
biocon's Report II 2010 to 2015

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2010-2015

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The Target Factory

Biocon's Report II
2010-2015

Integrated Research Platform for Novel Target and Lead Discovery

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Greeting

Medicinal Bioconvergence Research Center (Biocon) was initiated in 2010 as one of the Global Frontier Projects that are by Ministry of Science, ICT and Future Planning. Our goal is to build an integrated research platform namely “The Target Factory” to develop well-validated packages of targets and leads that can be used in biotech and pharmaceutical industry.

Biocon consists of the experts in target identification, drug design, drug screening and disease modeling.
The results from these four specialist groups are converged into integration core group. The matured packages of target and lead are then relayed to the group for translation and development (named TRADE).

“Biocon’s Report II” is prepared to introduce our target and lead pipeline, and research articles and patents that have been produced for past 5 years. We will do our best to establish Biocon the world’s first and best target factory that systematically translate original science and technology to new therapy and diagnosis for future medicine.

I appreciate the Korean governments, members and collaborating partners for the support of Biocon for last five years.

Sunghoon Kim Ph.D.

Director, Biocon / Professor, Seoul National University


BIOCON TECH FAIR 2015
The World's Best Target Factory
BIOCON
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The World's Best Target Factory
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TECH FAIR

01.

Vision: The Target Factory

An Integrated Research Platform for Novel Target and Lead Discovery

1 / 10000 % Probability

The Medicinal Bioconvergence Research Center of Seoul National University (or Biocon) has set a challenge to establish an "innovative research platform for drug discovery" that can significantly reduce the time and cost while improving the success probability of drug discovery.

Among the many different stages required for drug development, Biocon focuses on the "identification and validation of novel drug targets". Although well-validated druggable targets are critical determinants for the success of drug discovery, target discovery is typically a function

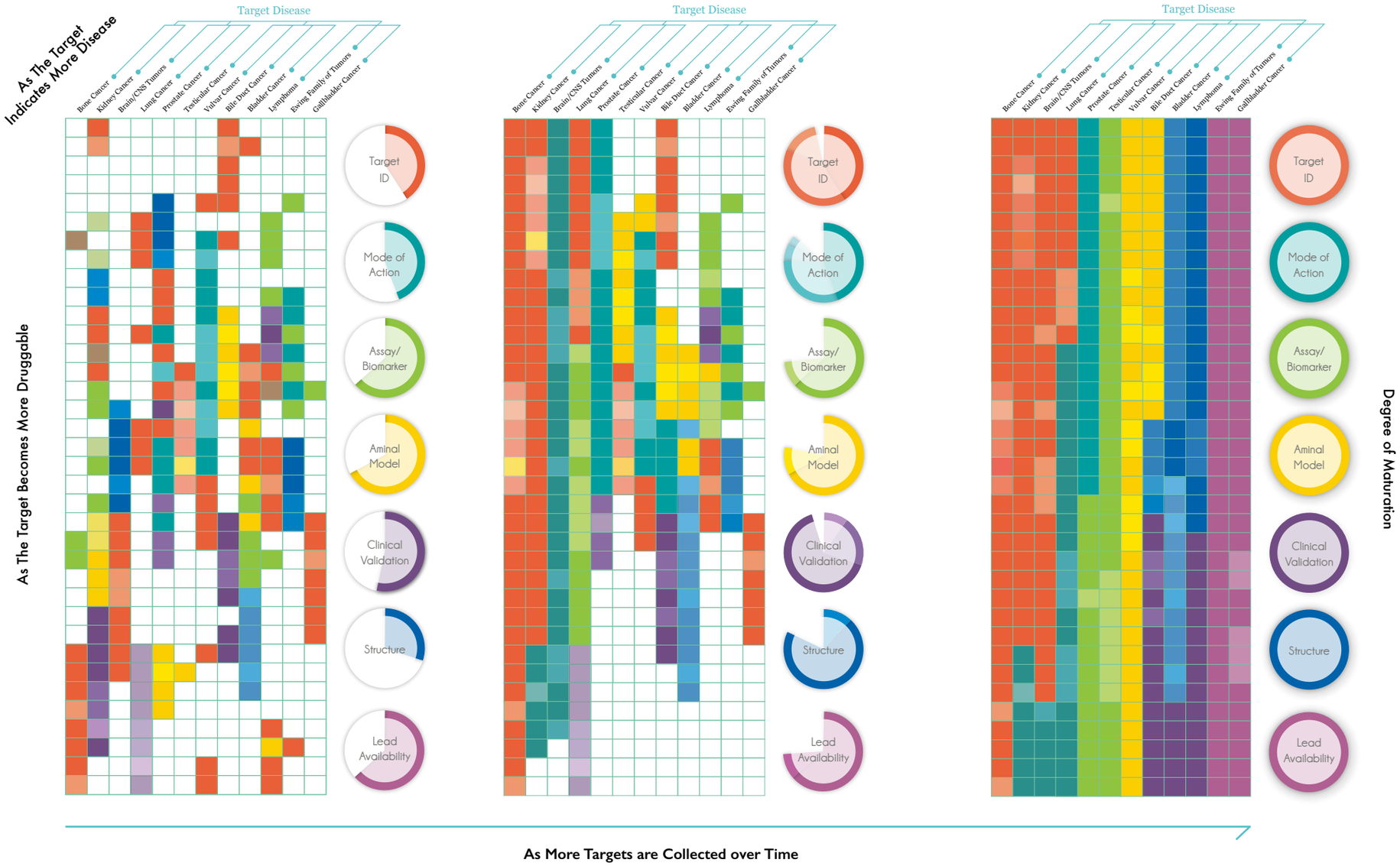
that pharma or biotech industry launch in-house, because it involves much basic science and there are no standard operation procedures for this process. Therefore, druggable targets have to be provided by the researchers in academia and public sectors. Biocon was established to fill the

