GbSciences' Plant-inspired Prescription Drugs

GbSciences

OTCQB:GBLX

Overview

Plant-Inspired Biotech Developing Prescription Drugs

Drug Development Pipeline: Preparing lead candidate in PD for First-in-Human Trial

- Parkinson's Disease (PD): Patent issued; Preparing for First-in-Human Q4 2023
- Chronic Pain (NP): Patent issued; Preclinical study at NRC Canada
- COVID-Cytokine Release Syndrome (CRS): Patent filed; Preclinical study at Michigan State Univ.
- Heart Disease (HD): Patent issued; Proof-of-concept obtained; Preclinical research (on-going)

Discovery Program: Intellectual Property Portfolio covers >60 serious health conditions

- 6 US & 3 Foreign Patents Issued; 18 US & 49 Foreign Patents-Pending
- Proprietary Drug Discovery Platform – PhAROS™ Drug Discovery Engine
- Natural Products Research Combining Traditional Medical Systems and AI/Machine Learning

GbSciences' Drug Development Pipeline

Rx PROGRAMS	DISCOVERY	PRECLINICAL	Pre-IND	CLINICAL TRIALS: First-in-Man/ Phase I	CLINICAL TRIALS: Combined Phase I-II
Parkinson's Disease (PD)					
COVID-Cytokine Release Synd. (CRS)					
Chronic Pain (CP)					
Heart Failure (HF)					
Anxiety/Depression (Piper plant family)					
Mast Cell Activation Syndrome (MCAS)					

KEY	
Completed	
In-Process	

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Plant-Inspired Strategy

Active Ingredients: Synthetic Homologues of Plant Compounds

- Synthetic homologues are identical in structure to plant compounds
- Manufactured under current Good Manufacturing Practices (cGMP)
- Regulatory & supply chain advantages over plant-based compounds

Formulations: Minimum Essential Mixtures (MEM™)

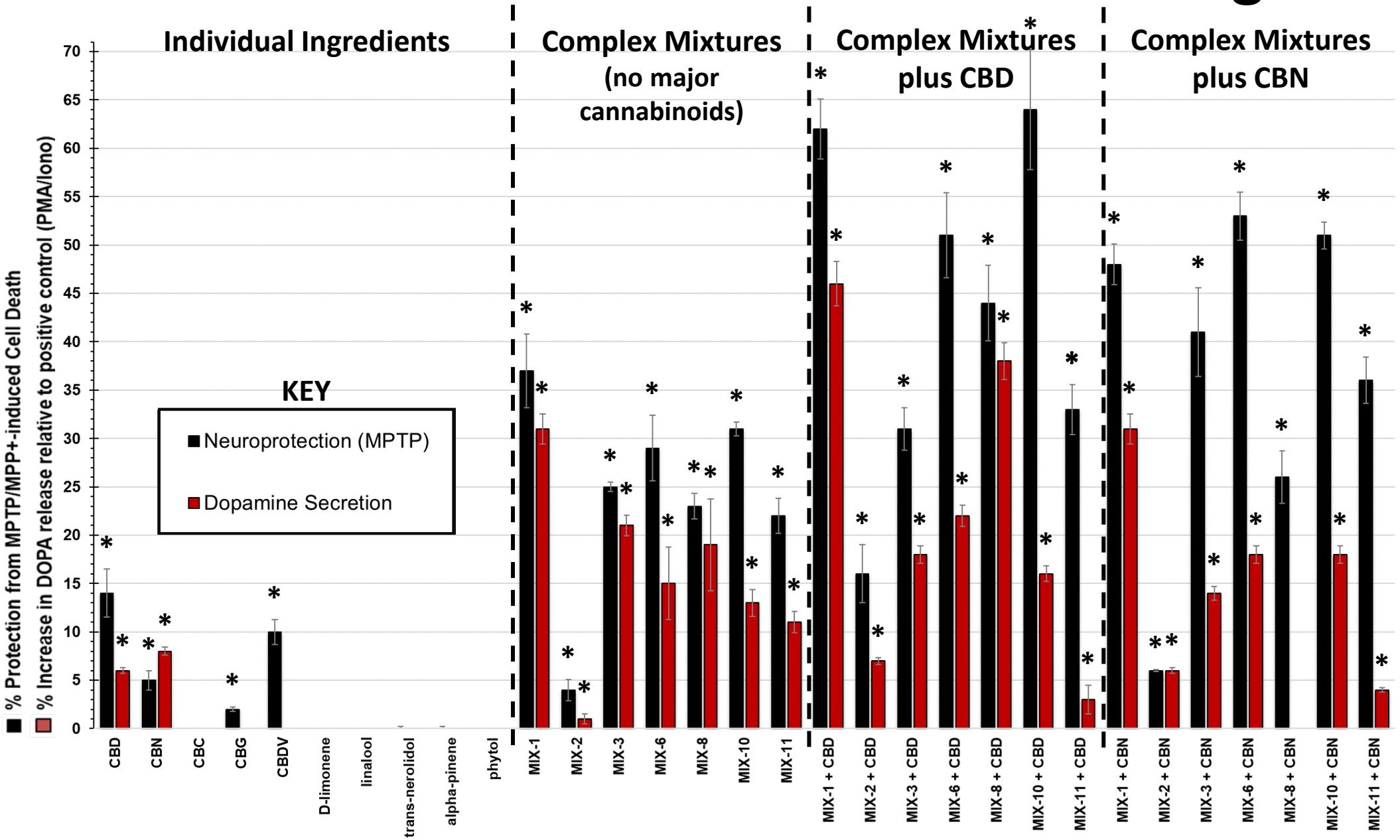
- Whole plant efficacy retained, yet efficiencies of single ingredient drugs
- MEM™ retain molecular synergies of plant extracts (>100 compounds)
- Simplified to 3-5 compounds per MEM™

Delivery Modes: Oral Routes

- Improved bioavailability
- Increased patient compliance
- Oral dissolving tablets (ODT), oral nanoparticles, oral thin film, gel capsules

GbSciences' Parkinson's Therapeutics

Mixtures More Effective Than Individual Ingredients



MPTP/MPP+ cytotoxicity & dopamine secretion assays assessed the potential effectiveness of cannabis-based ingredients (both alone and in mixtures). For the MPTP/MPP assay, the effectiveness is presented as the % protection from MPTP/MPP cell death evaluated based on the MTT cell viability assay, where the experimental value is normalized relative to the vehicle control. For the DOPA release assay, the experimental value is presented as the normalized value, which is a % of the positive control (secretion chieved with PMA/Ionomycin application) value.

