

Research and Development at Daiichi Sankyo



GLENN GORMLEY MD PhD Global Head, Research & Development Senior Executive Officer

Agenda of R&D Day



- 1. Research and Development Overview (Glenn Gormley)
- 2. Research Overview (Masahiko Ohtsuki)
- **3.** Biologics Overview (Junichi Koga)
- 4. Development Overview (Mahmoud Ghazzi)
- 5. Closing (Glenn Gormley)



R&D Challenge: More Competitive External environment

- Declining number of approved NMEs
- Escalating R&D costs

Growing share of biologics among approved NMEs



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R&D response to Challenges: Increase Productivity

- increase output at lower cost
- Accelerate development timelines
- Maximize the value of each R&D unit

Global R&D 5 Year Business Plan





2013 2014 2015 2016 2017

Drivers of success
Leadership
Innovation
Efficiency
Empowerment
Smart Risk taking

Global R&D 5 Year Business Plan Key success factors





Productivity gains at Daiichi Sankyo







Priority Areas at R&D Stages





Major R&D Pipeline

As of December 2014



Therapeutic area	Phase 1	Phase 2	Phase 3	Application
Cardiovascular- Metabolics	DS-1040 (Acute ischemic stroke / TAFIa inhibitor)	 CS-3150 (JP) (Hypertensive / DM nephropathy / MR antagonist) DS-8500 (JP) (Diabetes / GPR119 agonist) 	 Prasugrel (JP) (CS-747 / ischemic stroke / anti- platelet agent) Prasugrel (US) (CS-747 / sickle Cell Disease / anti- platelet agent) 	Edoxaban (US/EU/Others) (DU-176b / AF / oral factor Xa inhibitor) Edoxaban (US/EU/Others) (DU-176b / VTE / oral factor Xa inhibitor)
Oncology	 U3-1565 (US/JP) (Anti-HB-EGF antibody) DS-7423 (US/JP) (PI3K / mTOR inhibitor) DS-3078 (US/EU) (mTOR inhibitor) DS-3032 (US) (MDM2 inhibitor) PLX7486 (US) (Fms / Trk inhibitor) DS-8895 (JP) (Anti-EPHA2 antibody) DS-8273 (US) (Anti-DR5 antibody) PLX8394 (US) (BRAF inhibitor) DS-6051 (US) (NTRK / ROS1 inhibitor) 	 Patritumab (US/EU) (U3-1287 / anti-HER3 antibody) Vemurafenib (US/EU) (PLX4032 / BRAF inhibitor) PLX3397 (US) (Fms / Kit/Fit3-ITD inhibitor) 	 Tivantinib (US/EU) (ARQ 197 / HCC / Met inhibitor) Denosumab (JP) (AMG 162 / breast cancer adjuvant / anti-RANKL antibody) Nimotuzumab (JP) (DE-766 / gastric cancer / anti-EGFR antibody) Vemurafenib (US) (PLX4032 / melanoma adjuvant / BRAF inhibitor) Quizartinib (US/EU) (AC220 / AML / FLT3 inhibitor) 	
Others	 PLX5622 (Rheumatoid arthritis / FMS kinase inhibitor) DS-1093 (Anemia of chronic kidney disease / HIF-PH inhibitor) DS-3801 (Chronic obstipation / GPR 38 agonist) DS-1971 (Chronic pain) 	 Mirogabalin (JP) (DS-5565 / chronic pain / α2δ ligand) SUN13837 (US/EU) (Spinal cord injury / modulator of bFGF signaling system) Laninamivir (US/EU) (CS-8958 / anti-influenza / out-licensing with Biota) Ioforminol (JP) (GE-145 / X-ray contrast media / angiography) 	 Mirogabalin (US/EU) (DS-5565 / Fibromyalgia / α2δ ligand) Levofloxacin (JP) (DR-3355 / anti-infection / New quinolone) Denosumab (JP) (AMG 162 / rheumatoid arthritis / anti-RANKL anti-body) Hydromorphone (JP) (DS-7113 / narcotic analgesic / opioid µ-receptor regulator) CHS-0214 (JP) (Etanercept BS / rheumatoid arthritis / TNFa inhibitor) CL-108 (US) (Acute pain / opioid µ-receptor regulator) 	

Targets for Approval and Launch





Decision Making Body for Global R&D Projects





Daiichi Sankyo's Decision Making System:



- Simple: One decision making body for all teams in early phase development
- Fast: Monthly meetings
- Aligned: All stakeholders represented at TR-GEMRAD and empowered



Daiichi Sankyo's Decision Making System:



