

Axcelead Global Webinar #1

– Driving innovative drug discovery through integrated high-throughput screening platform –

August 17, 2022
4pm /PT, 7PM/ET

Axcelead Drug Discovery Partners, Inc.

Agenda

1. Company Overview

Speaker: Yoshinori Ikeura, PhD
CEO, Axcelead Drug Discovery Partners, Inc.



2. Driving innovative drug discovery through integrated high-throughput screening platform

Speaker: Tomohiro Kawamoto, PhD
Senior Director of Discovery Biology,
Axcelead Drug Discovery Partners, Inc.



Company Overview

Yoshinori Ikeura, PhD
Axcelead Drug Discovery Partners Inc.
August 17, 2022

We are Solution Provider in the drug discovery space from Japan

General information

- // Established in 2017 as Takeda spin-out company and became a fully independent company on April 1, 2019
- // Number of employee: 270 (as of July 2022)
- // Location: Shonan Health Innovation Park (Former Takeda Shonan Research Center)
- // Contract more than 170 organizations (as of July, 2022)



CEO: Yoshinori Ikeura, Ph.D

Axcelead Drug Discovery Partners

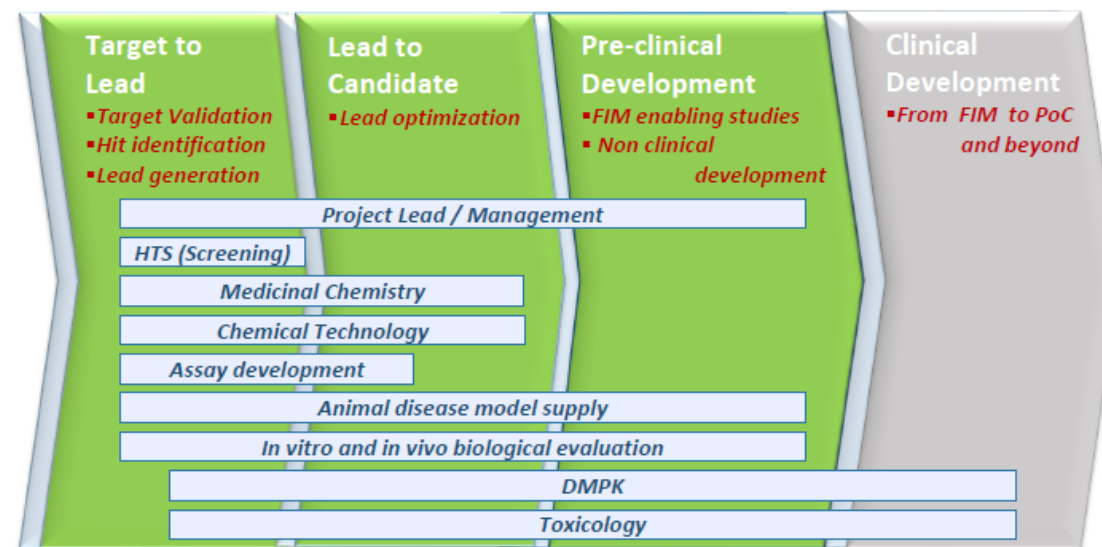
Highlight of Axcelead

- // The spin-out of Takeda Pre-Clinical R&D capability, inheriting its unique and proprietary drug discovery platform, "People", "Infrastructure" and "Legacy Data"

Scientific leadership team



- // Full Capabilities for small molecule & peptide drug discovery: from early stage exploration studies to optimization of candidate and even a bridge process to clinical development.



- // Partnership for new technologies and strong relationship with Japanese government

New modalities and technology

FUJIFILM/ FCDI
iPS cell

PassPort TECHNOLOGIES
Transdermal drug delivery

FRONTEO
AI

LAP&P
PKPD modelling & simulation

Schrödinger
Computed chemistry

SPERA PHARMA
CMC

創晶 SOSHO
Crystallization of protein

T-CiRA
iPS cell, regenerative medicine

ERS GENOMICS
Transgenic animals/cell

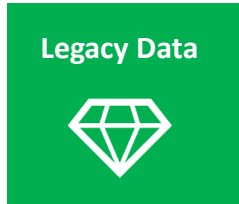
Croit
All japan library

PhoenixBio
Chimeric mouse w/ humanized liver

Japanese government & bio industry

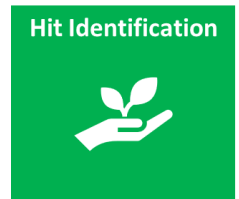
- Japan Agency for Medical Research and Development (AMED)
- Pharmaceuticals and Medical Devices Agency (PMDA)
- Japan Pharmaceutical Manufacturers Association
- Japan Bioindustry Association etc

Our strength is to generate the candidate



Legacy Data

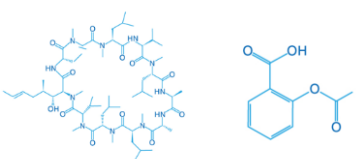
Jump start utilizing Takeda legacy data



Hit Identification

Hit compounds identified by our HTS capability

Customers' seeds



One site, fully integrated

	Lead generation	Lead optimization	Candidate Selection
Screening	In vitro evaluation	In vitro evaluation	
Chemistry	Design and Synthesis	Design and Synthesis	non-GxP bulk. (API synthetic route)
Biology	In vitro Pharmacology	In vivo PD	Efficacy in disease model
DMPK	HT-ADME	HT-ADME PK/PD	Human PK. PK/PD
Safety	In vitro toxicology	In vitro toxicology. In vivo toxicodynamics.	In vivo toxicology

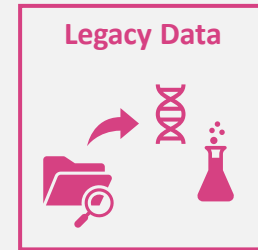
Integrated Drug Discovery capability inheriting from Takeda Pharmaceuticals



Pharma Scientists



Knowledge Experience



Legacy Data



Target Identification/Validation

Biology platform:

- Omics
- Bioinformatics (single cell/single nucleus analysis etc)
- Histopathology (Visium, mIHC etc)
- KO/KI animals
- Pharmacology etc

Candidate Selection



IND enabling study

GLP tox study, DMPK

- 100+ IND 20+ NDA
- Network with PMDA/FDA

IND

Axcelead Global Webinar #1

Driving innovative drug discovery
through integrated high-throughput
screening platform

Tomohiro Kawamoto, PhD

Axcelead Drug Discovery Partners Inc.

August 17, 2022

- ◆ Key factors for hit identification
 - High quality and diverse library
 - Hit identification platform
- ◆ Approach to drugging unknown targets
 - Phenotypic screening using iPS cells
 - Target deconvolution
- ◆ Capabilities on drugging undruggable targets
 - Targeted protein degradation
 - RNA targeted drugs

◆ Key factors for hit identification

- High quality and diverse library
- Hit identification platform

◆ Approach to drugging unknown targets

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◆ Capabilities on drugging undruggable targets

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- RNA targeted drugs



Key Factors for Hit Identification



- Diversity
- Druglikeness
- Size (>1.0 million)
- Design, Synthesis, Purchase

- Quality, Speed, Cost
- Throughput
- Robustness
- Disease relevancy
- Phenotypic rule of three (Cell X Stimulant X Readout)
- Profiling
- Data analysis

- Robotics
- Plate readers
- Dispensers
- Systems
- Maintenance

- Knowledge, Skill, Experience
- Expertise
- Strategy planning
- Problem solving ability
- Reliability
- Communication
- Collaboration

➤ ***Axcelead provides comprehensive hit identification services through our integrated platform***

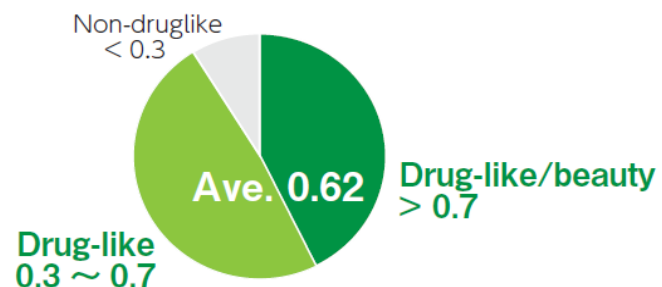
Axcelead Compound Library

>1,500,000
Compounds

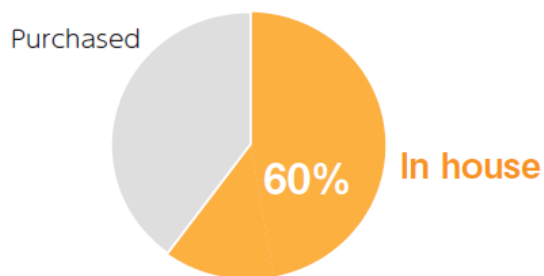
Quality

Lead likeness

QED: Quantitative Estimate of Drug-likeness



In-house compounds



Library sets for HTS

■ Diversity libraries

- Single library 129,000 compounds
- Pooled library 500,000 compounds (Standard 320,000 cpds)

■ Focused libraries 41,000 compounds

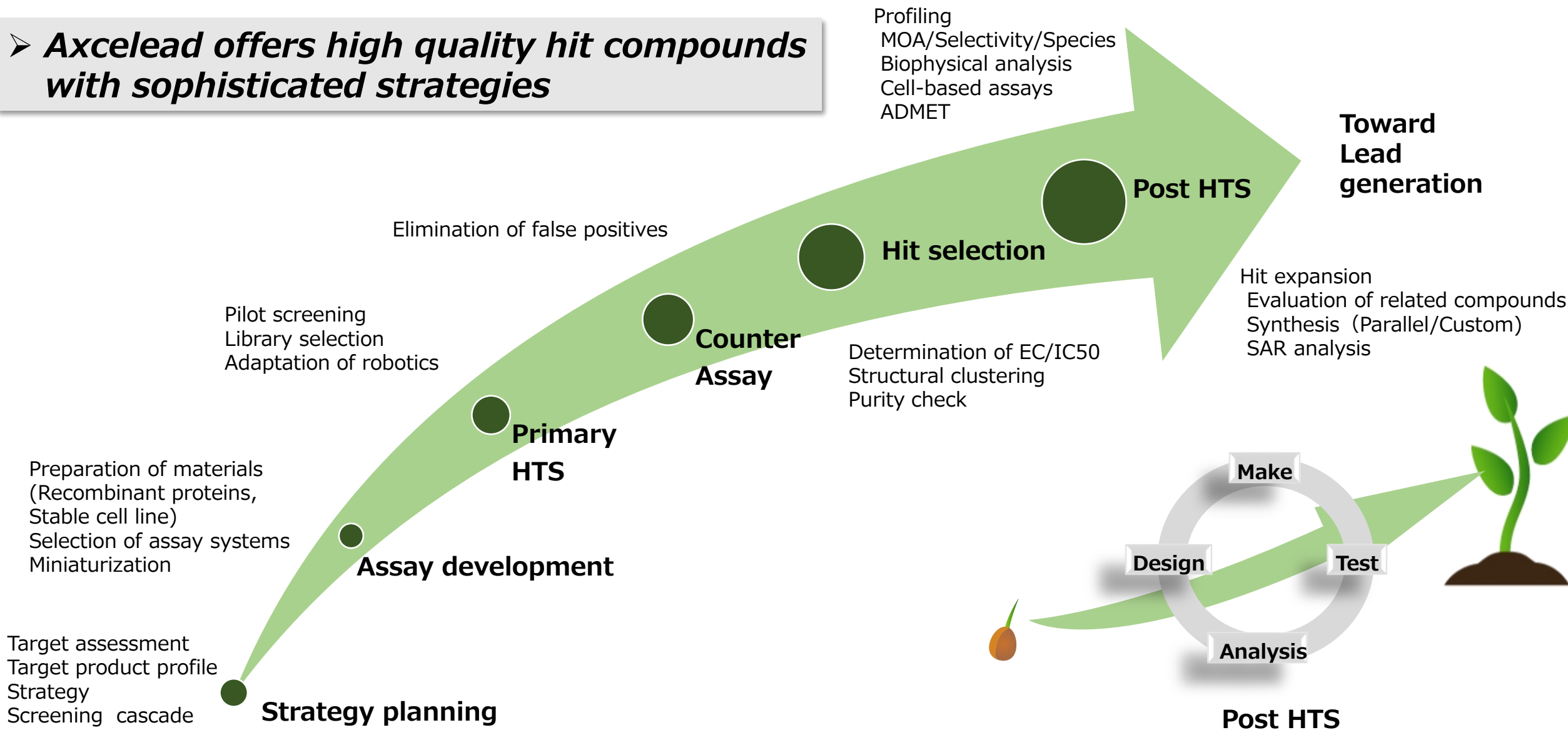
- Libraries for target classes (Kinase, GPCR, Protease, PPI, etc.)
- Macrocyclic
- RNA
- Covalent
- Extended rule of 5
- Natural product
- Annotation