Chaminade University

Significant PD-Motor Symptom Reduction

PD MEM™ in Parkinson's Animal Study—NRC Canada

- Zebrafish model of Parkinson's Disease-72 hr OHDA Exposure
  - Restored overall movement levels (measured based on total distance moved)
  - Reduced "resting tremor"(measured frequency & duration of shifts in activity states)
  - Normal startle response (Light/Dark)
- Statistically Significant Reduction of PD-like Motor Symptoms
  - 3 of 10 Equimolar MEM™
  - 22 of 63 Cannabinoid-Ratio Controlled MEM™
  - 5 outperformed the other MEM™
  - 3 selected for formulation and ADMET testing as clinical trial prototypes

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NRC·CNRC Canada

PD Clinical: Orally Disintegrating Tablets (ODT)

Zydis™ Orally Disintegrating Tablets (ODT)

- Unique, freeze-dried oral solid dosage
- Instant oral dispersion – typically less than 3 seconds

Parkinson's MEM™ in Zydis™ ODT

- Convenient dosing solution for Parkinson's patients
- Greater than 50% of Parkinson's patients have swallowing problems

Clinical Advantages

- Improved bioavailability
- Increased patient compliance
- Rapid onset through buccal/sublingual absorption

Zydis™ Orally Disintegrating Tablets (ODT)

GbSciences

Catalent®

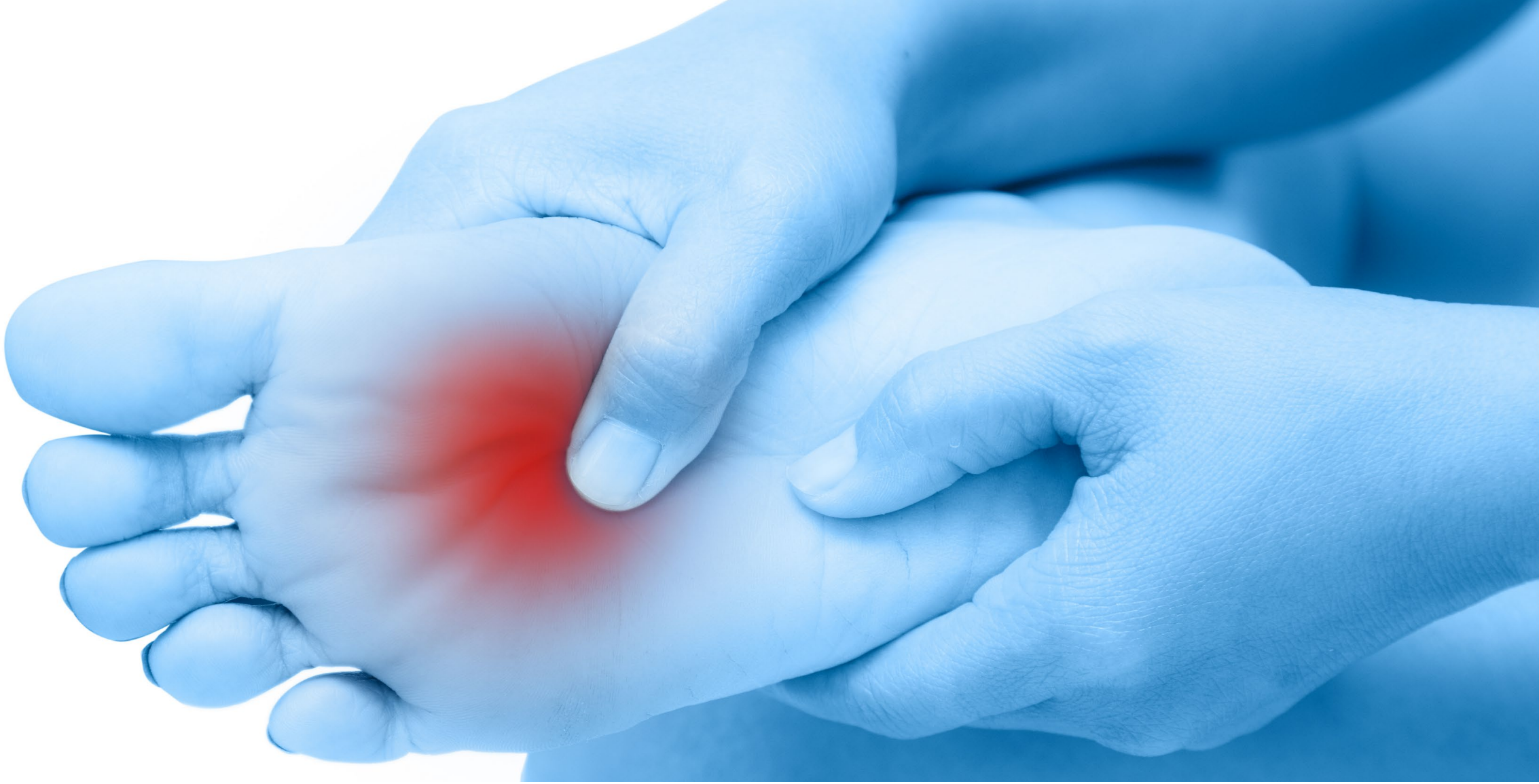
Next Steps & Milestones

1. **Dose-Response Study in Rodents** – University of Lethbridge
2. **Prepare Zydis format of PD.MEM formulas** (Catalent Pharma)
   - Prepare test batches of Oral Dissolving Tablets
   - Stability Testing
   - Chemistry Manufacturing Controls (CMC) for IND filing US FDA
3. **Run Toxicology & ADME Studies on PD.MEM formulas**
   - Toxicology on Parkinson's clinical prototypes
   - ADME Studies = Absorption, Distribution, Metabolism and Excretion on Parkinson's clinical prototypes
4. **Engage CRO** for First-in-Human Clinical Trial
   - Write & file pre-IND
   - Run First-in-Human Trial
5. **File pre-IND Application** with US FDA
6. **Pre-IND Meeting** with the US FDA
7. **First-in-Human Clinical Trial**

Gb Sciences' Research Articles

Cannabinoids and Terpenes for Parkinson's Disease

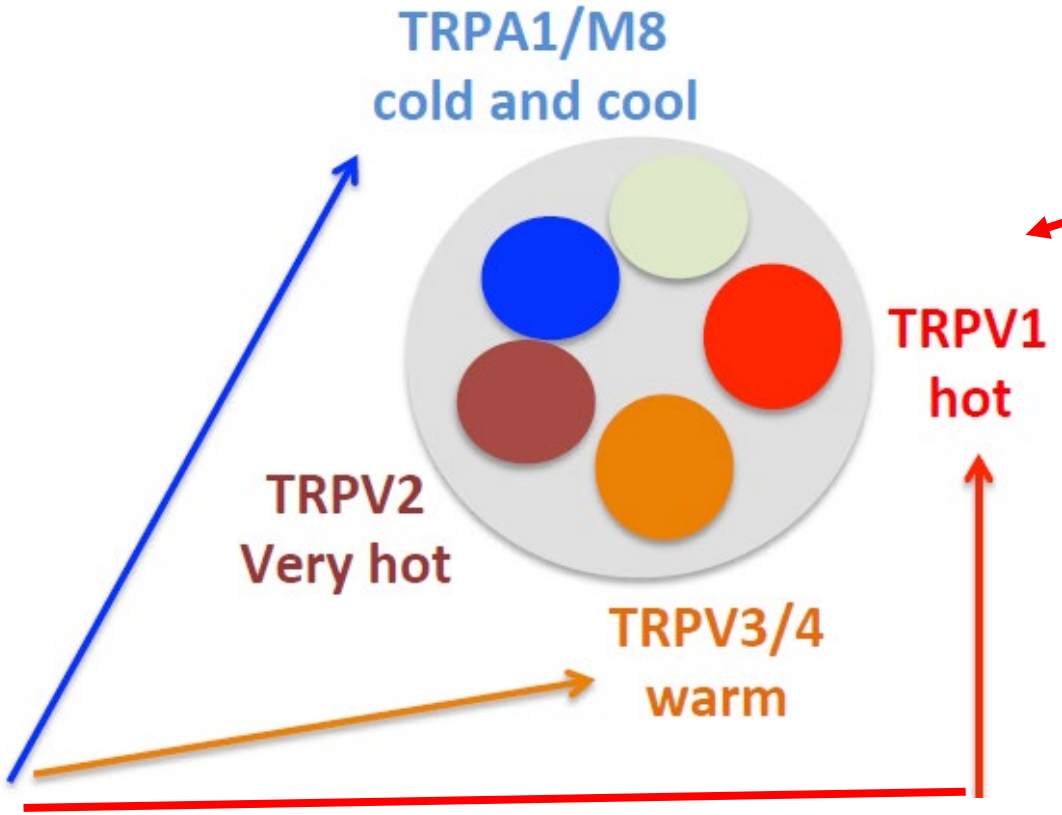
- Turner H, Chueh D, Ortiz A, Small-Howard A. Cannabinoid Therapeutics in Parkinson's Disease: Promise and Paradox. *J. Spices and Medicinal Plants*. 2017 March; 23(3):231-248.
- Morash MG, Nixon J, Shimoda LMN, Turner H, Stokes AJ, Small-Howard AL, Ellis L. 2022. Identification of minimum essential therapeutic mixtures from Cannabis plant extracts by screening in cell and animal models of Parkinson's disease. In preparation for Special Issue of *Frontiers in Pharmacology* entitled "Cannabidiol Treatment in Neurotherapeutic Interventions, Volume II".