gap between academia and industry by maturing potentially druggable targets. The identification of novel targets involves a broad spectrum of research activity from in-depth basic biology to translation. The strength of Biocon is based on the integration of biology and chemistry teams combined with cutting-edge convergence technologies. Through this fully united research teamwork, Biocon is aiming to become the world's first and best target factory, providing innovative targets to the pharmaceutical industry.

1 Billion Dollar

12 Years

Atlas Of Targetome



Biocon's integrated target discovery team involves genomics, proteomics, molecular and cell biology, biochemistry, animal modeling and pathology to fill out the criteria that are required for druggable targets. The processes include; "understanding the mode of action"; "creating assays for drug screening"; "clinical validation"; "biomarker discovery"; "understanding target structure"; "generation of disease models" and "development of early drug leads". With this set of data, Biocon seeks deliver targets to industry at an early stage, so that the drugs can be developed seamlessly with a higher probability of success. Ultimately, Biocon aims to build a 3D atlas (with the axis of target identification, disease indication, data attributes) of druggable targets (3D targetome) that provides a groundwork from which new drug discovery initiatives can be launched.

02.

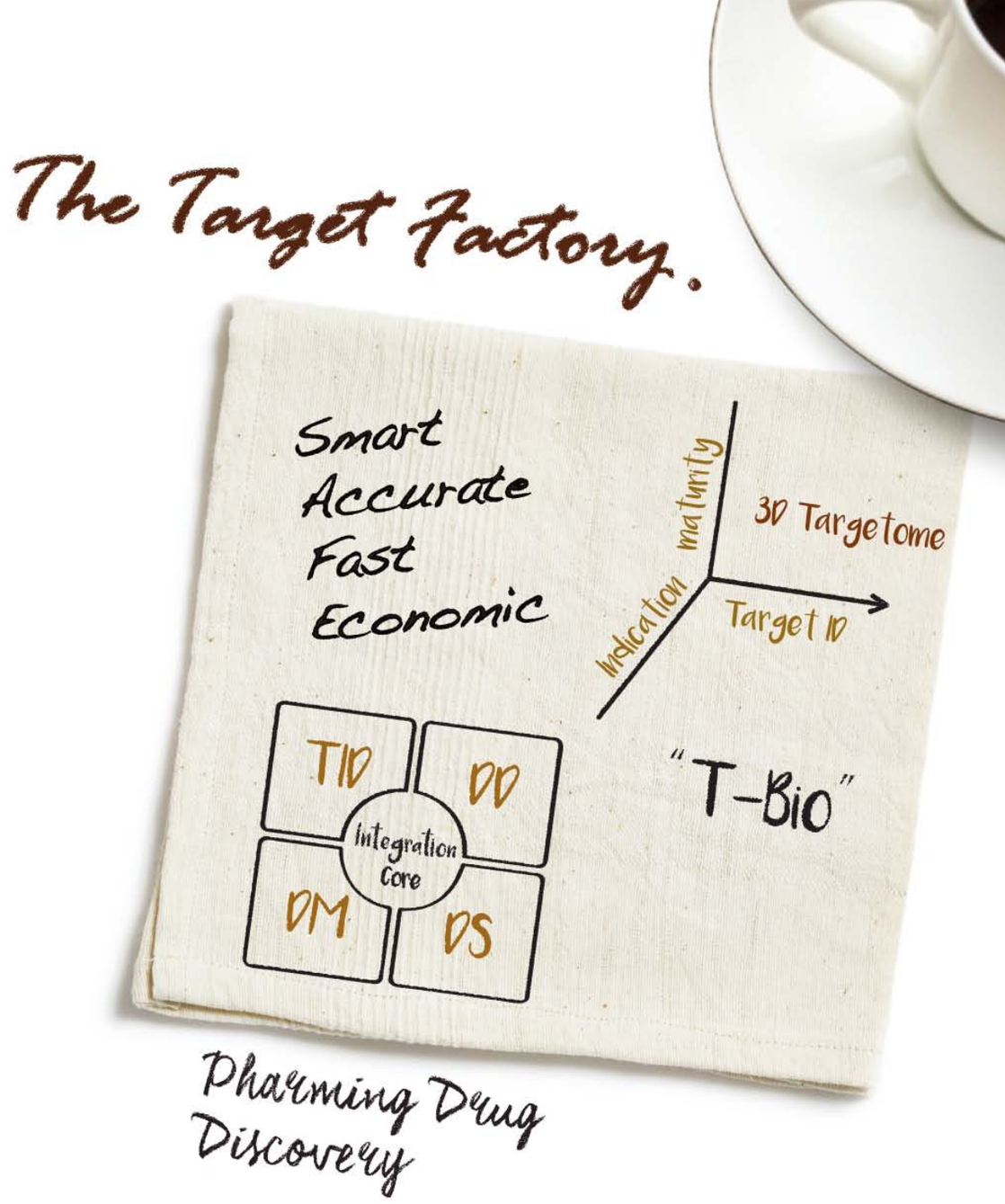
Initiation

Searching for Novel Targets

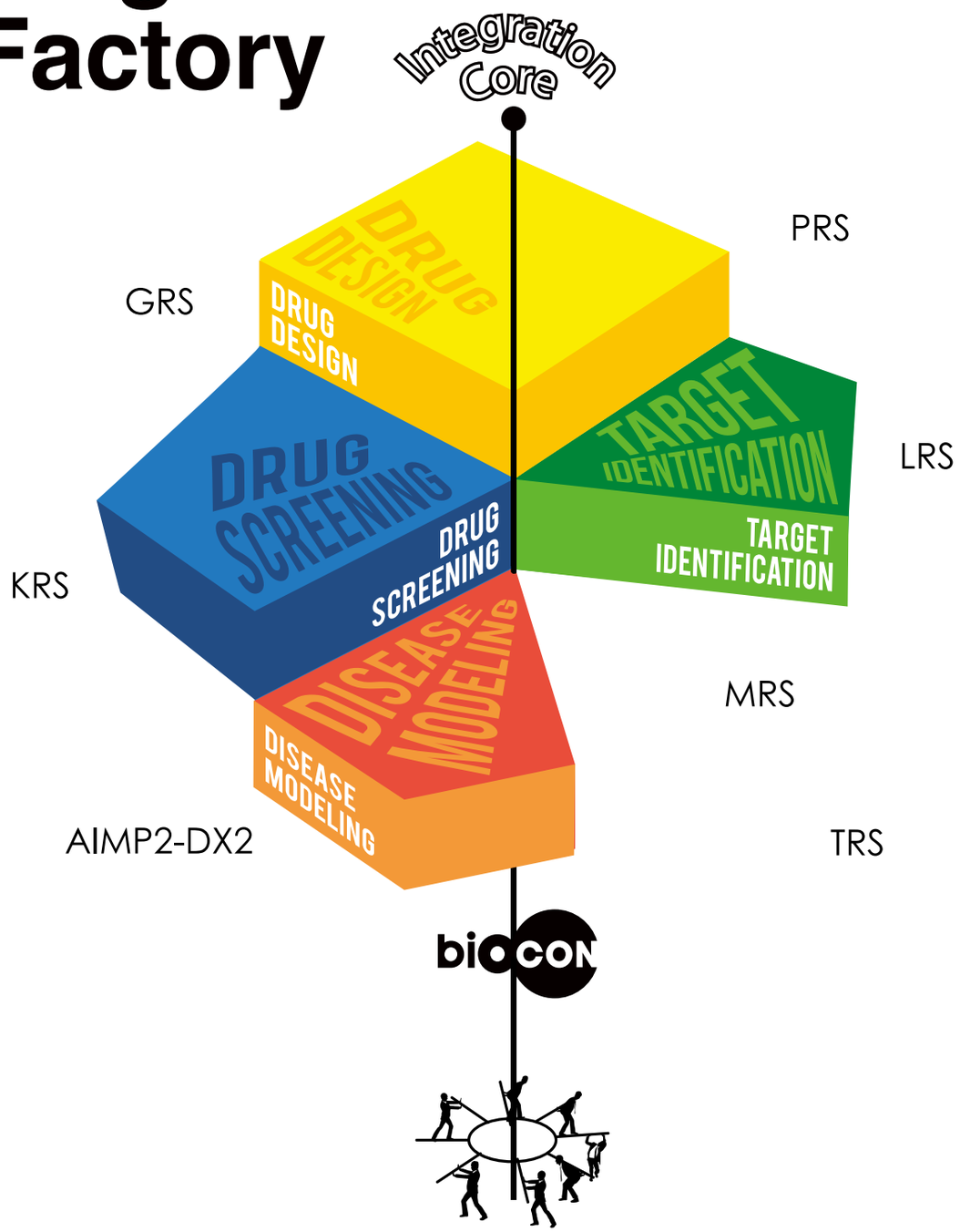
The need for new drugs is ever increasing due to the surge in diseases such as cancer, diabetes and dementia that are mainly caused by extended life span. However, the number of newly approved drugs is continuously decreasing, giving a crisis not only for drug industry but also eventually for human health.

