fogging, and using mosquito traps.
- Terminix: Terminix is another pest control company that offers mosquito control services. The company uses a variety of methods to control mosquitoes, including spraying, fogging, and using mosquito traps.
- Mosquito Joe: Mosquito Joe is a franchised mosquito control company that offers a variety of services, including spraying, fogging, and using mosquito traps.

In addition to these companies, there are a number of startups developing new solutions for mosquitoes. These startups are working on a variety of technologies, including genetically modified mosquitoes, mosquito-killing drones, and mosquito-repelling plants. The mosquito control market is rapidly evolving, and there are a number of new technologies and products being developed. This makes it a challenging market to enter, but it also offers a lot of potential for innovation.

12. Development Stage vs. Target Stage

The current development stage of the project includes preliminary *in vivo* proof of concept showing efficacy in repelling insects in electrophysiological and behavioral assays. The target stage would provide information needed to garner further industry support (*i.e.*, chemical characterization, toxicity testing).

13. Total Funding to Date and Funding Sources

This project is building on 15 million USD worth of grant funding provided by the Bill and Melinda Gates Foundation.

14. Leveraged Internal or External Programming

Our team has been working closely with CTTC's licensing team for years. Vanderbilt has invested substantial funds in patent protection and technology maturation for this project.