- Simple: One decision making body for all teams in late phase development
- Fast: Monthly meetings
- Aligned: All stakeholders represented at GEMRAD and empowered



Decision-Making Body

> Project Team



In Translational research phase:

- Test key elements of Target Product Profile quickly
- Take smart risks to establish Proof of Concept
- Ensure continuous feedback loop to maximize learning

Global Sites for competitive theme creation



Venture Science Laboratories (VSL) in-house Venture model



- Deliver innovative FIC products in a biotech-like lab
- Develop therapeutics and diagnostics for neurodegenerative diseases such as Alzheimer's disease through research collaboration with UCSF-IND (Institute for Neurodegenerative Diseases)

UCSF-IND

 World class academia laboratories focusing on neurodegenerative diseases led by Dr. Stanley B. Prusiner, recipient of Nobel Prize for research on prions in 1997



Passion for Innovation. Compassion for Patients.[™]



Research Overview

Masahiko Ohtsuki Global Head of Research



Mission for Global Research of Daiichi Sankyo



- Challenge high unmet medical needs by novel science and technologies
- Create a Competitive Pipeline and Deliver Innovative Products Quickly and Consistently to Patients
- Approach in Priority Area
 - CV-M:Utilizing past experience and strength and challenge to new approaches
 - Oncology: Actively utilize open innovation and create strong franchise
 - Frontier: Targeting First-In-Class drug discovery through new approach, Discovery Focus

Total care of thrombotic diseases







TAFIa inhibitor brings safer thrombolysis

UMN in Acute Ischemic Stroke

DS-1040

- SOC for blood reflow: rt-PA (alteplase)
 - Very limited eligible patient
 - Strict applied condition including narrow therapeutic time window due to increasing intracranial hemorrhage (ICH) risk

TAFIa inhibitor brings safer thrombolysis

- TAFIa inhibitor would recruit plasminogen and tPA to fibrin surface followed by promoting thrombolytic effect of tPA/plasmin
 - Expected low ICH risk by localizing thrombolysis around the fibrin

Open Innovation is the key for success



Daiichi Sankyo

 Strong Medicinal Chemistry

Library

Unique Compound



Innovative Target

Academia



- Academic Network
- Scientific Excellence

Experienced
 Pharmaceutical Science





Open innovation at Daiichi Sankyo







IDH1 mutant inhibitor: cancer drug with much lower adverse effect



Comprehen

-sive

Mechanism of Action: Selective inhibition of IDH1 mutant Indication: Leukemia, solid tumor (glioma etc) Collaborator: National Cancer Center



IDH1 mutant inhibitor is effective in leukemia model

 Administration of IDH1 mutant inhibitor decreases 2HG level and AML cells



(National Cancer Center, Daiichi Sankyo 2014)

Comprehen -sive

Daiichi-Sankyo



Multi ENTRANCE

From preliminary ideas to strengthening IP

Multi EXIT

From contract-based research to supported collaboration to establish a venture

FY	Entries	Selected
2014	234	24
2013	222	23
2012	250	20
2011	337	21

Access to a variety of academia: (Alliance with Virtici/Celdara Medical(VCM)

- Partnership for novel drug target identification research
- VCM gathers many collaboration proposals from their wide range academia network in US
- DS selects research projects and conduct drug discovery research
 - 1. collaboration proposal





Networking

Library compounds exchange with Compound Astellas: For better drug candidates





precompetitive

Daiichi-Sankvo

Possibility of obtaining hit compounds T Diversity of hit compounds





Better drug candidates

competitive

Designed compound library for high Compound quality hit: Pharma Space Library

Novel fragments

Conversion of reactive functional group *etc*

Bioactive fragments

ligand-protein interaction substructures

Combination

Novel structures

Novel fragments

Conversion of ring system etc

Drug-like fragments

Substructures common to

bioactive compounds





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Biologics Overview

Junichi Koga Global Head of Biologics



Business value, opportunities





Advance in technology

: value drivers)

Stepwise approach for biologics business





Biologics Pipeline Growth & Progress



Bio-Research engine creates RD candidates effectively.

	Discovery	Pre-clinical	Phase 1
2007	2	0	2
2012	10	4	1
As of Mar 2014	46	11	4 (New entry)

2nd wave (ADCC)

Antibody

(DS-8895a)

Y



- EPHA2 is known to be highly expressed in multiple tumors (gastric, breast, lung, ovarian, colorectal cancer etc.)
- Potent ADCC activity

FPHA2

Receptor

 It is effective even in the tumors with KRAS active mutation in preclinical models



Effector

Immune effector cells (mainly NK cells)

DS-8895a: anti-EPHA2 Ab





- One of the 2nd wave technologies, ADCC enhancement technology, was applied.
- DS-8895a is effective in EPHA2 positive preclinical tumor models including gastric, breast, lung, and ovarian cancer.
- Phase 1 study is ongoing.