GbSciences' Chronic Pain Therapies

Chronic Pain Strategy: TRP Receptors

Within a pain-sensing bundle, the neurons express multiple "TRP channels", so they can respond to different pain stimuli.



Conventional capsaicin pain therapies target only TRPV1 and leave other neurons in the bundle untouched, which potentially causes more pain.

KEY CONCEPTS: Computer-aided drug discovery and lab experiments reveal that Gb Sciences' chronic pain mixtures have the potential to target multiple receptors in the sensory nerve bundle to increase their net effectiveness at reducing pain.

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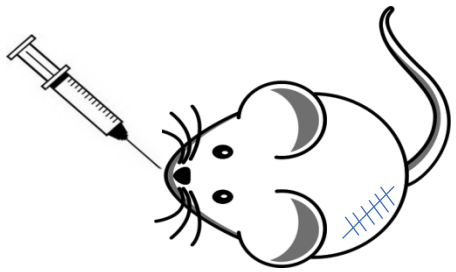
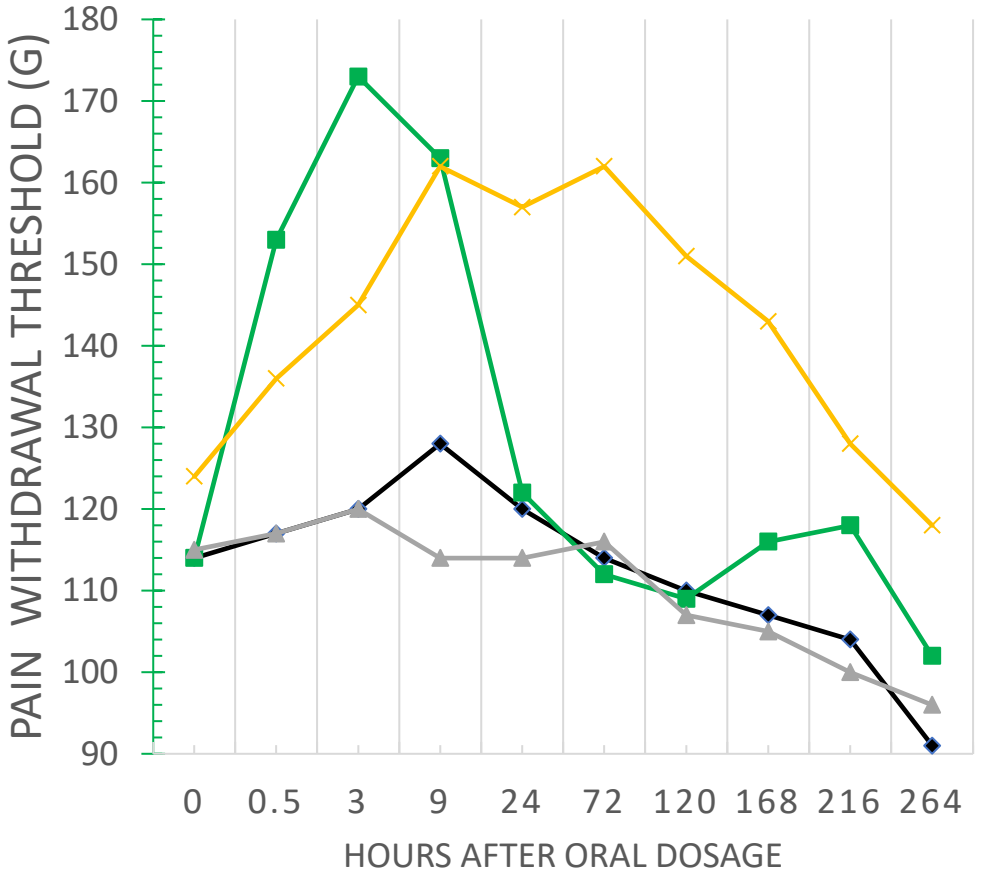
Proof of Concept: Extended-Relief Nanoparticles

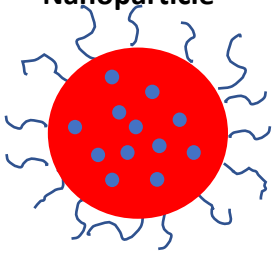
Esther Berrocoso, PhD, Raquel Rey-Brea, MS, Mercedes Fernández-Arévalo, PhD, Juan Antonio Micó, MD, PhD, Lucía Martín-Banderas, PhD. 2017. Single oral dose of cannabinoid derivate loaded PLGA nanocarriers relieves neuropathic pain for eleven days. Nanomedicine: Nanotechnology, Biology, and Medicine. 13 (2017) 2623-2632.

Oral Administration (one dose)





Cannabinoid-containing Nanoparticle



Single oral doses of cannabinoid-containing nanoparticles relieve pain for up to 11 days compared to less than 1 day of pain relief from free (unencapsulated) cannabinoids at the same dosage. The peak effectiveness of the free cannabinoids was between 0.5 and 9 hours; whereas, the cannabinoid-containing nanoparticles remained maximally effective between 1 and 9 days.

Current: Terpene-LNP Testing in Zebrafish

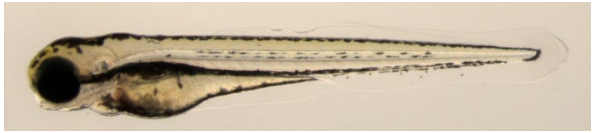
Ellis, L.D., Berrue, F., Morash, M., Achenbach, J.C., Hill, J., McDougall, J.J. (2018) Comparison of cannabinoids with known analgesics using a novel high throughput zebrafish larval model of nociception. *Behavioral Brain Research* 337:151-159.