- Biologically annotated library is available for phenotypic screening
- We are also able to construct a focused library selected from 1.5 million compounds library by virtual screen

Hit Identification in Axcelead

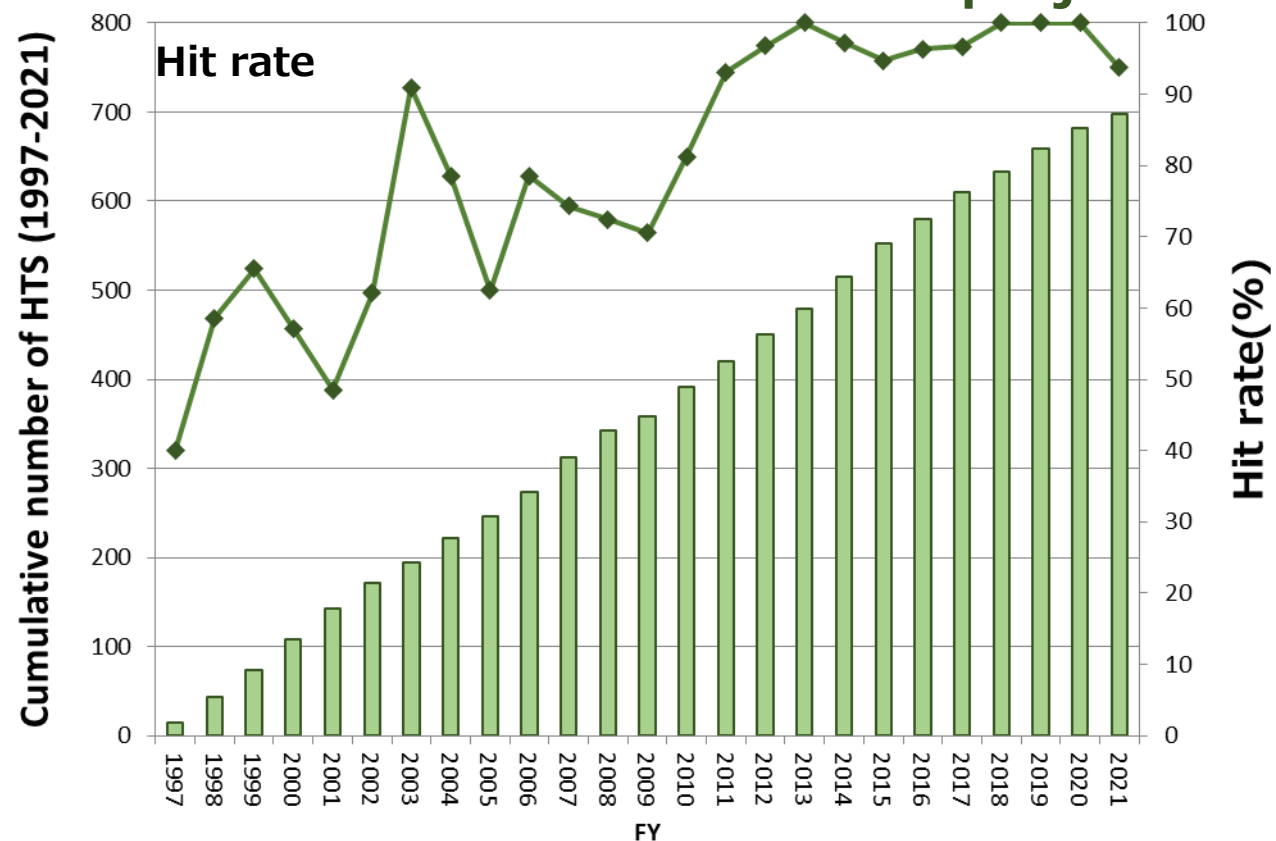
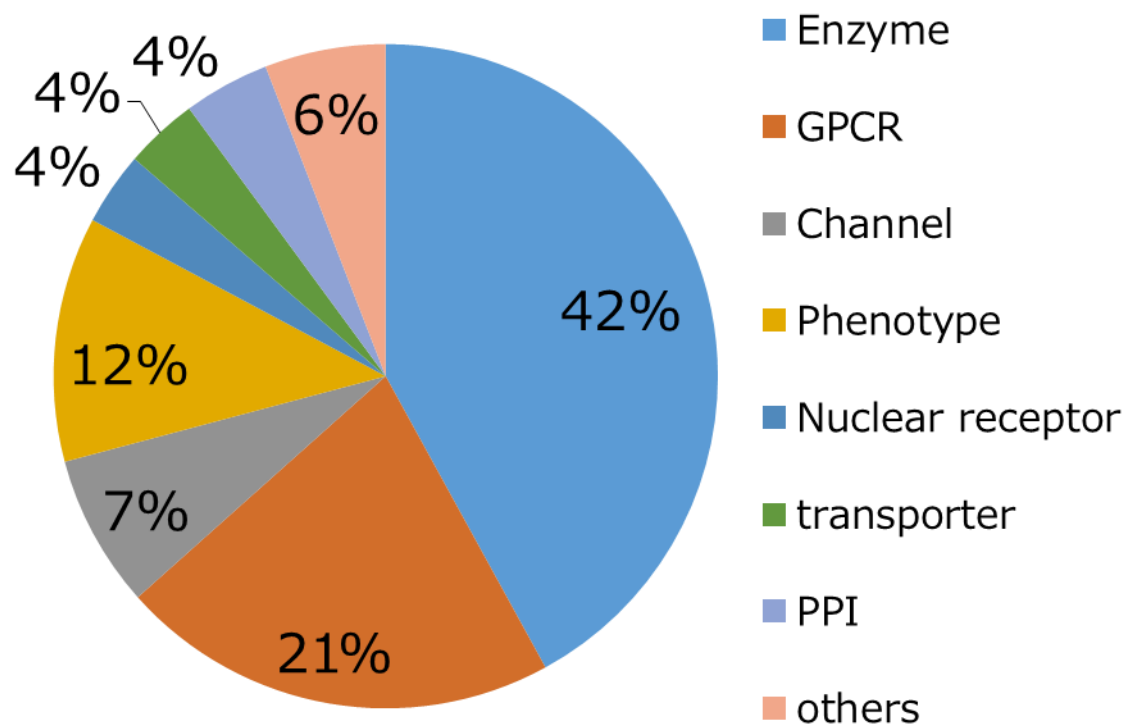
➤ **Axcelead offers high quality hit compounds with sophisticated strategies**



Track Record of HTS Campaigns

698
projects

Target class

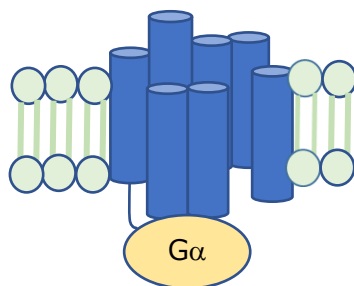


➤ **We have successfully completed around 700 HTS campaigns for various target classes with high hit rates**

Target-based Assay Platform

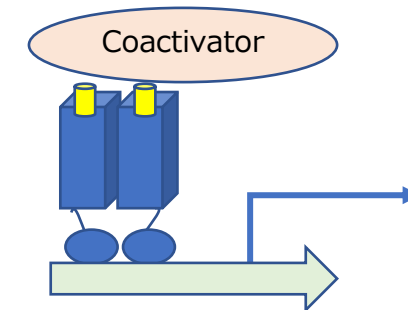
GPCR

cAMP assay
Ca²⁺ flux assay
Reporter gene assay
Arrestin/Internalization assays
Binding assay
Impedance assay



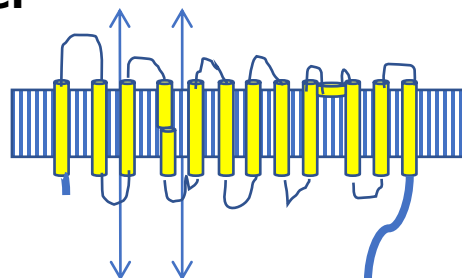
Nuclear receptor

Binding assay
Cofactor recruitment assay
Reporter gene assay
Nuclear translocation assay



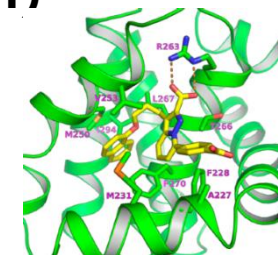
Ion channel / Transporter

Ion influx assay
Membrane potential
Electrophysiology
Substrate uptake
Binding



PPI (protein-protein interaction)

TR-FRET/Alpha screen assay
ELISA
NanoBit/BRET
Two-hybrid assay
Biophysical assay



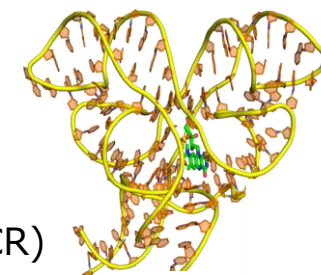
J Med Chem **56** 9635–45 (2013)

Enzyme

Luminescence, Absorbance, Fluorescence, TR-FRET
Alphascreen, ELISA
Radiometric assay
Label-free assay (e.g. Rapidfire-MS)
Coupling assay
Global kinase panel