Antibody Drug Conjugate



Enhance anti-tumor activity of Antibody

2nd wave

(ADC)

Deliver enough amount of drug to the target tumor

Provide ADCs which combine the features of Strong Anti-tumor Effect and Excellent Safety

DS original technology of ADC



- Targeting to tumor specific Ags* prone to efficiently internalize
- Stable in blood, specific drug release by endolysosomal enzymes
- Unique and strong payload: Topoisomerase I inhibitor



Potential to be a global standard Payload/Linker system

B7-H3 ADC showed potent efficacy



Most advanced Abs mfg plant based on Single Use Bioreactor (SUB)



Concept

- Compliant with JP, US, EP GMP
- Single Use Facility Integration
- Multiproduct facility
- Facility / Equipment
 - 2,000L SUB* x 2 x 2 lines
 - Two purification lines
 - Start of operation : Feb, 2012







*Single Use Bioreactor

What is process development?





Our challenge !!

Host

Screening procedure

003479 15.0kV X3.0dk 10.0jm

Vector

media

* Monoclonal antibody

Contribution to consortium* led by METI

- * <u>Manufacturing</u> Technology Research <u>Association of</u> <u>B</u>iologics (MAB)
 - 4 Univ., 1 Research Inst., 2 NPO^{*} and 25 companies
 - DS is the only pharmaceutical company in MAB
 - To establish upstream techs
 - To identify the requirements from user's view point



METI : Ministry of Economy, Trade and Industry NPO : Non-profitable organization

Duchenne-type and Becker-type Muscular Dystrophy



Туре	Duchenne	Becker	
	Dystrophin protein		
Cause	Deficient	incomplete expression (quality, quantity)	
Mutation	Out-of-frame	In-frame	

ENA[®] Oligonucleotide-induced exon skipping would save Duchenne type patients by changing to Becker type.

3rd wave (Nucleic acids) ENA®Oligonucleotides



ENA: 2'-0,4'-C-Ethylene-bridged Nucleic Acids

- High affinity
- Highly resistant to nucleases
- In vivo antisense activity was observed in diabetic mice model*
 *Koizumi et al., Oligonucleotides, 16: 253-262 (2006)



ENA is a registered trademark of Daiichi Sankyo.

Concept of ENA[®] Oligonucleotideinduced exon skipping



Daiichi-Sankyo

New business model for open development

DS has interest in research and development for Orphan Disease, in order to achieve this we have structured new business model



* Duchenne Muscular Dystrophy

Academia/ Industry/Financier

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Global Development at Daiichi Sankyo

Mahmoud Ghazzi, MD PhD Global Head of Development

Daiichi-Sankyo Global Development



Governance

Structure (Matrix)



Global Development governance and structure is designed to deliver quality new medicines, efficiently and quickly

An Example of DS Development Capability:



Giugliano et al. N Engl J Med 2013

The Hokusai-VTE Investigators. N Engl J Med 2013

Edoxaban project enrolled over 30,000 patients in phase 3 trials and was submitted to JP, US, EU, Switzerland, Brazil, Taiwan and South Korea

Targets for Approval and Launch







Late Stage Development Update

- Edoxaban for Atrial Fibrillation and Venus Thrombo-Embolism
- Mirogabalin (DS-5565) for Neuropathic Pain and Fibromyalgia
- CL-108 for Pain management
- Quizartinib a FLT3 inhibitor for Acute Myeloid Leukemia
- PLX3397 a CSF1R/KIT/FLT3 inhibitor for Pigmented Villonodular Synovitis (PVNS)



Late Stage Pipeline: Edoxaban



Edoxaban: Competitive advantage





- Oral, highly selective, direct, and reversible Factor Xa inhibitor
- Unique combination of both once-daily convenience and superior safety for atrial fibrillation and VTE

The only NOAC with three approved major indications in Japan: AF, VTE and DVT-OS

AF : Atrial Fibrillation; VTE : Venous Thromboembolism; DVT-OS : Deep Vein Thrombosis - Orthopedic Surgery

Edoxaban: Regulatory Update



Target Indications	Schedule	
Prevention of stroke and systemic embolic events in patients with atrial fibrillation	Japan: Approved in Sep 2014 US: Filed in Jan 2014,	
Treatment and prevention of recurrence of venous thromboembolic event in patients with DVT/PE*	Advisory committee (AF indication) in Oct 2014 PDUFA date in Jan 2015 EU: Filed in Jan 2014 Other: Filed in Switzerland, Brazil, Taiwan and South Korea	
Prevention of venous thromboembolism in patients undergoing major orthopedic procedures of the lower limb (DVT- OS)	Japan: Launched in Jul 2011	