Chronic Pain LNP = Lipid NanoParticles

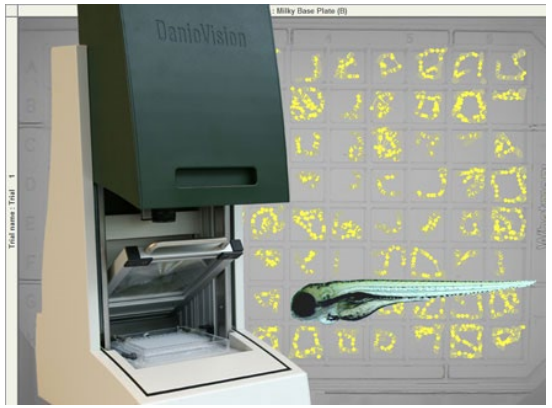
- Testing Single Compounds
  - Within nanoparticles
  - Non-encapsulated
- Testing Complex Mixtures
  - Within nanoparticles
  - Non-encapsulated
- 2 zebrafish nociceptive models
  - Place preference
  - Nociception

- *Danio rerio*

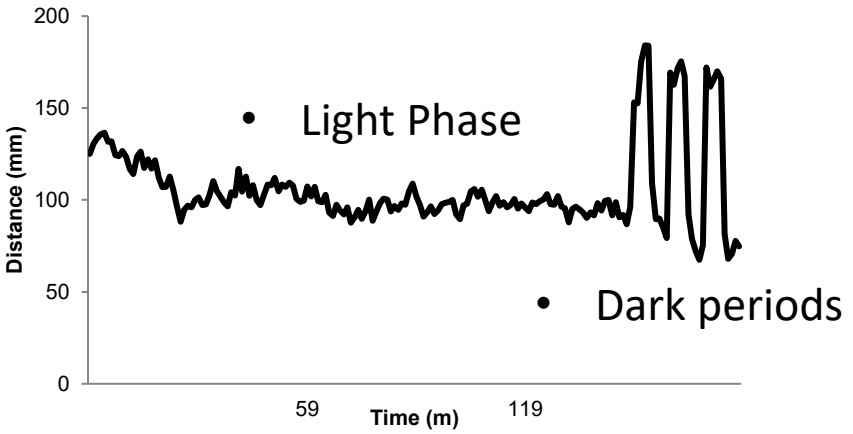
- Hundreds of larvae per female



- Body patterning established by 5dpf



- High throughput screening



- Light Phase
- Dark periods

- Stimulus induced behavioral responses

Next Steps & Milestones

1. **Complete Animal Proof of Concept at the NRC Canada**
   - Nanoparticles produced at the University of Seville
   - Stability Testing
   - Proof-of-concept testing at the NRC Canada
2. **Scale-up Production of Nanoparticles**
3. **Run Toxicology & ADME Studies** on Chronic Pain MEM™
   - Toxicology on clinical prototypes
   - ADME Studies = Absorption, Distribution, Metabolism and Excretion
4. **Engage CRO** for First-in-Human Clinical Trial
   - Write & File pre-IND
   - Run First-in-Human Trial
5. **File pre-IND Application** with US FDA
6. **Pre-IND Meeting** with the US FDA
7. **First-in-Human Clinical Trial**

Gb Sciences' Research Articles

Cannabinoids and Terpenes for Chronic Pain through TRP Channel Desensitization

- El-Hammadi MM, Small-Howard AL, Jansen C, Fernández-Arévalo M, Turner H, Martín-Banderas L. Potential use for chronic pain: Poly(Ethylene Glycol)-Poly(Lactic-Co-Glycolic Acid) nanoparticles enhance the effects of Cannabis-Based terpenes on calcium influx in TRPV1-Expressing cells. *Int J Pharm*. 2022 Jan 30;616:121524. doi: 10.1016/j.ijpharm.2022.121524. Epub ahead of print. PMID: 35104595.2.
- El-Hammadi M, Small-Howard A, Fernández-Arévalo M, Martín-Banderas L. Development of enhanced drug delivery vehicles for three cannabis-based terpenes using poly(lactic-co-glycolic acid) based nanoparticles. *Industrial Crops and Products*. 2021:164. 113345. 10.1016/j.indcrop.2021.113345.
- Jansen C, Shimoda LMN, Kawakami JK, Ang L, Bacani AJ, Baker JD, Badowski C, Speck M, Stokes AJ, Small-Howard AL, Turner H. Myrcene and terpene regulation of TRPV1. *Channels* (Austin). 2019 Dec;13(1):344-366. doi: 10.1080/19336950.2019.1654347. PMID: 31446830; PMCID: PMC6768052.
- Starkus J, Jansen C, Shimoda LMN, Stokes AJ, Small-Howard AL, Turner H. Diverse TRPV1 responses to cannabinoids. Channels (Austin). 2019 Dec;13(1):172-191. doi: 10.1080/19336950.2019.1619436. PMID: 31096838; PMCID: PMC6557596.

COVID-related Cytokine Release Syndrome

Minimum Essential Mixtures (MEM™) Reduced Viral-Induced Hyper-Inflammation

Overview

Co-Culture Human Immune Cells

4 Treatment Groups

- Untreated (no inflammatory stimulus)
- Inflammatory Stimulus (viral-CpG or bacterial-LPS)
- Positive Control=Inflammatory Stimulus + vehicle
- MEM™ + Inflammatory Stimulus

Measure Cytokine & Inflammatory Markers

All 24 MEM™ achieved Statistical Significance

Clinical Categories Created for Development

Overview of COVID-related CRS Results

All 24 MEM™ achieved Statistically Significant Immunomodulation

- **8 MEM™ = 'Selective' Anti-Inflammatory Drugs**
  - ✓ **7 MEM™ = Decreased key COVID-19 related cytokines & preserved anti-viral immune responses**
  - ✓ **1 MEM™ = Reduced Pro-Inflammatory Mediators from a Single Immune Cell Type**
- **16 MEM™ = 'Broad-Spectrum' Anti-Inflammatory Drugs**
  - ✓ **Unmet need for novel, plant-inspired, anti-inflammatory drugs**
  - ✓ **One sub-category shows promise for chronic inflammatory conditions**

Next Steps & Milestones

1. **API integrated into Delivery Mode** for Cytokine Release Syndrome Therapeutics
   - Hire a Contract Manufacturing-CMO
   - Create Chemistry Manufacturing and Controls (CMC) file
2. **Run Toxicology & ADME Studies** on CRS.MEM formulas
   - Toxicology on COVID-CRS clinical prototypes
   - ADME Studies = Absorption, Distribution, Metabolism and Excretion
3. **Engage CRO** for First-in-Human Clinical Trial
   - Write & File pre-IND
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Gb Sciences' Research Articles