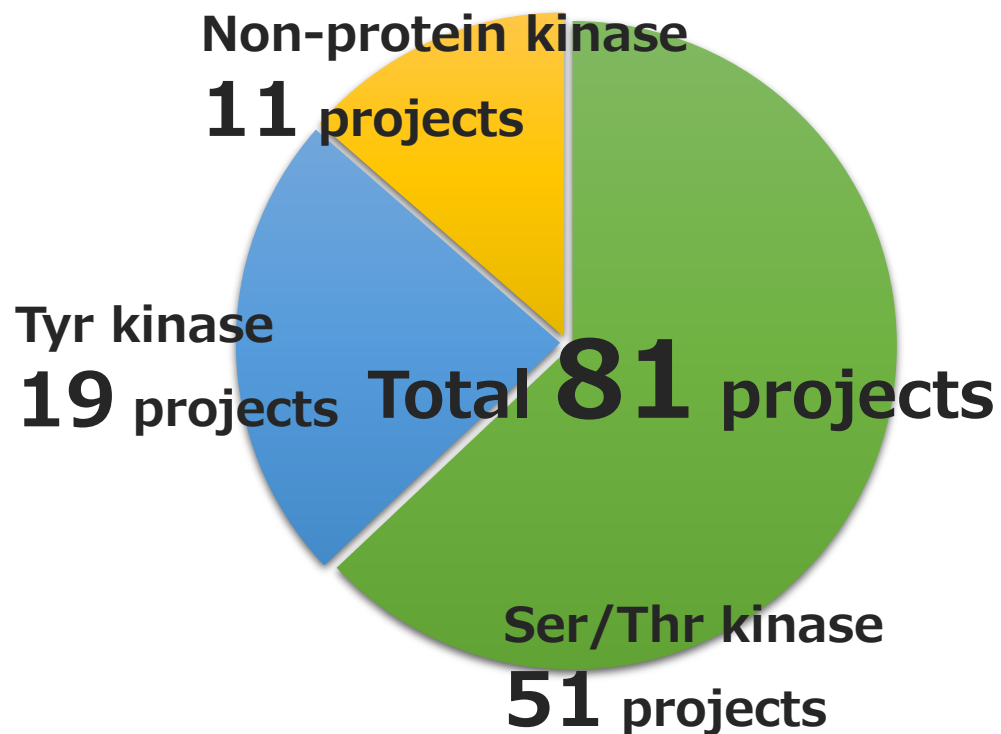
Nucleic acid

Biophysical assay (e.g. ASMS)
Fluorescence probe binding
FRET
Cell-based assay (Reporter gene, RT-qPCR)



Kinase Platform

Kinase HTS track records



Full range of assay/HTS platform

Assay / HTS

- Enzyme activity assay (TR-FRET, Glo, Radiometric isotope, RapidFire-MS)
- Binding assay (Kinase tracer, AS-MS)

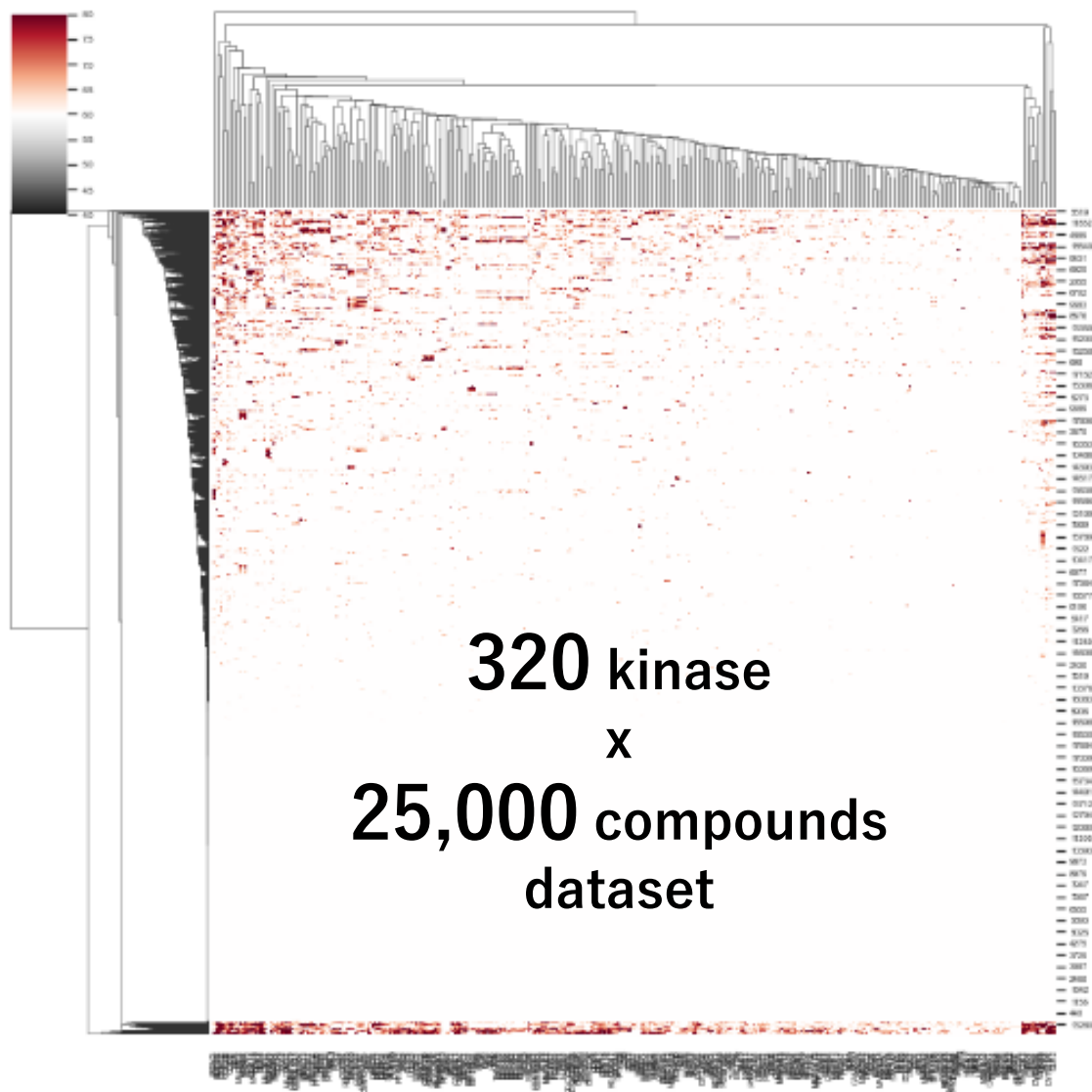
Profiling

- Internal Kinase Panel assay
- Molecular MoA analysis
 - Binding kinetics analysis
 - Substrate competition
- Cell-based assay

Biophysics

- SPR, ITC, TSA
- Crystal structure analysis

Original Selective Kinase inhibitors



A-SKIP (Axcelead Selective Kinase Inhibitor Profiler) for > **120** kinases

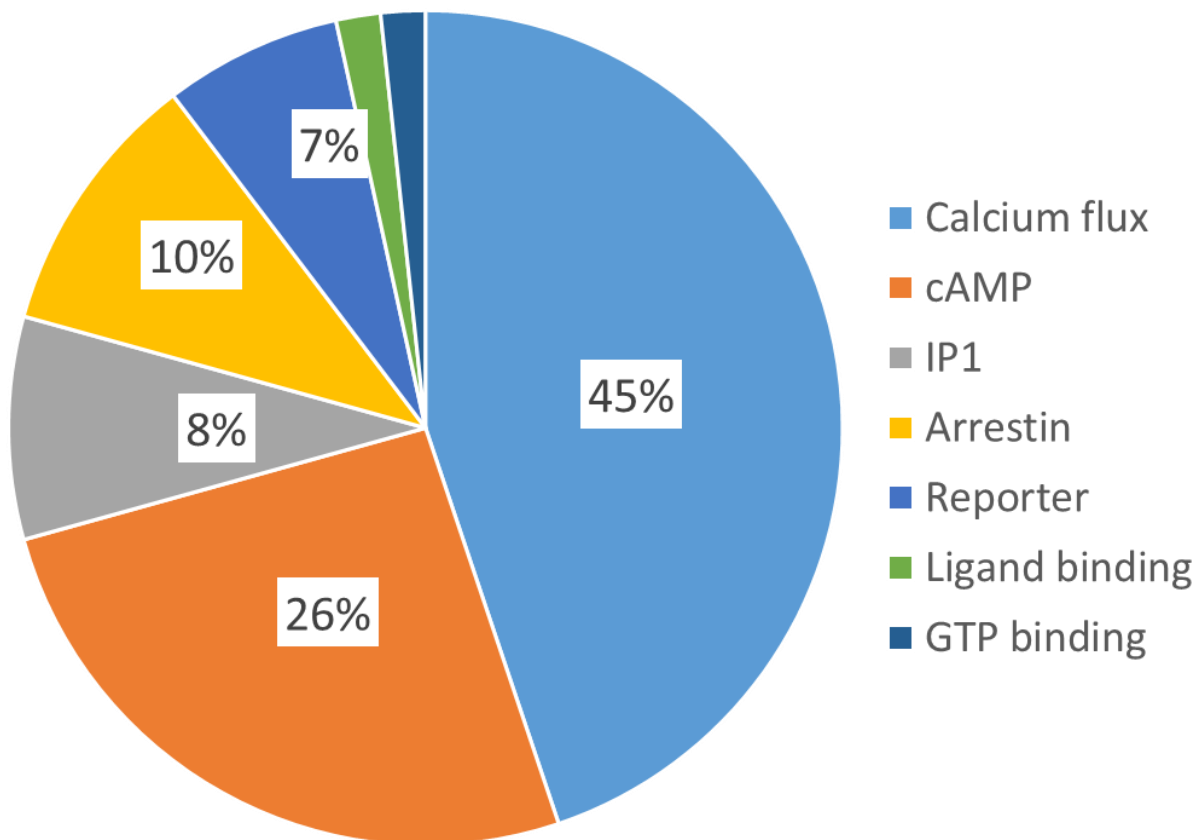
- *Axcelead has original selective kinase inhibitors (A-SKIP) through our global kinase panel consisting of >300 kinases.*
- *We can accelerate your drug discovery with our assets as an integrated drug discovery service*

***A-SKIP criteria**

- **Selectivity Score ≤ 5% (>300 kinase)**
- **highest pIC₅₀ ≥ 7.5**
- **Num of (pIC₅₀ ≥ 7.5) ≤ 4**