In 2010, the Korean Ministry of Education, Science and Technology (MEST) launched the Global Frontier Project, targeted at solving global challenges in major R&D areas. The Medicinal Bioconvergence Research Center (Biocon) was initiated as one of the three projects with the aim of resolving difficulties during the development of novel drug discovery. This project will proceed for an initial nine years from 2010 to 2019, and is divided into three stages (1st: 2 years, 2nd: 3 years, 3rd: 4 years). With the financial support of about 140 million dollars and a projected time-line of 9 years, Biocon has leveraged a unique capability to discover and validate molecular pathways and targets at a level that is possible at few commercial enterprises.

For the last five years, Biocon has achieved outstanding progress in basic and applied researches. On the academic side, it produced more than 179 research articles including high impact journals such as Cell, Molecular Cell, Cell Reports, Nature Structure and Molecular Biology, Nature Chemical Biology, Nature Materials, Nature Rev Cancer and PNAS.
On the application side, Biocon has filed more than 152 patents from the related research and has established research alliance with ten pharma and biotech companies.



The Target Factory



03.

Strategy

4 specialist groups + 1 integration core group

Biocon seeks innovation across all of its activities including research, technology and strategy. At its core, Biocon is remodeling the R&D process itself. In the current global drug development process, target discovery, drug design, drug screening and disease model are generally addressed in a linear fashion, much like a factory product assembly line. In this system, the down-stream processes totally depend on the upstream, and any errors occurring upstream can be cumulative since there is little communication between the different research functions. This situation can be one of the attributes to the high failure rate of drug discovery. To avoid this problem, Biocon has built a unique “4+1” matrix system.

Specifically, four specialist groups have been established for target identification, drug design, drug screening and disease modeling. The discoveries and inventions generated from these four units are integrated, validated and matured in the integration core unit (ICU). This way, the time and cost for target validation and discovery can be significantly reduced. The team also includes the specialists from clinical and pharma industry to orient target development according to the clinical and industry unmet needs.

In addition, Biocon actively seeks and nurtures technical innovation by adopting cutting-edge technologies into bioscience. To achieve this goal, each project is driven by a under the technical framework that we call S.A.F.E. (standing for Smart, Accurate, Fast, Economic). Through these integrated biology and convergence technologies, Biocon seeks to build up world’s most efficient operational research system for target and lead discovery.

04.