Cannabinoids and Terpenes for Selective Anti-inflammatory Therapies

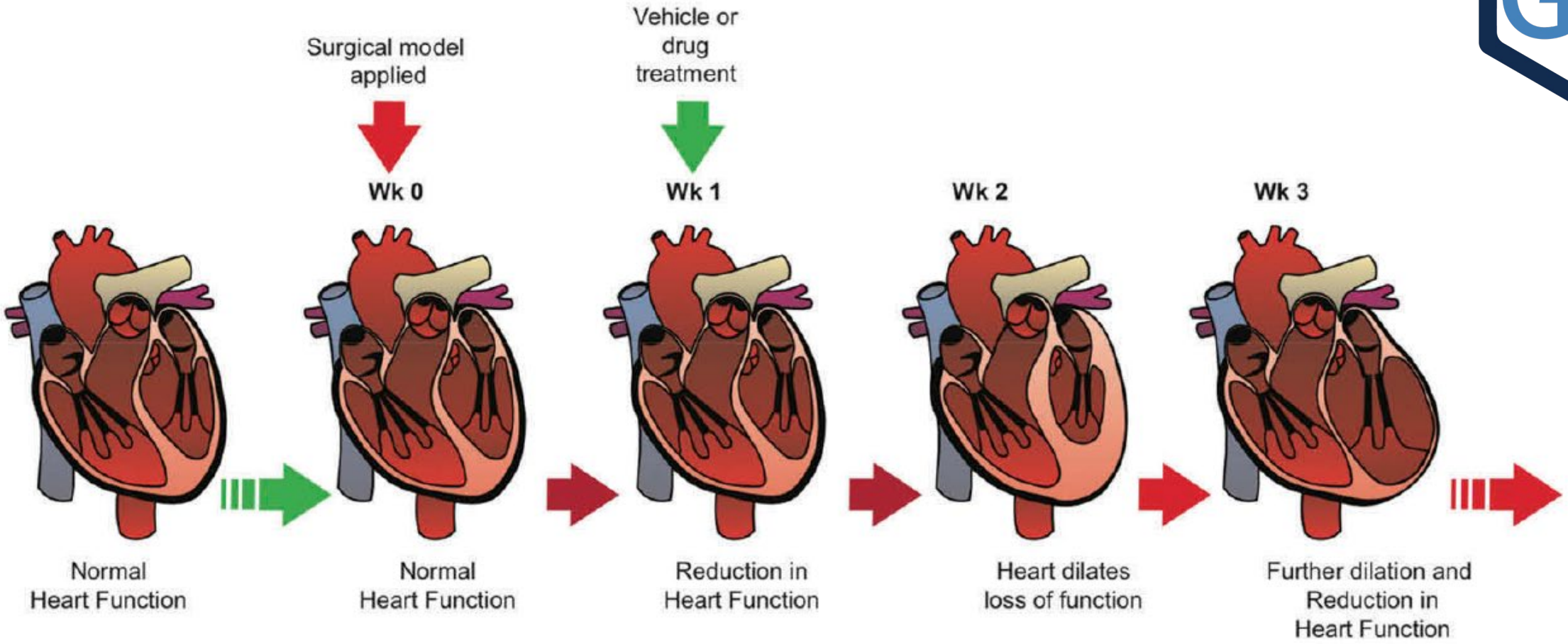
- Blevins, LK, Bach, AP, Crawford, RB, Zhou, J, Henriquez, JE, Rizzo, MD, Sermet, S, Khan, IO, Turner, H, Small-Howard, AL, Kaminski NE. Evaluation of the anti-inflammatory effects of selected cannabinoids and terpenes from Cannabis Sativa L employing human primary leukocytes. In preparation for submission to the journal *Cannabis and Cannabinoid Research*.
- Gonzalez A, Turner H, Crawford RB, Blevins, LK, Bach, AP, Kaminski NE, Stokes, AJ, Small-Howard AL. Selective Immunomodulatory Potential of Different Cannabinoid-Containing Mixtures Evaluated in a Co-Cultured, Human Primary Leukocyte Model. In preparation for submission to the *Journal of Cannabis Research*.

GbSciences' Heart Therapies

Cardiovascular Program Strategy

- **TRV1 Modulation Prevents/Treats Cardiac Hypertrophy in Rodent Models**
- **Cannabinoids & Terpenes Modulate TRPV1**
  - Screened Cannabis-based Ligands for TRPV1 Activity
  - Validated using Electrophysiology Experiments
- **Minimum Essential Mixtures Modulate TRPV1**
  - Confirmed in Cell Models
  - Animal Proof-of-Concept (on-going)
- **Patent Protection Issued**
  - Two Issued US & 2 Issued Foreign Patents Licensed by Gb Sciences for TRPV1-based Prevention & Treatment of Cardiac Hypertrophy
  - US Patent Issued for Cannabinoid-based Mixture for TRPV1-mediated Heart Disease Prevention & Treatment

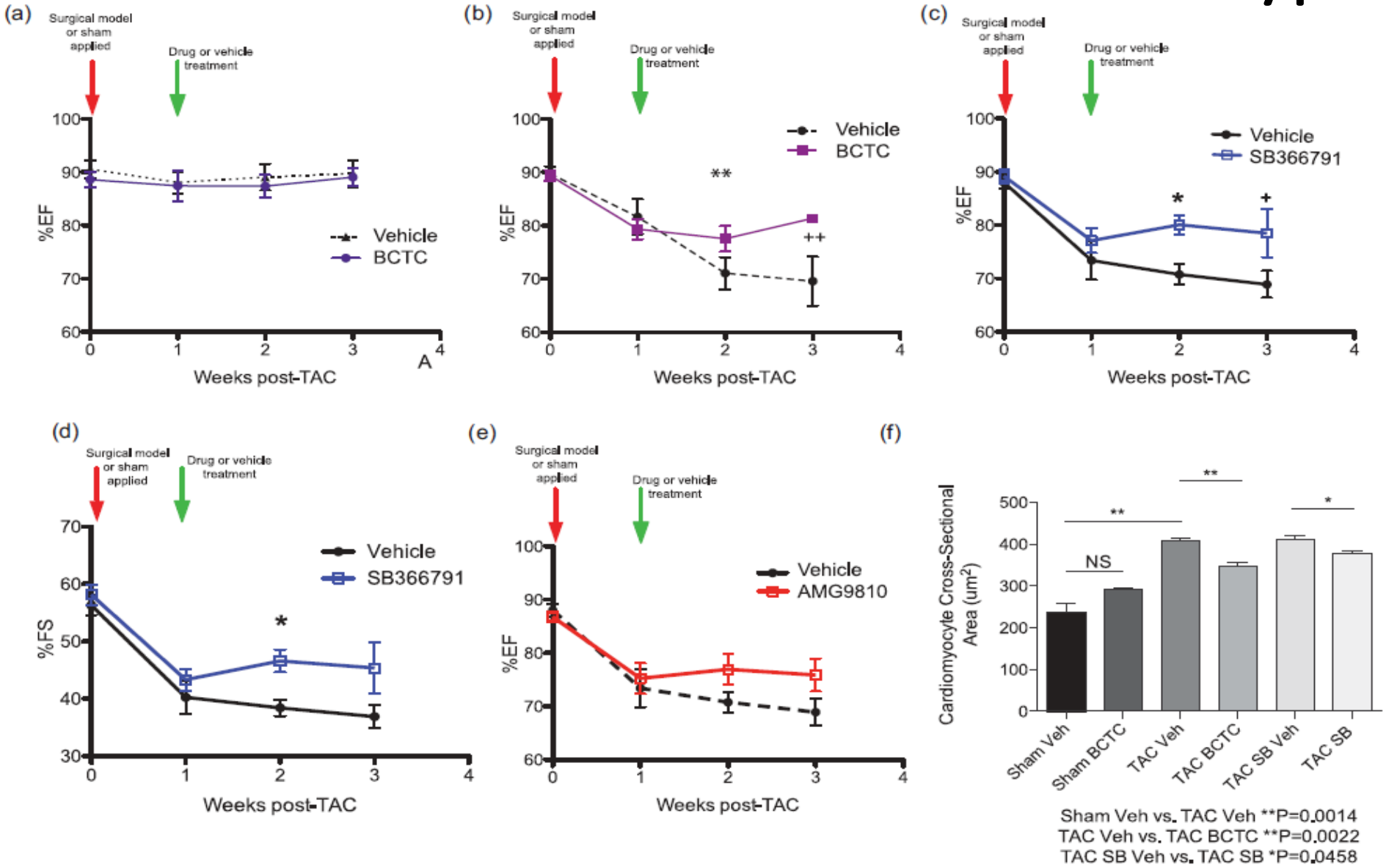
Rodent Model: TRPV1 Proof of Concept Data



Schematic Timeline of *in vivo* Hypertrophic Reversal Experimental Design in TAC Induced Pressure Overload Mouse Model

Horton JS, Shiraishi T, Alfulaij N, Small-Howard AL, Turner HC, Kurokawa T, Mori Y, Stokes AJ. TRPV1 is a component of the atrial natriuretic signaling complex, and using orally delivered antagonists, presents a valid therapeutic target in the longitudinal reversal and treatment of cardiac hypertrophy and heart failure. *Channels* (Austin). 2019 Dec;13(1):1-16. doi: 10.1080/19336950.2018.1547611. PMID: 30424709; PMCID: PMC6298697.