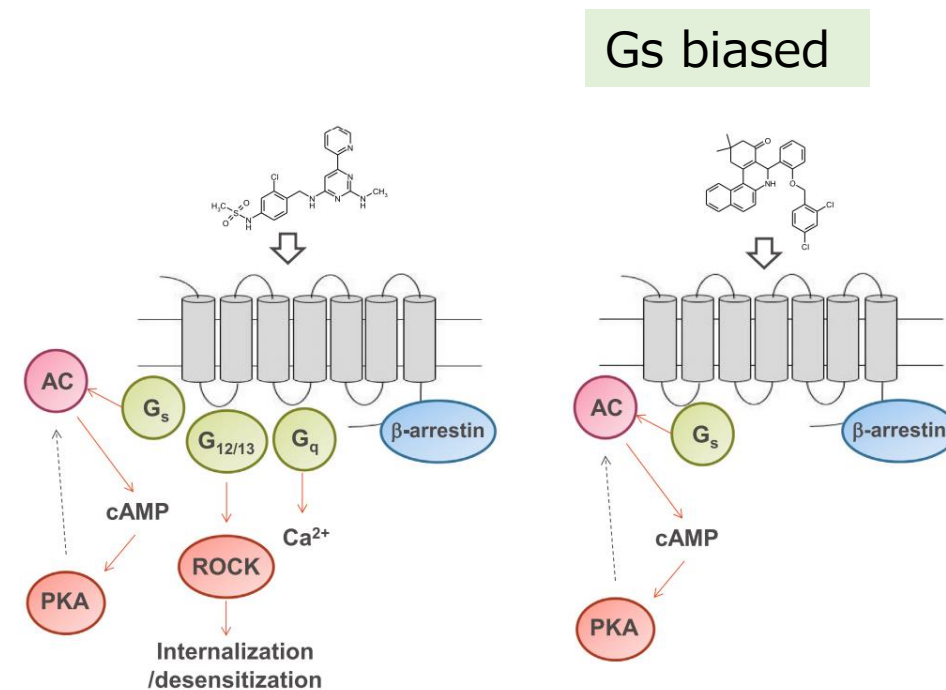
Discovery of GPCR Biased Ligands

Track record of primary assays in HTS campaign targeting GPCRs



GPR39 positive allosteric modulators

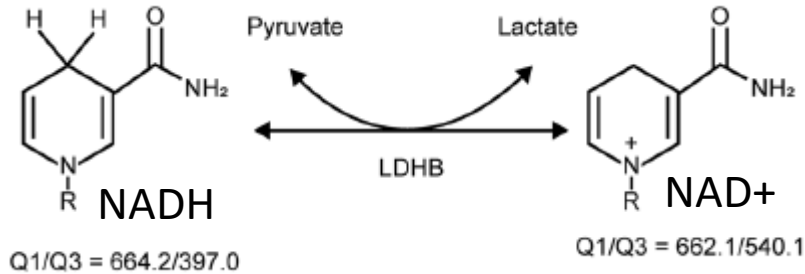
Library: >600,000 cpds at 3 μ M
Primary assay: FRET (cAMP), PAM mode



Biochemical Pharmacology 140 (2017) 105–114

Discovery of Enzyme Inhibitors using Rapidfire-MS

LDHB



HTS cascade

Primary screening (ca. 370,000 compounds)

- Diversity pooled library 10 μ M, N=1
- Enzyme assay with Rapidfire-MS

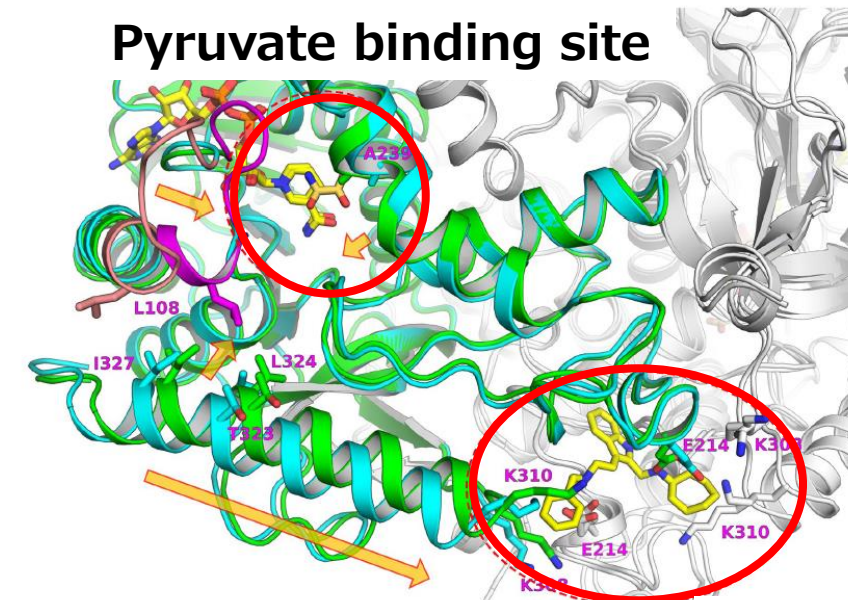
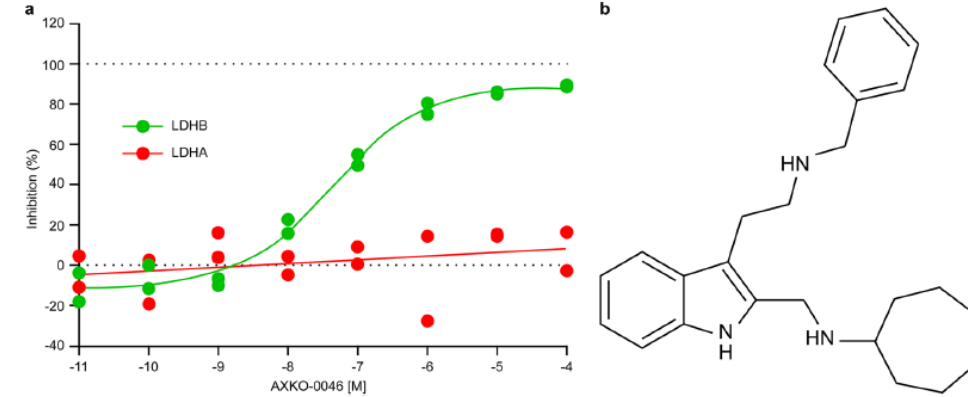
Deconvolution assay (ca. 800 cpds)

- Positive compounds from primary screening 30 μ M, N=1

Dose response test

- 4-5 dose, N=2
- Selectivity test (LDHB/LDHA)
- Clustering
- Purity check
- Evaluation of related compounds

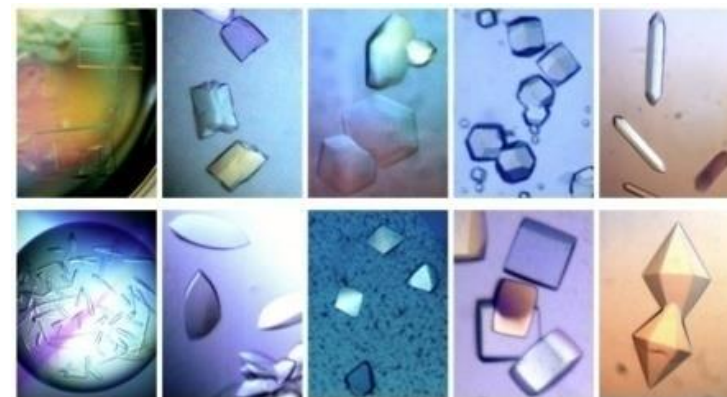
Hit compounds



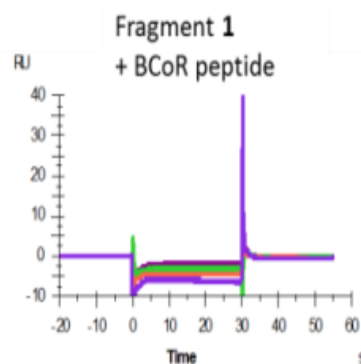
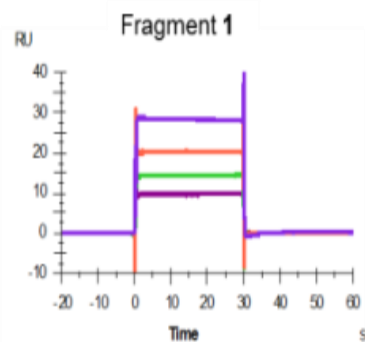
Sci.Rep 2021 11:21353

In vitro Assay Platform for Profiling

- Biochemical assay (Potency/Selectivity/Species difference for SAR)
- Mode of action/ Kinetics analysis and Profiling assay
- Cell-based assay (Cellular target engagement, Cellular function etc.)
- Biophysical analysis for target-compound interaction assay
 - AS-MS, TSA, NMR, ITC, SPR, X-ray crystallography



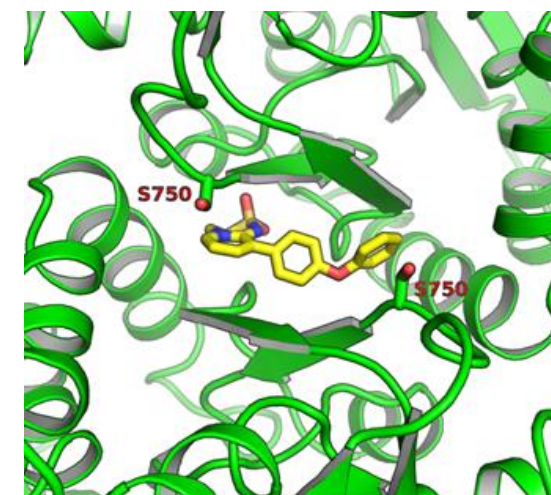
Competition experiment



Kinetics assay
with SPR



Thermodynamics
assay with ITC



X-ray crystallography

Neuropsychopharm 44 961–70 (2019)

➤ ***We can drive drug discovery by using various technologies led by multidisciplinary teams***

- ◆ Key factors for hit identification
 - High quality and diverse library
 - Hit identification platform
- ◆ Approach to drugging unknown targets
 - Phenotypic screening using iPS cells
 - Target deconvolution
- ◆ Capabilities on drugging undruggable targets
 - Targeted protein degradation
 - RNA targeted drugs



Drug Discovery Strategy

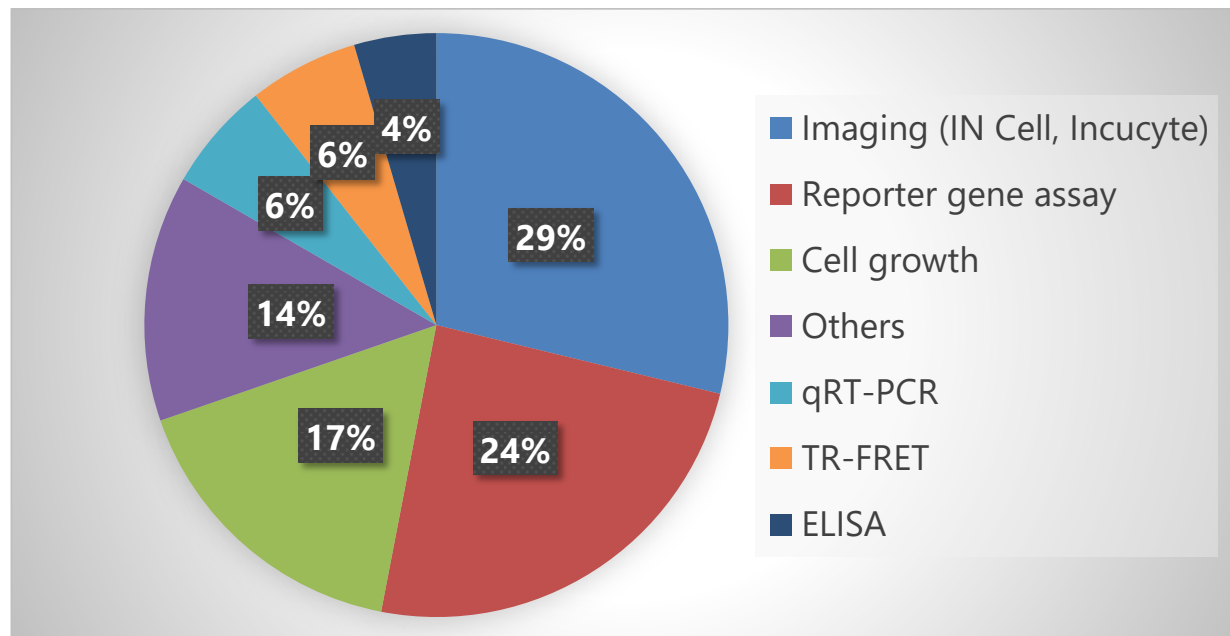
Strategies	Materials	Pros	Cons
Target-based Drug Discovery (TDD)	Recombinant protein, Nucleic acid, Cell	<ul style="list-style-type: none">■ High throughput■ Robust screening cascade has been established■ Structure-based approach is possible	<ul style="list-style-type: none">■ Hit compounds may not show efficacy in cell-based assay■ Shortage of druggable target molecules
Phenotypic Drug Discovery (PDD)	Cell, Tissue, Organ	<ul style="list-style-type: none">■ Not need to know molecular targets of a disease■ Possibility to discover hit compounds with unique MOAs■ Novel biological discovery	<ul style="list-style-type: none">■ Low throughput■ Low stability and robustness of assay system■ Target deconvolution and MOA analysis can be challenging