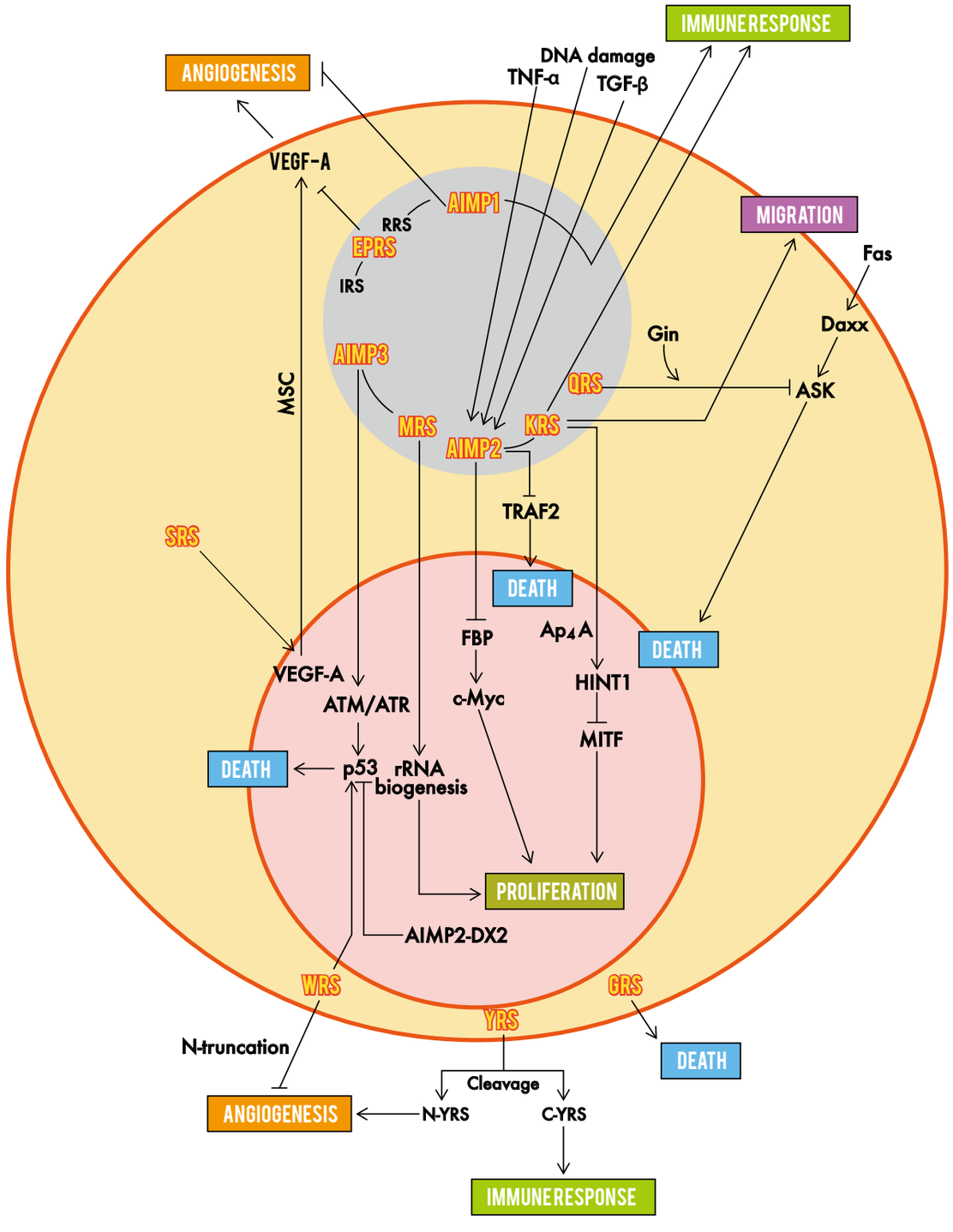
Focused Subject & Pipeline

Oncology and other complex diseases

Biocon focuses on human aminoacyl-tRNA synthetases (ARSs) and their interacting proteins as our primary target space of interest, and explores their potential to address diverse human diseases. These enzymes emerged early in evolution and catalytically link their cognate amino acids to tRNAs for protein synthesis.

For this reason, ARSs have been traditionally considered as housekeeping proteins solely dedicated to protein synthesis. However, recent new findings from Biocon and other groups world-wide on the novel functions of ARSs are rapidly changing the classical view of these enzymes. Indeed ARSs are emerging as central coordinators linking cell fate determination processes with protein synthesis.

Many ARSs are involved in the regulation of diverse signaling pathways beyond their catalytic roles in protein synthesis. Some representative functions of different ARSs (red letters) are shown schematically. Many ARSs change their cellular locations for their new roles outside protein synthesis. The pink