TRPV1-Modulation Reduced Cardiac Hypertrophy



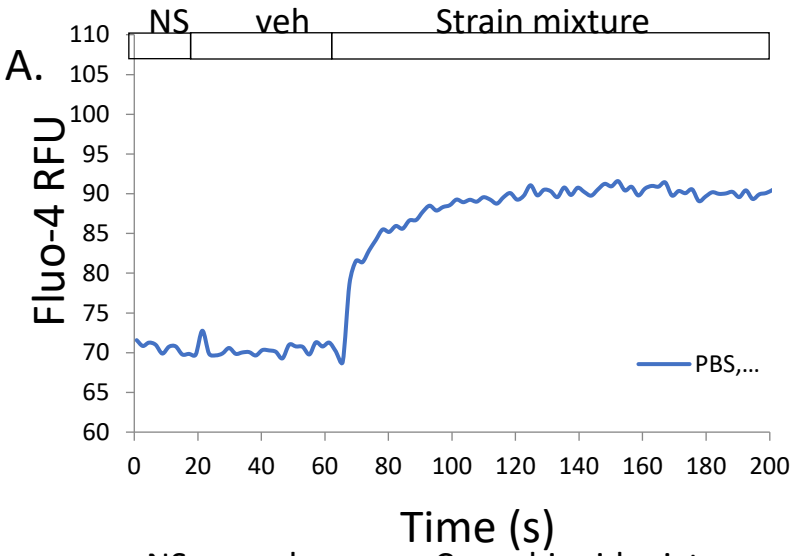
In the TAC induced pressure overload model, TRPV1 modulation significantly reduced cardiac hypertrophy and improved functionality. (%EF is %Ejection Fraction, %FS is %Fraction Shortening)

Horton JS, Shiraishi T, Alfulaij N, Small-Howard AL, Turner HC, Kurokawa T, Mori Y, Stokes AJ. TRPV1 is a component of the atrial natriuretic signaling complex, and using orally delivered antagonists, presents a valid therapeutic target in the longitudinal reversal and treatment of cardiac hypertrophy and heart failure. *Channels* (Austin). 2019 Dec;13(1):1-16. doi: 10.1080/19336950.2018.1547611. PMID: 30424709; PMCID: PMC6298697.

Plant-Inspired Mixtures Activate TRPV1

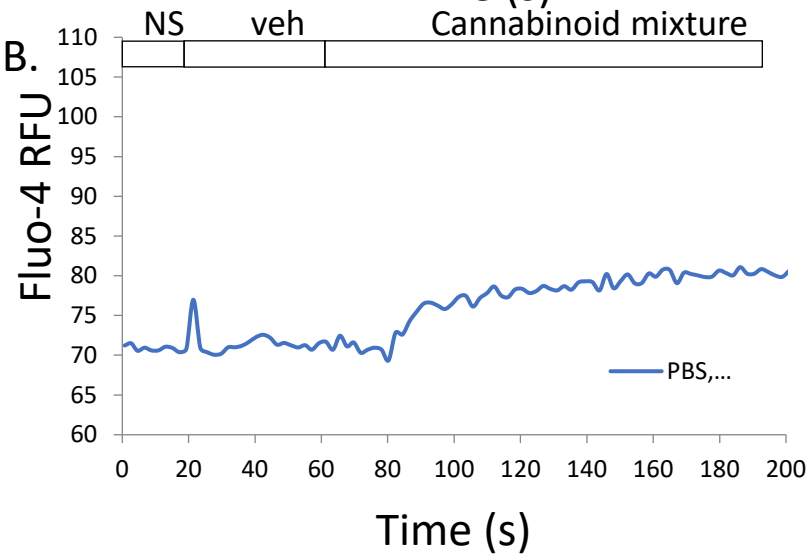
Jansen C, Shimoda LMN, Kawakami JK, Ang L, Bacani AJ, Baker JD, Badowski C, Speck M, Stokes AJ, Small-Howard AL, Turner H. Myrcene and terpene regulation of TRPV1. *Channels* (Austin). 2019 Dec;13(1):344-366. doi: 10.1080/19336950.2019.1654347. PMID: 31446830; PMCID: PMC6768052.

A.

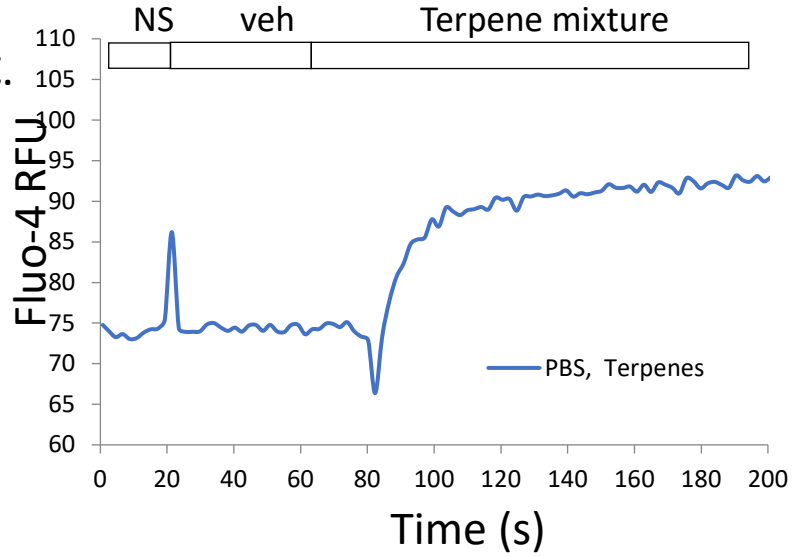


Terpenes contribute significantly to calcium fluxes via TRPV1 induced by Cannabis-equivalent mixtures. a. HEK-TRPV1 differentiate TRPV1-dependent calcium responses. HEK WT and HEK-TRPV1 were loaded with Fluo-4 and population-based calcium assays were conducted in the presence of 1mM external calcium. After a non-stimulated (NS) period, HEK-TRPV1 were exposed to a matched vehicle mixture (veh) or the indicated mixtures of cannabinoids plus terpenes (Strain mixture}, cannabinoids, or terpenes, as indicated.

B.