➤ ***Axcelead has both capabilities of TDD and PDD and provides the best solution***

Track Record of Phenotypic Screening

Track record for **>70** PDD programs

Assay methods



Assay methods	Usual screening library size
Imaging	100K compounds
Reporter gene assay	400K compounds
Cell growth Incl. synthetic lethality	400K compounds 3200 compounds
qRT-PCR	30 K compounds
TR-FRET	100K compounds
ELISA	100K compounds
POI-HiBit screening (for degrader screening)	100K compounds

➤ *We can propose the best screening strategies according to your needs*

Phenotypic Screening using iPS Cells

A β uptake assay in iCell[®] Microglia AD TREM2

HTS cascade

Primary screening (c.a. 4000 compounds)

- Biologically annotated compounds, > 3,000 cpds
- 3 μ M, N=1
- Phagocytosis assay and cytotoxicity (CellTiter-Glo[®] Luminescent Cell Viability Assay)



Reproducibility test (350 compounds)

- Positive compounds from primary screening
- 3 μ M, N=1
- Phagocytosis assay and cytotoxicity (CellTiter-Glo[®] Luminescent Cell Viability Assay)

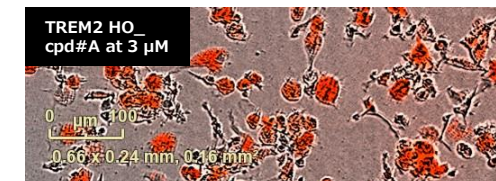
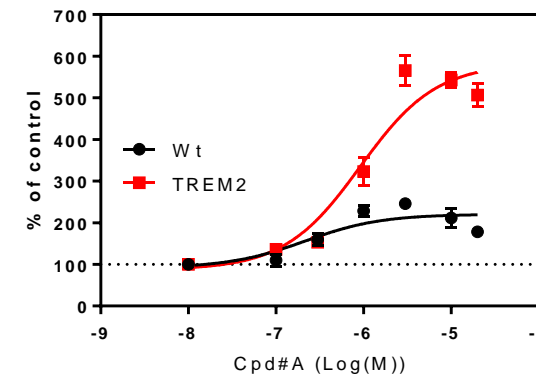
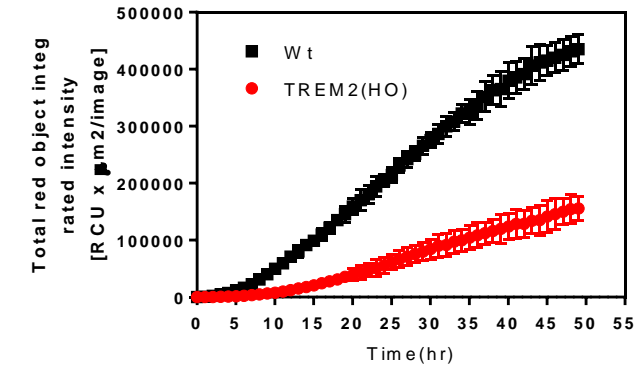


Dose response test (24 compounds)

- Selected compounds from reproducibility test
- 6 dose, N=2
- TREM2 mutant and WT
- Phagocytosis assay and cytotoxicity (CellTiter-Glo[®] Luminescent Cell Viability Assay)

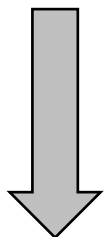


Hit compounds



MOA Analysis Using Annotation Library

Hit compounds from annotated library



Target candidates

- Kinase A
- GPCR B
- Nuclear receptor C

Predict MOAs for other hit compounds

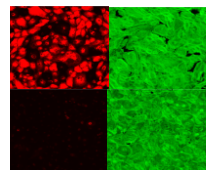


Search if we have other Kinase A inhibitors with different chemical structures
in our internal compound library

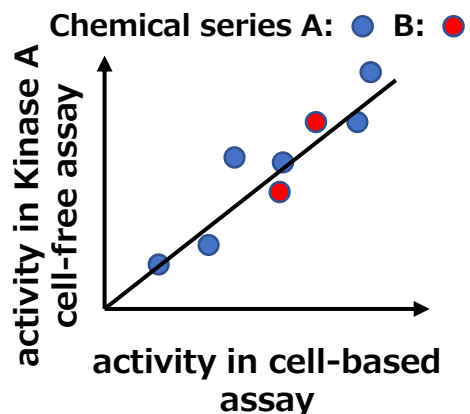
Compounds X and Y are Kinase A inhibitors,
but have different chemical structures

Hit
Compounds X
from
screening

Compounds Y
from
Our library



Both compounds induce
the same phenotypic outcomes ?

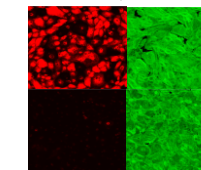


Both activities correlate well?

Kinase A could be
a possible drug
targets to
modulate the
phenotype

Validation study

Genome-editing tools
si/shRNA
CRISPR/Cas9



Same phenotypic
outcomes as Kinase A
inhibitors?

Target Deconvolution

Target deconvolution

- Phenotypic screening

- Target-unknown drugs

Annotation analysis

Chemical proteomics

Finger printing

- Target based drug discovery

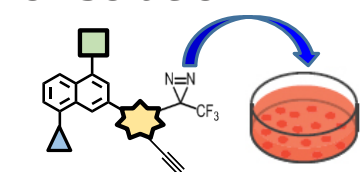
- Drug repositioning

Direct target fishing

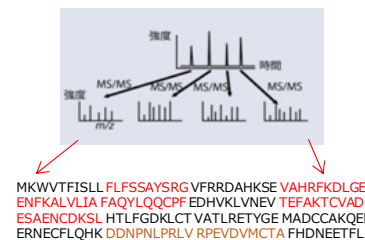
Target/ pathway prediction

1. Probe design & synthesis

2. Probe labeling & isolation

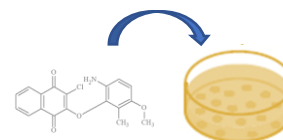


3. LC-MS/MS analysis



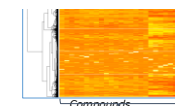
4. Biological/ biochemical target validation

1. Compound treatment



2. NGS (AmpliSeq) & gene signature analysis

3. Search compound with similar gene signature



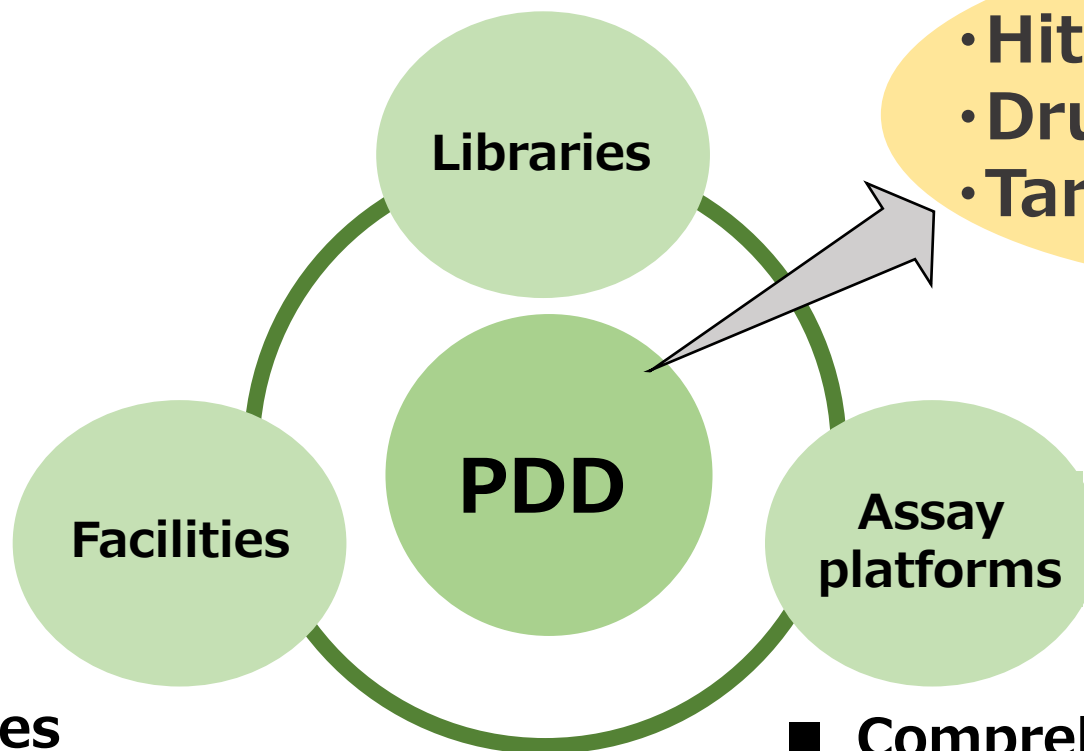
- Public database (in service)
- AXL original database (in plan)

4. Biological target validation

Phenotypic Drug Discovery (PDD) in Axcelead

■ High quality and attractive libraries

- Diversity
- Biological annotation
- FDA approved
- Focused



- **Hit-Lead finding**
- **Drug repositioning**
- **Target discovery**

■ Cutting edge facilities

- Automation system
- Wide range of devices
 - Envision
 - Incubator 6000
 - qRT-PCR system etc.
- BSL2 laboratory