circle indicates the nucleus of the cell and the grey circle indicates the macromolecular protein complex consisting of the indicated ARS. In the period from initiation of the program until the mid-point in 2015, Biocon has rapidly advanced the science in several key areas of ARS technology. A depiction of the key programs is shown below, together with the key high impact paper published for that program. In addition, several new targets with different indications are currently under active validation although they are not included in the table.



Glycyl-tRNA synthetase (GRS)

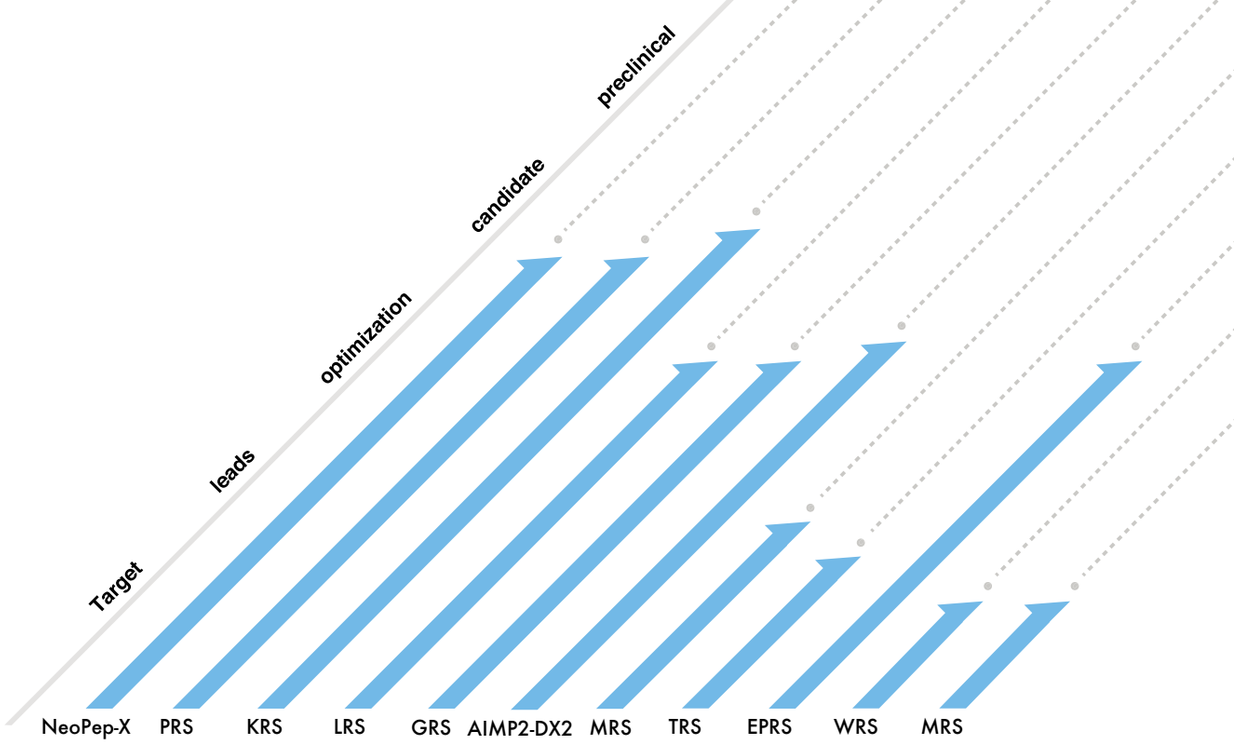
We have demonstrated that secreted human GRS is implicated in immune surveillance against cancer. Specifically, we have shown that GRS is secreted by macrophages and acts against certain tumor types via an interaction with K-cadherin. Injection of purified GRS has shown potent anti-tumor activity in vivo. This pathway is likely to have important implications in various cancers, including colon and lung cancer, and suggests GRS and its peptides as a novel resource for cancer immunotherapy.