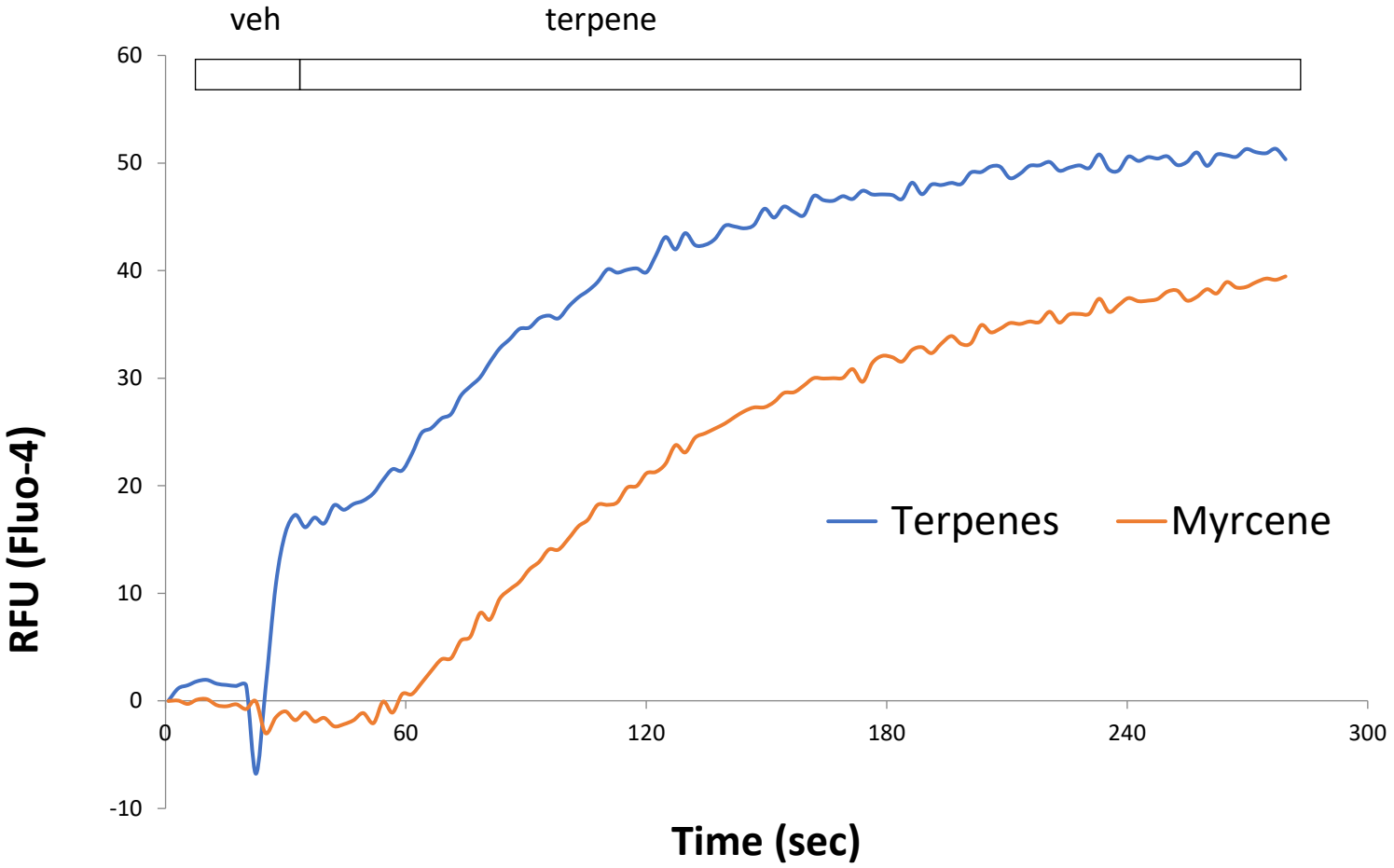
C.



Chaminade University

Significant Activation of TRPV1 by Myrcene

Jansen C, Shimoda LMN, Kawakami JK, Ang L, Bacani AJ, Baker JD, Badowski C, Speck M, Stokes AJ, Small-Howard AL, Turner H. Myrcene and terpene regulation of TRPV1. *Channels* (Austin). 2019 Dec;13(1):344-366. doi: 10.1080/19336950.2019.1654347. PMID: 31446830; PMCID: PMC6768052.



While beta-myrcene alone does not account for all of the TRPV1 activation from the terpene fraction, beta-myrcene activation of TRPV1 is significant. The HEK-TRPV1 were loaded with Fluo-4 and population-based calcium assays were conducted in the presence of 1mM external calcium. After a matched vehicle exposure (veh) period to establish a baseline, cells were stimulated at 20 s with all the indicated terpenes at 10 μM or beta-myrcene only at 10 μM.

Chaminade University

Next Steps & Milestones

1. **API integrated into Delivery Mode**
   - Hire a Contract Manufacturing-CMO
   - Create Chemistry Manufacturing and Controls (CMC) file
2. **Run Toxicology & ADME Studies** on CRS.MEM formulas
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Gb Sciences' Research Articles

Cannabinoids and Terpenes for the Prevention and Treatment of Heart Disease

- Alfulaij N, Meiners F, Michalek J, Small-Howard AL, Turner HC, Stokes AJ. Cannabinoids, the Heart of the Matter. *J Am Heart Assoc.* 2018 Jul 13;7(14) PubMed PMID: 30006489; PubMed Central PMCID: PMC6064852.
- Jansen C, Shimoda LMN, Kawakami JK, Ang L, Bacani AJ, Baker JD, Badowski C, Speck M, Stokes AJ, Small-Howard AL, Turner H. Myrcene and terpene regulation of TRPV1. *Channels* (Austin). 2019 Dec;13(1):344-366. doi: 10.1080/19336950.2019.1654347. PMID: 31446830; PMCID: PMC6768052.
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TRPV1 Modulation for the Prevention and Treatment of Heart Disease