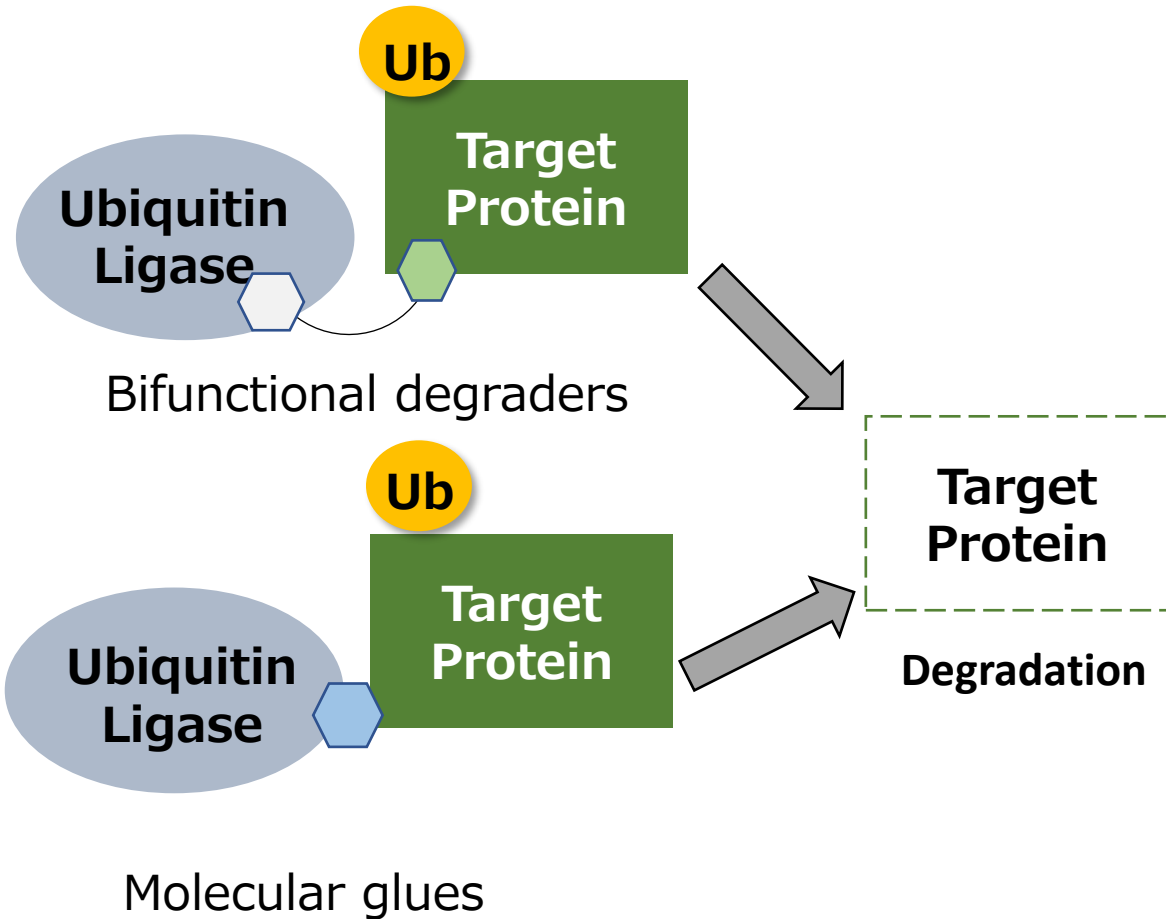
■ Comprehensive services

- Cell construction
- Assay platforms
- Target discovery with Crispr Cas KO screen
- MOA analysis
- Biochemistry and Biophysics
- Target deconvolution

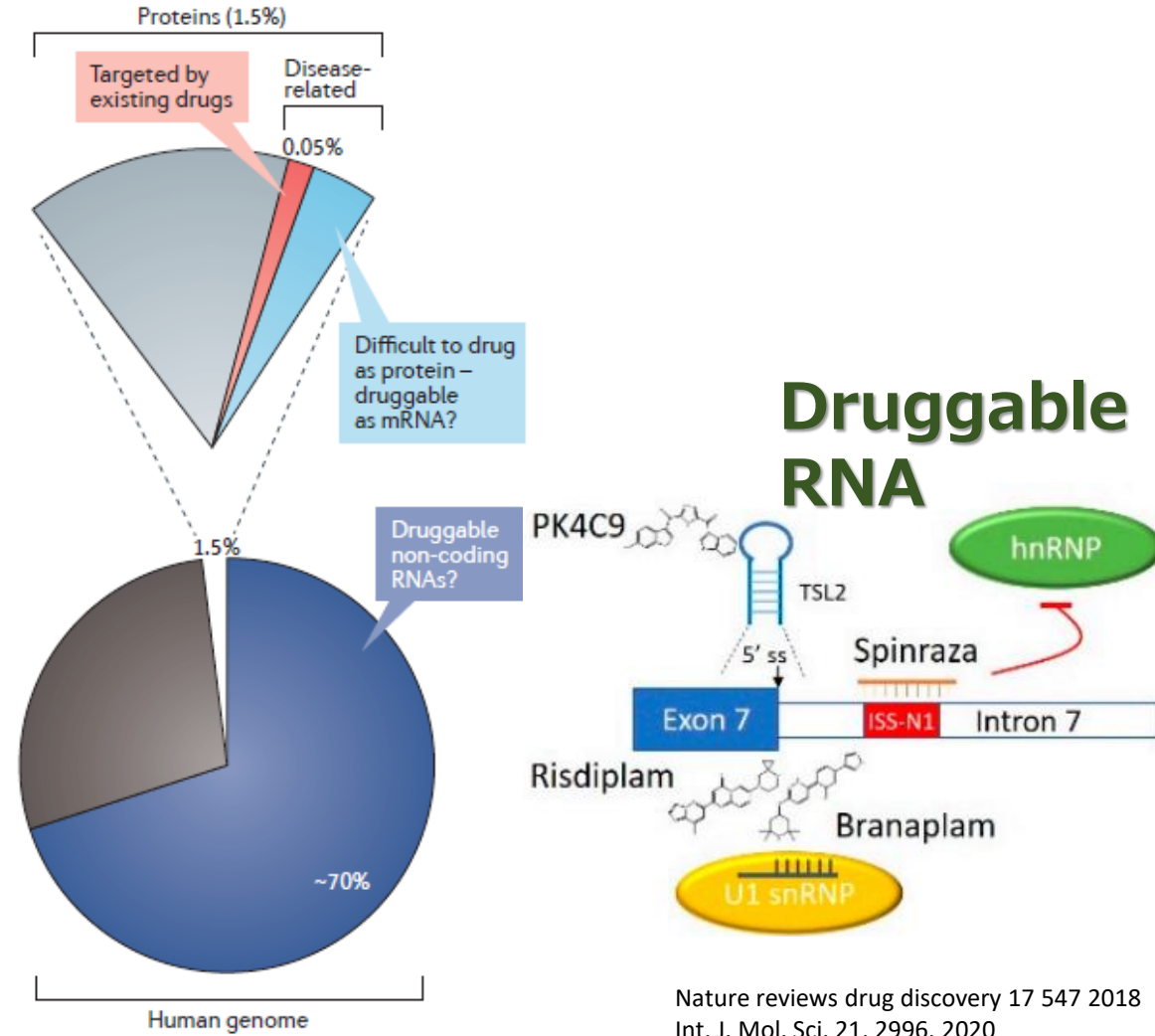
- ◆ Key factors for hit identification
 - High quality and diverse library
 - Hit identification platform
- ◆ Approach to drugging unknown targets
 - Phenotypic screening using iPS cells
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- ◆ Capabilities on drugging undruggable targets
 - Targeted protein degradation
 - RNA targeted drugs

Recent Advances in Drugging Undruggable Targets

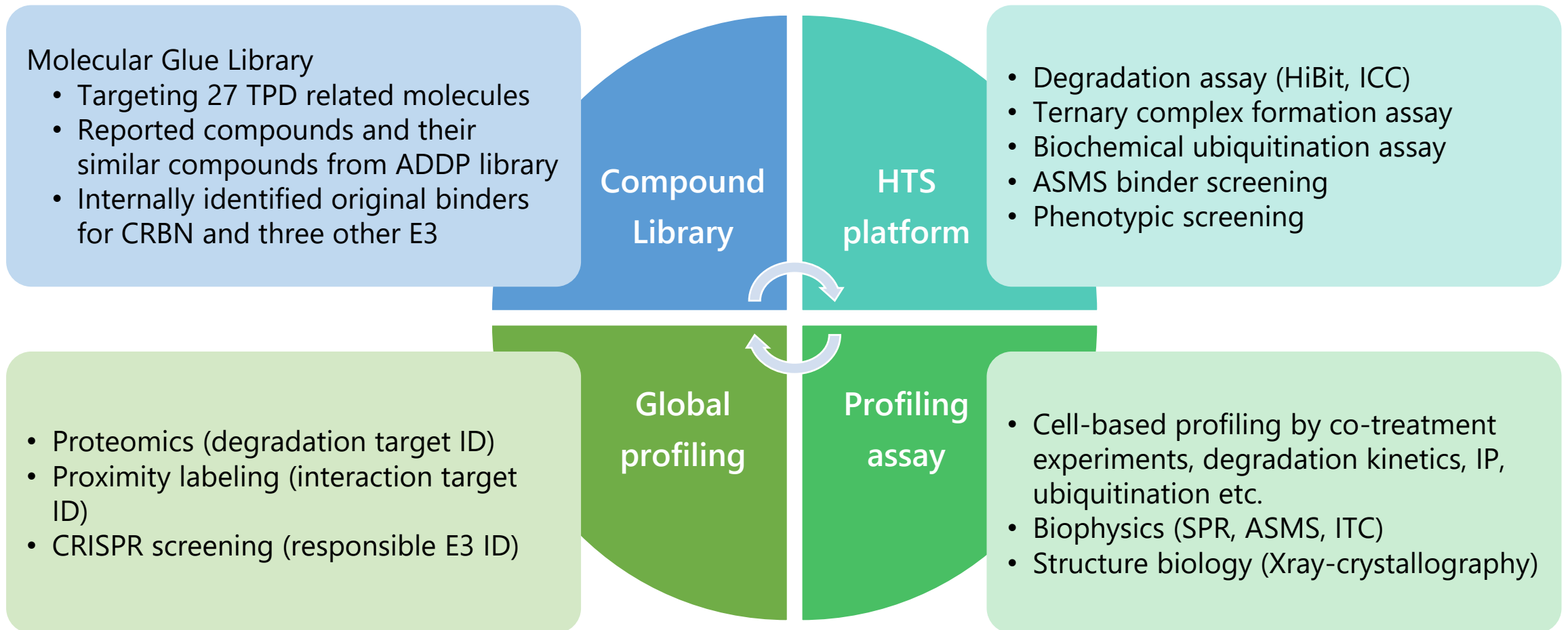
Targeted Protein Degradation



RNA targeted drugs



Targeted Protein Degradation Capabilities



➤ Track record – **16** targeted protein degradation related HTS projects including internal Lead Generation program

Discovery of Protein Degradation Inducers

HTS cascade

Primary screening (100,000 cpds)