Lysyl-tRNA synthetase (KRS)

We found that human KRS relocates to the plasma membrane after a laminin signal and enhances the cancer metastatic properties of cancer cells. We have discovered a class of small molecules that specifically binds to a unique cleft of KRS to inhibit its pro-metastatic activity. We believe that this set of observations offers an interesting new pathway to the development of novel drugs against metastasis and some other relevant diseases.

AIMP2-DX2

AIMP2 (ARS-interacting multifunctional protein 2) was previously found as an auxiliary factor associated with many different ARSs. We found that AIMP2 can also serve as a potent tumor suppressor with multiple mechanisms, including the activation of p53, a well-studied tumor suppressive protein. While establishing the important role of AIMP2 in tumor suppression over the past decade, we identified AIMP2-DX2, an exon-2 deleted splice variant of AIMP2 that trumps the tumor suppressive nature of AIMP2, and importantly, is upregulated in specific cancers. Thus, this variant may represent a promising target for many refractory cancers. We have identified potent small molecule candidates that inhibit AIMP2-DX2 with excellent selectivity over the wild type full-length AIMP2.



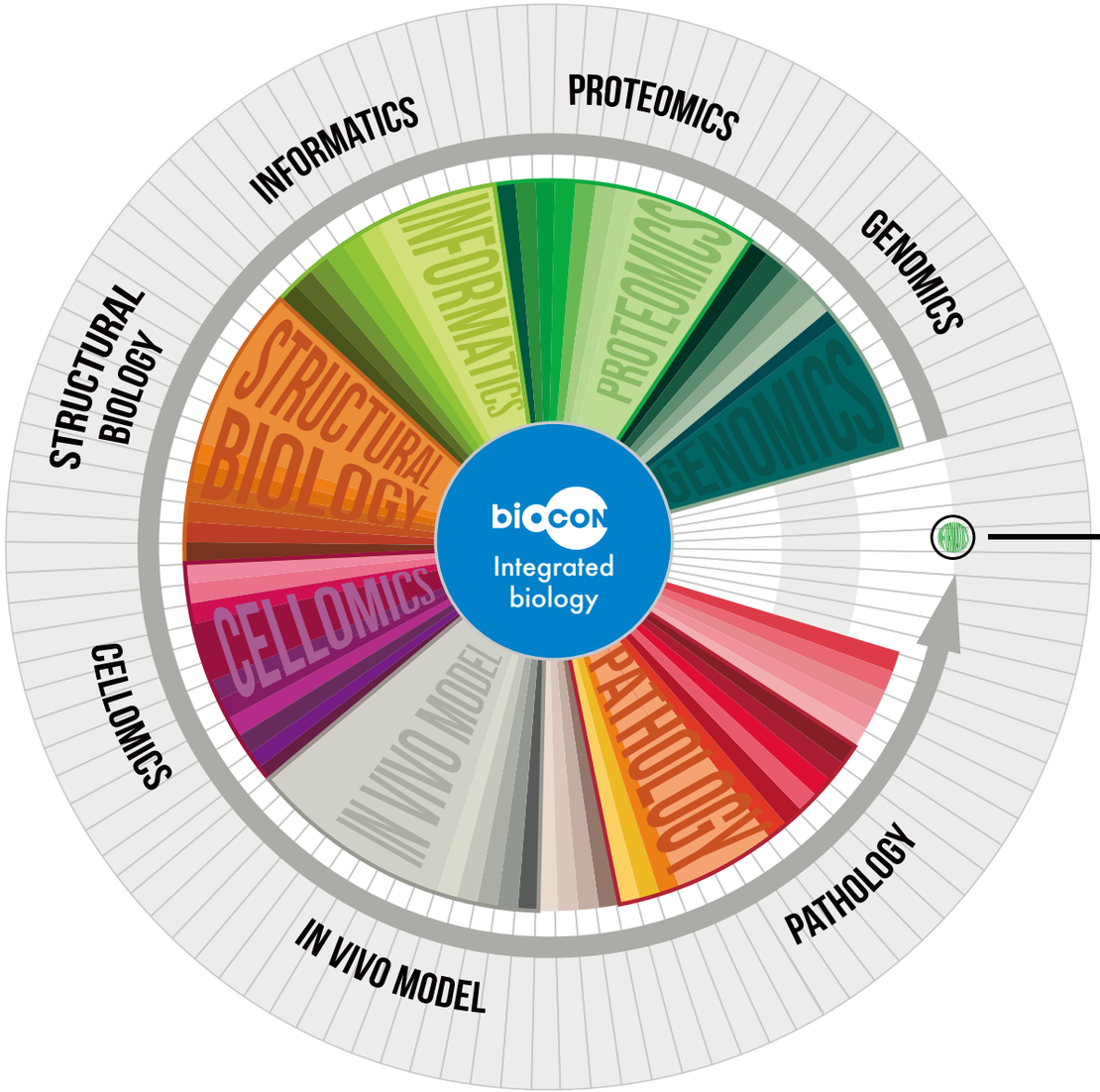
Biocon's Current Pipeline

Targets	Potential indications	Status	Key references
NeoPep-X	Tissue Regenerationi Alopecia	Pre-candidate	Unpublished
PRS (prolyl-tRNA synthetase)	Fibrosis Immune Diseases	Pre-candidate	Son et al, Acta Cryst D 2013 Unpublished
KRS (lysyl-tRNA synthetase)	Metastasis	Pre-candidate	Kim et al, Nat Chem Biol 2014 Unpublished
LRS (leucyl-tRNA synthetase)	Cancer Metabolic Diseases	Lead optimization	Han et al, Cell 2012 In preparation, 2016
GRS (glycyl-tRNA synthetase)	Cancer	Lead optimization	Park et al, PNAS 2012
AIMP2-DX2	Cancer Neural Disease	Lead optimization	Choi et al, Plos Genet 2011
MRS (methionyl-tRNA synthetase)	Cancer	Hit identified	Kwon et al, PNAS 2011 Nat Comm 2016, review
TRS (threonyl-tRNA synthetase)	Angiogenesis	Hit discovery	Fang et al, Nat Comm 2015
EPRS (glu-prolyl-tRNA synthetase)	Anti-viral	Lead optimization	Nat Immunol 2016, under review
WRS (tryptophanyl-tRNA synthetase)	Sepsis	Therapeutics & Biomaker	In preparation
MRS	Pancreatic cancer	Biomarker	In preparation

05.

Translation & Drug Development

Well-matured Leads are Linked to Industry



Lead Discovery

With excellent research achievements during last five years of Biocon, it is time to put in place a flexible and professional management group that can assess, decide and implement decisions for down-stream development that are independent of, but in co-operation with, the underlying scientific mission of Biocon. The action of this group needs to be focused and operated at the standard of global Pharmas since Biocon's assets in the pipeline are all "first-in-class". In light of the imperative to move programs from the academic to a translational setting, Biocon has established a TRAnslation and DEvelopment Group (TRADE), comprised of experienced professionals from the global drug development industry.

The TRADE group, led by the Biocon's Chief Business Officer, has a mandate to take Biocon's inventions and capabilities to global drug development partners. Currently, the TRADE group carries out rigorous assessment of internal Biocon programs with a particular emphasis on matching the target discovery and validation progress of Biocon with unmet market needs or opportunities.

Well-matured leads are linked to industry

Integration Core

biocon

Target & Lead Packages

The TRADE group is unique in having the capability to advance certain projects further downfield than most academic institutions. This capability is again derived from the internal structure of Biocon wherein access can be sought in a collaborative way with research groups specializing in chemistry, pre-clinical development or toxicology. Wherever necessary, Biocon has the financial capability to contract with well-recognized commercial laboratories to confirm data at a level that is appropriate to initiate formal discussion with pharma partners. Additionally, the TRADE group is working to establish relationships with both Known Opinion Leaders (or KOLs) in many of the target diseases that Biocon is seeking to address.

Since the Biocon model is to develop first-in-class approaches to many if not all of our disease targets, we recognize the need to get early "buy-in" from the key clinical leaders addressing these disease targets.