AF : Atrial Fibrillation

DVT: Deep Vein Thrombosis PE : Pulmonary Embolism

Commitment to Edoxaban Life Cycle Management:



Generating supportive data related to AF and VTE

- Safety of edoxaban in patients with AF undergoing planned electrical cardioversion (On-going)
- Safety of edoxaban in patients with AF following PCI with stenting (under evaluation)
- VTE in patients with cancer for whom long term treatment with LMWH is intended (under evaluation)

Reversal agent programs (Multiple)

- Perosphere, PER977 (small molecule)
- Portola, Andexanet Alfa (recombinant proteins)
- CSL Behring, Beriplex[®]/Kcentra[®] (4-factor prothrombin complex concentrate)





Late Stage Pipeline: Mirogabalin

Phase 2 (U201) Study Results

Broad Global Development Strategy

Mode of Action



- In neuropathic pain, neurons respond to stimuli with excessive Ca²+ influx and release of neurotransmitters
- Mirogabalin binding to presynaptic α2δ subunits inhibits Ca²+ influx and neurotransmitter release





U201 Phase 2 Study Results



ADPS Change from Baseline at Week 5



*p<0.05, **p<0.01 vs placebo (LOCF); †p< 0.05 vs pregabalin (LOCF), ADPS (average daily pain score)

Mirogabalin: Broad Global Development Strategy



Development program in three indications

Focus on Fibromyalgia (FM) in West and future consideration for Japan

(Fibromyalgia: a chronic condition of widespread pain, debilitating fatigue, sleep disturbance, and joint stiffness)

 Focus on Peripheral Neuropathic Pain (DPNP and PHN) indication in Japan and Asia

Program Status: Phase 3

- Fibromyalgia: on-going, FPI: Nov. 2014
- Broad Neuropathic Pain: FPI: Jan. 2015

DPNP: Diabetic peripheral neuropathic pain; PHN: Post herpetic neuralgia



Late Stage Pipeline: Quizartinib (Ambit AC 220)



Quizartinib (AC220): Ph3 for Acute Myeloid Leukemia (AML)



Target Indication:

Relapsed or refractory FLT3-ITD positive AML patients.

Mechanism of Action:

Potent and selective inhibitor of FLT3, a validated target in AML

Unmet Medical Need:

- AML accounts for ~36% of all new leukemia cases
- Five-year survival 23%
- No new treatments approved in the last 30 years.
- Fast Track review granted



FLT3 receptor tyrosine kinase. Litzow, Blood 2005



Fröbling. S. et al., 2002

Quizartinib: Effect in FLT3-ITD(+) AML



Response Rate for FLT3 Inhibitors Observed in Clinical Trials of AML



Ambit Presentation & Knapper, S., 2011



Late Stage Pipeline Hydrocodone combination CL-108

CL-108: Hydrocodone combination



Pain relief with less Opioid-Induced Nausea and Vomiting



Novel, fixed-dose, bi-layered tablet provides anti-emetic activity prior to hydrocodone effect

- Exclusive license for commercialization in US from Charleston Laboratories Inc.*
- Indication: Opioid Induced Nausea and Vomiting (OINV)
- Ph3 studies: treatment of moderate to severe acute pain as well as the reduction of OINV
- NDA: Targeted for FY2015

* Charleston Laboratories, Inc., privately held and located in Jupiter, Florida, is a specialty pharmaceutical company focused on the research and development of novel pain products



Late Stage Pipeline: PLX3397: Pigmented Villonodular Synovitis (PVNS)

PLX3397: for the treatment of Pigmented Villonodular Synovitis (PVNS)



PVNS:

A painful and motion limiting joint disease characterized by inflammation and overgrowth of the joint lining.

MOA:

PLX3397 targets the CSF1 Receptor blocking tumor-produced cytokines action on CSF1

• Unmet Medical Need: No systemic therapies available.

Clinical Study Status:

- Phase 1 ongoing, and preliminary data presented at ASCO June 2014
- Phase 3 in planning







Daiichi-Sankyo development is a global and capable organization with proven record of delivery of large scale projects

There is an exciting list of phase 3 projects with a mix of best-in-class and first-in-class mechanisms Passion for Innovation. Compassion for Patients.™



Closing Remarks – Our Culture



DS R&D Culture



People

- Smart risk taking
- Venture Spirit

Productivity
- Rapid Decisions
- Empowerment

Projects

- FIC Focus

- Personalized Medicines