Cell based assay

using Target X-Hibit knock-in cells



Reproducibility test

➤ Reproducibility and counter assays



Dose response test

➤ EC50 determination

➤ Selectivity test

➤ Cell toxicity test

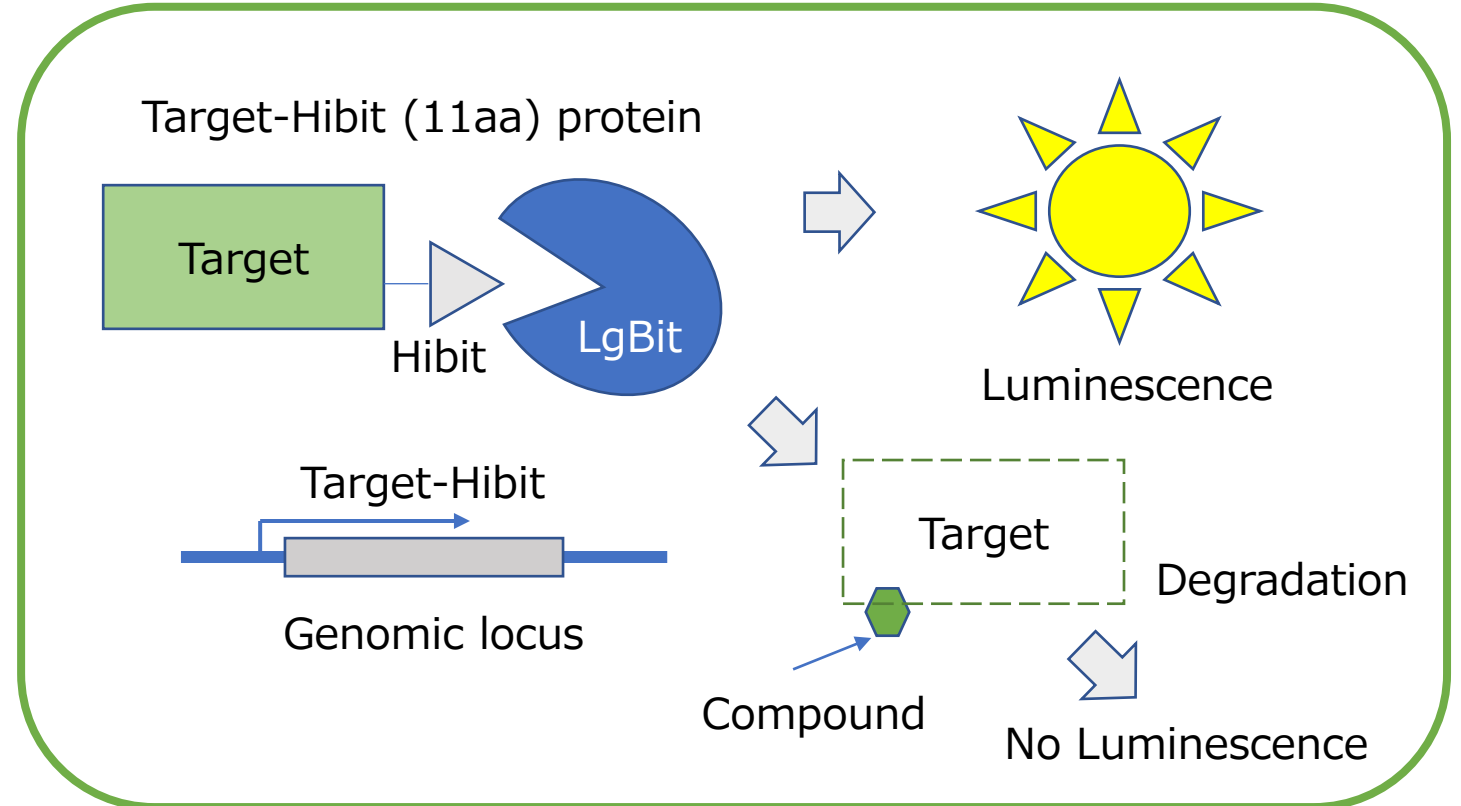
➤ Purity check

➤ Clustering



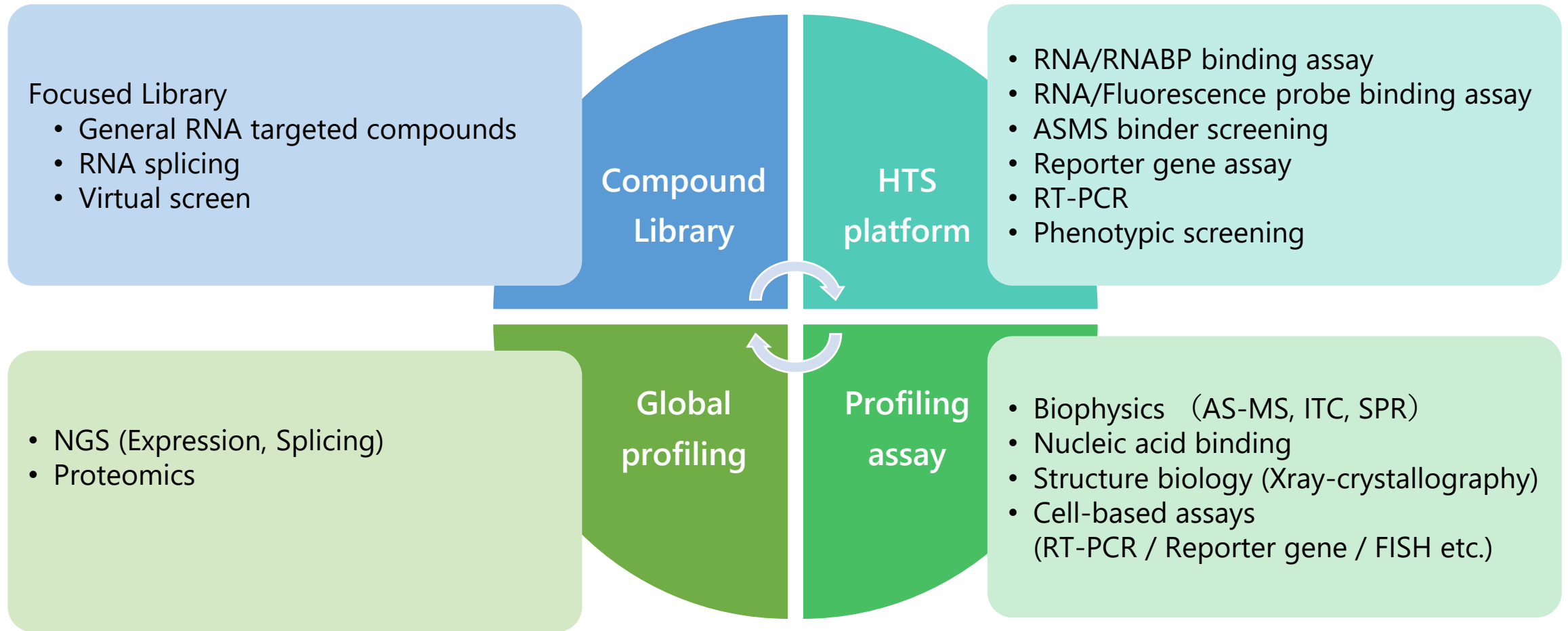
Hit compounds

HiBit system (Promega)



- Detection of endogenous expression of targets
- Homogenous assay (High throughput)
- Luminescence based assay (Robustness)

RNA Targeted Drugs Capabilities



- Track record- **15** RNA targeted drugs related HTS projects including internal Lead Generation program
- One Joint research with xFOREST and Kyowa Kirin is ongoing



RNA focused Small Molecule Libraries

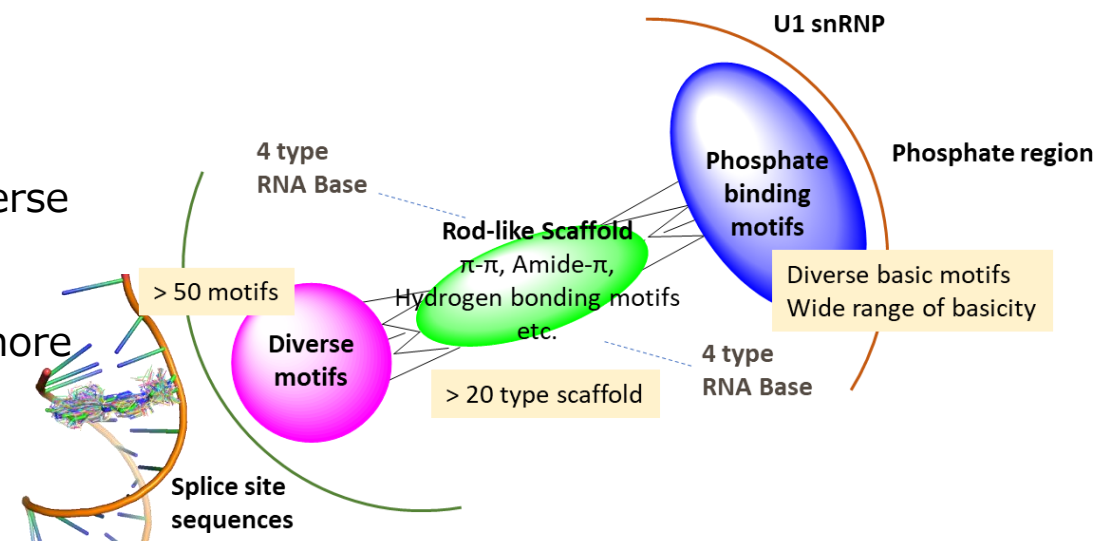
1. General RNA focused library

- **6,400** compounds selected from ADDP-1.5M library
- This library was selected by our multiple analysis of RNA-binders and RNA-cocystal structure information, followed by prioritization of favorable physicochemical properties for RNA-binder and drug discovery
- We have some track records of hit compound discovery and higher hit ratio than other libraries



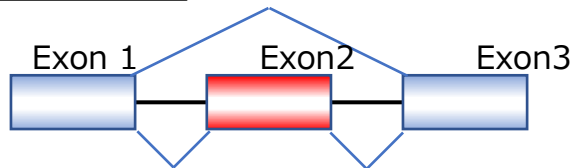
2. RNA splicing focused library

- Originally designed and synthesized **1,700** compounds
- The design concept is based on interaction patterns between diverse splice sites and snRNP
- All compounds designed by expertized medicinal chemists have high drug-likeness and diversity with splicing modulator pharmacophore
- This chemical space is rarely filled by commercially available compounds
- We have impressive track records of selective hit compound discovery and extremely high hit ratio for several targets

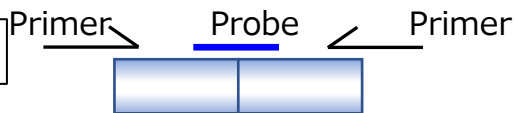


In-house study for splicing focused compound library

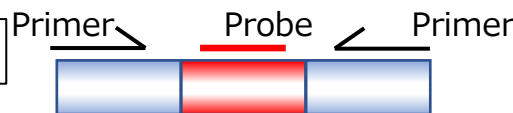
RNA splicing



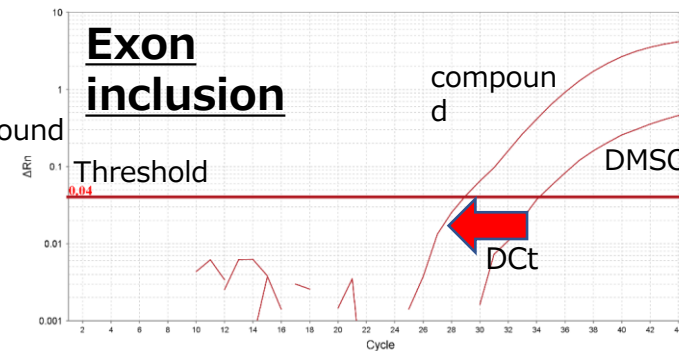
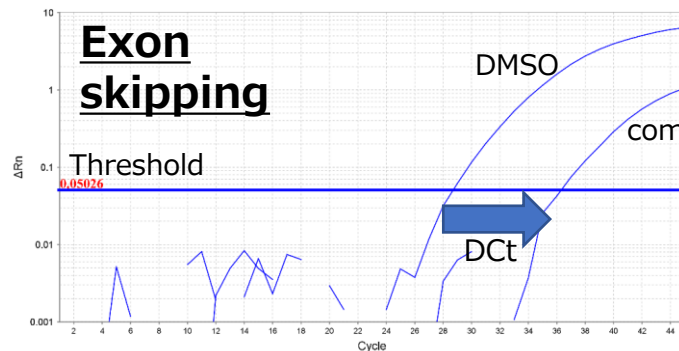
Exon skipping