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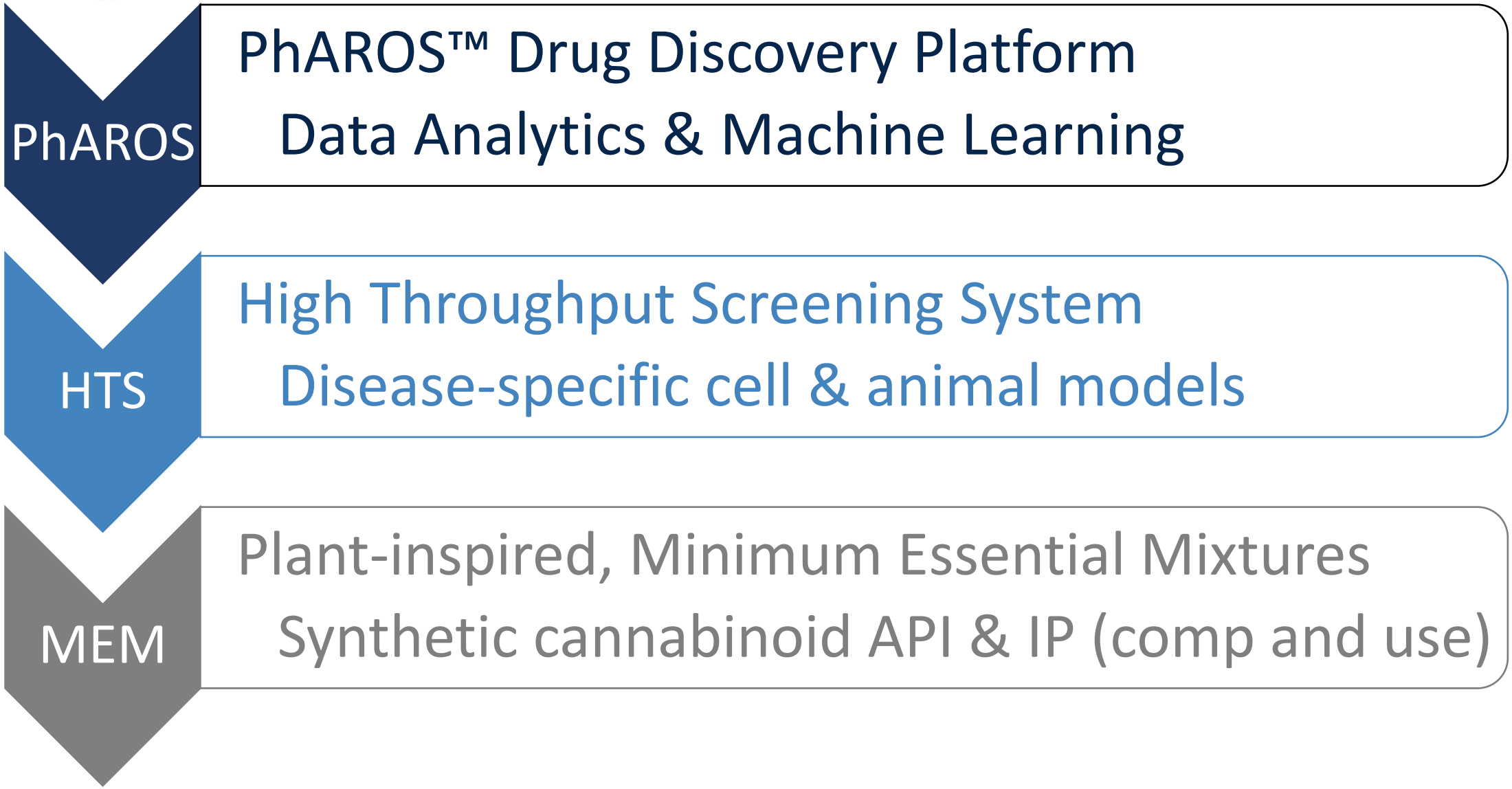
- Buckley CL, Stokes AJ. Mice lacking functional TRPV1 are protected from pressure overload cardiac hypertrophy. Channels (Austin). 2011 Jul-Aug;5(4):367-74. doi: 10.4161/chan.5.4.17083. Epub 2011 Jul 1. PMID: 21814047; PMCID: PMC3225734.
- Horton JS, Buckley CL, Stokes AJ. Successful TRPV1 antagonist treatment for cardiac hypertrophy and heart failure in mice. Channels (Austin). 2013 Jan 1;7(1):17-22. doi: 10.4161/chan.23006. Epub 2012 Dec 6. PMID: 23221478; PMCID: PMC3589277.

Research & Development Advantages

GbSciences' Research & Development Partners

GbSciences' Drug Discovery Process



PhAROS™ Drug Discovery Platform

Phytomedical Analytics for Research Optimization at Scale

- Proprietary plant-based Rx therapies based on traditional medicine systems
- Minimum Essential Mixtures
- Pre-validates efficacy of drug-target-indication relationships
- “Transcultural Medicines” = ingredients not constrained by geography or culture
- De-risked as Rx therapies
- Multiple Uses: Novel Rx & Global Health Initiatives

Jansen C, Baker JD, Kodaira E, Ang L, Bacani AJ, Aldan JT, Shimoda LMN, Salameh M, Small-Howard AL, Stokes AJ, Turner H, Adra CN. Medicine in motion: Opportunities, challenges and data analytics-based solutions for traditional medicine integration into western medical practice. *J Ethnopharmacol.* 2021 Mar 1;267:113477. doi: 10.1016/j.jep.2020.113477. Epub 2020 Oct 21. PMID: 33098971; PMCID: PMC7577282.

Gb Sciences' Research Articles

Proprietary Drug Discovery Platform: PhAROS™

- Jansen C, Baker JD, Kodaira E, Ang L, Bacani AJ, Aldan JT, Shimoda LMN, Salameh M, Small-Howard AL, Stokes AJ, Turner H, Adra CN. Medicine in motion: Opportunities, challenges and data analytics-based solutions for traditional medicine integration into western medical practice. *J Ethnopharmacol.* 2021 Mar 1;267:113477. doi: 10.1016/j.jep.2020.113477. Epub 2020 Oct 21. PMID: 33098971; PMCID: PMC7577282.

Cannabinoids and Terpenes in Natural Cannabis Plant Extracts

- Reimann-Philipp U, Speck M, Orser C, Johnson S, Hilyard A, Turner H, Stokes AJ, Small-Howard AL. Cannabis Chemovar Nomenclature Misrepresents Chemical and Genetic Diversity; Survey of Variations in Chemical Profiles and Genetic Markers in Nevada Medical Cannabis Samples. *Cannabis and Cannabinoid Research*. 2019 March; 3.

GB Sciences' Scientific Advisory Board

ANDREA SMALL-HOWARD, PHD, MBA

Chairman of the Scientific Advisory Board, Chief Science Officer and President of GB Sciences/GBS Global Biopharma

Dr. Andrea Small-Howard has more than 20 years of scientific research experience; as well as executive experience in the biopharmaceutical industry supervising research & development, manufacturing, and quality control divisions in the US and China.

DR. HELEN TURNER

VP Innovation, Professor of Natural Sciences & Mathematics at Chaminade University

Helen Turner is Vice President of Innovation and Dean of the Division of Natural Sciences and Mathematics at Chaminade University in Honolulu, Hawaii.

DR. NORBERT E. KAMINSKI

Professor, Department of Pharmacology & Toxicology, MSU

Dr. Norbert E. Kaminski is a Professor in the Department of Pharmacology and Toxicology and is the Director of the Institute for Integrative Toxicology, at MSU.

GbSciences' Scientific Advisory Board

DR. CARLOS F. RIOS-BEDOYA

Corporate Director of Scholarly Inquiry at McLaren Health

Dr. Carlos is the Corporate Director of Scholarly Inquiry at McLaren Health overseeing research across 13 health care facilities with over 30 residency programs in Michigan.

DR. ZOLTAN MARI

Director of the Parkinson's Disease and Movement Disorders Program and The Ruvo Family Chair, Cleveland Clinic Lou Ruvo Center for Brain Health in Las Vegas, NV

Dr. Zoltan Mari graduated first in his medical school class in Hungary before completing a post-doctoral fellowship in SUNY Downstate (Brooklyn, NY) on Parkinson disease (PD) animal models and electrophysiology.

DR. ALEXANDER STOKES

Assoc. Professor at the University of Hawaii in the John A Burns School of Medicine's Center for Cardiovascular Research, Founder, Makai Biotechnology, LLC

Dr. Alex Stokes has an impeccable pedigree from a twenty-five career in research and development. He has an excellent track record of cutting-edge research.

Gb Sciences' Intellectual Property Assets

PhAROS™ Platform for Plant-Inspired Formulations

Plant-Inspired, Minimum Essential Mixtures-MEM™

- Novel MEM™ composed of natural or synthetic homologs of plant-derived ingredients
- Composition of Matter and Field of Use Claims
- Combinations of Novel Formulas and Delivery

Current Portfolio (USPTO & WIPO/PCT)

- Patents Issued: 6 US & 3 Foreign
- Patent-Pending Applications: 18 US & 49 Foreign

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