Exon inclusion



e.g.) RNA-focused library compound which increases Exon-inclusion RNA and decreases exon-skipping RNA (Gene A)



High hit rate

		Splicing focused library chemotypes													
	5' splice site	A	B	C	D	E	F	G	H	I	J	K	L	M	Hit rate
SMN2	GGA	Red	Light	Red	Red	Light	Red	Light	Light	Red	Red	Light	Light	Light	15 / 80 (18.75%)
Gene A	AGA	Light	Red	Light	Red	Light	Light	Light	Light	Red	Light	Light	Light	Light	9 / 80 (11.75%)
Gene B	TCA	Light	Red	Light	Red	Light	Light	Light	Light	Red	Light	Light	Light	Light	10 / 80 (12.5%)

Selective hit compounds

$ \Delta Ct $	Red	Light	White
	> 3	3 ~ 1	1 >

Hit compound : $|\Delta Ct| > 3$

Discovery of RNA Binders with HT-ASMS

HTS cascade

High-throughput Affinity Selection Mass Spectrometry for FMN riboswitch RNA binders

Diversity Library: 140,633 cpds

General RNA focused Library: 6,400 cpds

FMN riboswitch RNA 5 μ M
Compound conc.: each 0.5 μ M

Reproducibility test

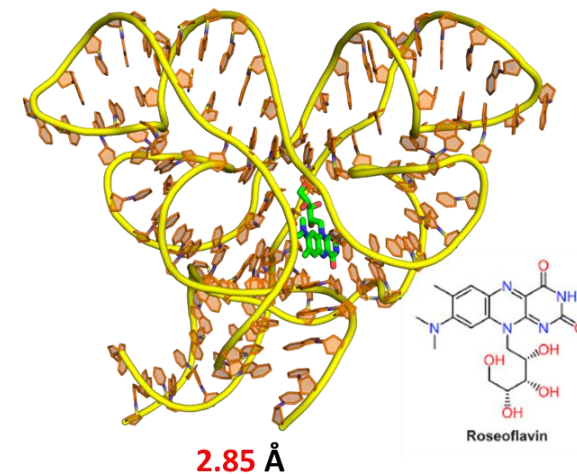
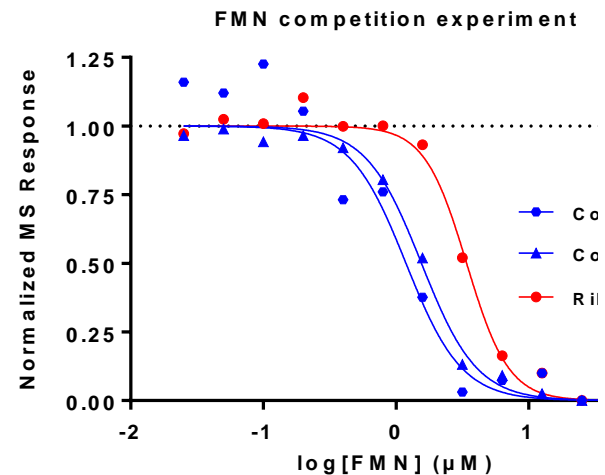
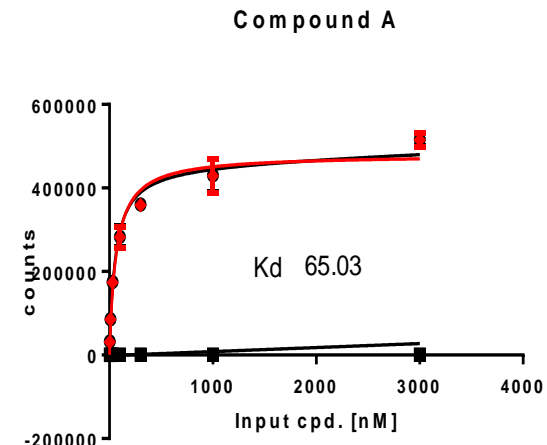
Counter Screen using scramble RNA

Confirmation assay

Diversity Library : 72 hits

RNA focused Library : 7 hits

Kd determination



In house data

Post HTS Service

➤ We strongly propose our Post HTS and Lead generation services to accelerate your drug discovery



Target ID
& Validation

Hit
Identification

Hit Expansion
(Post HTS)

Lead
Generation

Lead
Optimization

IND enabling
study



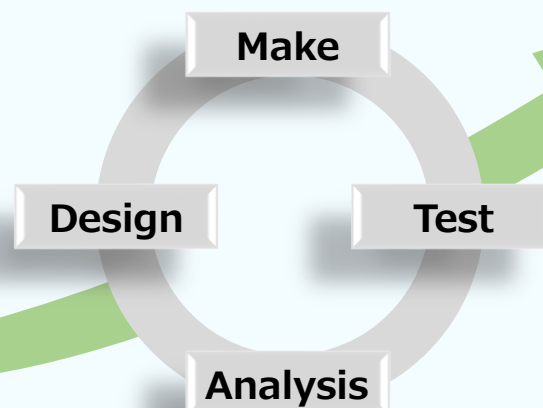
HTS

Screened from high-quality compound library

- Physicochemical property
- Number of related compounds in ADDP library



Quality Hit



DMTA cycle



Advanced Hit

Advanced Hit

Related Compound Assay
Chemical synthesis for initial SAR study

- SAR information (Potency, Selectivity)
- ADME data

Extensive information enable smooth transition to LG stage

Accelerate Lead Generation

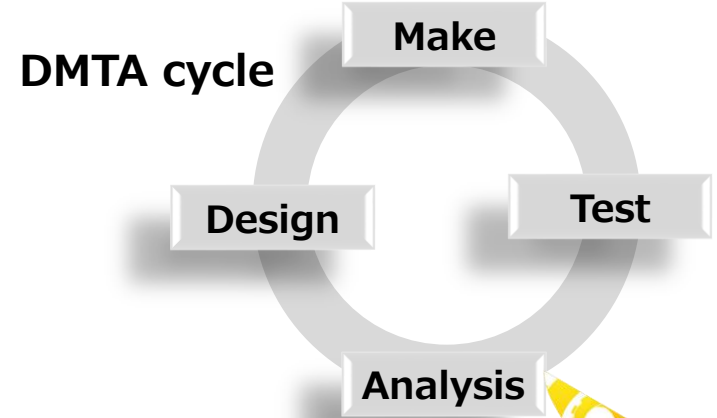


contact@axcelead.com

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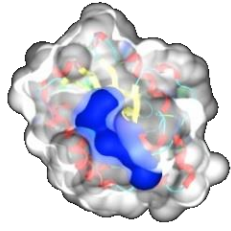


Axcelead high performance COmputing systems for Drug dESign

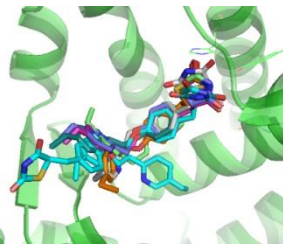


- AutoDesign**
 - Hopping**
 - e-ADME**
- Multiple drug design tools

Pocket
Feasibility,
Ligandability

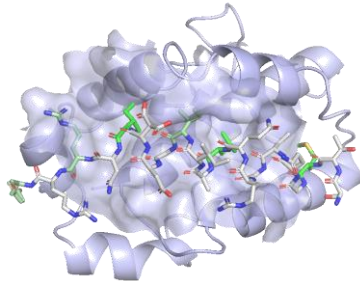
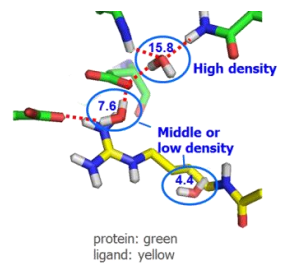


Docking model



Dynamics

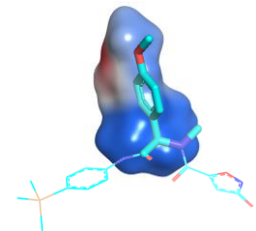
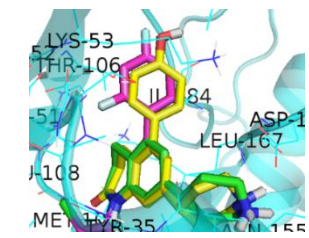
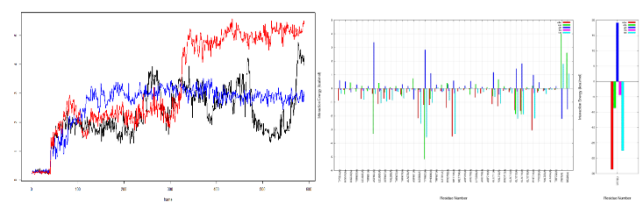
MD simulation



A-code

MMPBSA

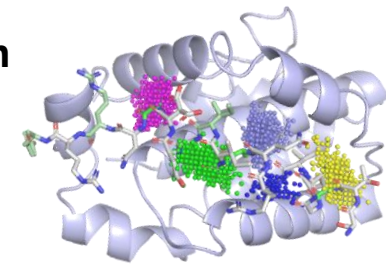
Prediction of IC50/EC50
Molecular dynamics calculation



Property	Property
PAMPA	PAMPA
BA	BA
MDR1	MDR1
MS	MS
HERG	HERG
CYSs	CYSs
Cytotox	Cytotox
Solubility	Solubility
logD	logD

LigMap

Hot spot discovery



Integrated HTS Platform

1. Attractive library

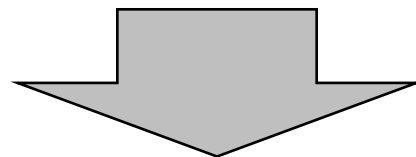
- Pharma origin, huge, high-quality and diverse library

2. State-of-the-art infrastructure

- Fully automated screening systems
- Comprehensive platforms covering diverse target classes and phenotypic screens

3. High quality and comprehensive services

- A proven track record of around 700 HTS campaigns for drug discovery
- Comprehensive services in hit identification including strategy planning, assay development, HTS and profiling
- Hit expansion and lead generation services by highly experienced medicinal chemists
- High-throughput-ADMET profiling services with extensive experience and sophisticated protocols



➤ ***We efficiently offer high-quality hit and lead compounds through our integrated HTS platform***



Together
We can Create a Hopeful Future
through Drug Discovery

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