We expect that this strategy will pay dividends as our programs advance to the clinic, and to interactions with regulatory bodies such as the FDA and EMEA. We also recognize the value of interacting with experienced US and global drug development experts. In this case, we have a specific aim to hire, consult with and bring to Korea, development experts who have previously taken other drugs to the market in indications of interest to us such as oncology or fibrosis. By finding the right people we believe that we will both save time and money by being efficient in our down-stream activities but also have the benefit of avoiding development mistakes. There is additional benefit in the "cross fertilization" of these experts with the internal Biocon professional team members.

It is not the expectation that Biocon team members become drug development experts themselves but it is vital that their activities are integrated and assimilated into downstream clinically focused efforts to ensure true sustainability for the Biocon efforts.

Translation for IND Filing

* IND: Investigational New Drug

TRADE

Spinoff & License

Partnering

The Biocon's downstream strategy is flexible and pragmatic. We recognize that our academic network is best suited to basic research and to the development of students and future science professionals. However, we constantly seek ways to coordinate our work with the demand and the capabilities of the global pharma industry. We have identified three possible pathways as part of our translational and development strategy:

- Direct partnering of assets to global pharma or biotech partners.
- Spinning off start-up companies that will seek funding for further development.
- Internal development of assets to the IND stage, followed by either of the two pathways above.

At this moment, several different pharmaceutical and biotech companies and venture capital groups are working with Biocon on the early assessment of Biocon's original research outcome.

While commercialization efforts are still at an early stage, there is a continuing appetite among global pharma and venture capital companies to exploit novel targets and approaches. The role of the TRADE group is to continue to bridge the gap between Biocon and these down-stream customers.

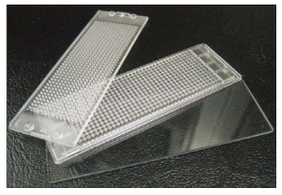

2014
2013
2012
2011
2020
2015
2015 기술사업화 유공자 산자부 장관상
제25회 호암상
2014
BRIC 선정 국내 바이오 성과 5대 뉴스
BRIC 선정 국내 바이오 성과 5대 뉴스
2013
KOFST 선정 10대 과학기술 뉴스
News

06.

Innovative Tech Products

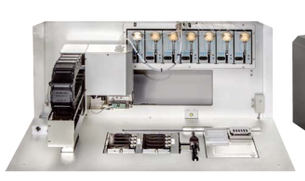
Smart, Accurate, Fast, Economic (S.A.F.E.) technologies

Biotechnology is to support drug to be commercialized and increase the productivity of drug use high technology, kit, and equipment in new drug discovery and to develop actual drug. For outstanding product, we have machine that can analyze the protein interaction, antibody develop technology, live image of disease detection, 3D culture analysis and also new biochip products are in process of development or have been developed.



Micropillar/microwell chip platform

- High-throughput screening platform for 3D human cell cultures
- Cost effectiveness:
  Minimal volume < 1 uL
  (beneficial for valuable human cells)
- Higher predictability:
  Spanning a gap between gene sequencing and xenografted animal models
- Social responsibility:
  Minimizing need for animal testing for drug development

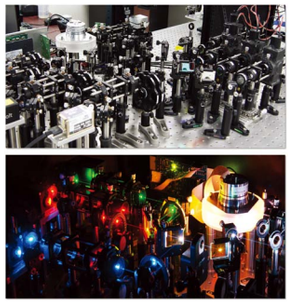


Microarray Spotter

- Liquid handling system designed for high speed, non-contact dispensing
- Dispensing volume of sample can be measured by a camera inspection system
- Flexible dispensing volume between 20 nL and 1000 nL by solenoid valves
- Ultra small dispensing volume such as 0.1 nL by piezoelectric pipettes

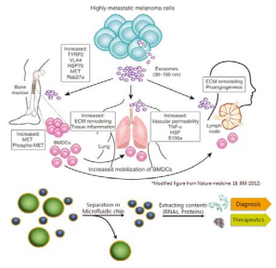
Scanner

- High-throughput fluorescence scanning system designed for cell-based biochemical assay
- Mercury lamp or a high-power LED illuminator is accommodated as a light source
- Real-time autofocus that enables uniform image quality across the whole scan area



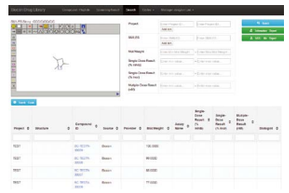
IntraVital Microscopy (IVM)

- Full custom-built system providing flexible system design for future modification and update
- Highly optimized for in vivo observation of mouse model for human disease
- Video-rate imaging
  (max. 100 fps - 512x512 pixels)
- 4-Color simultaneous imaging acquisition & recording
- Sub-pm in vivo imaging resolution
- In vivo visualization of molecular, cellular mechanism for novel target identification
- In vivo efficacy monitoring of various novel drug compound
- In vivo 4D cell tracking and monitoring
- In vivo monitoring of material delivery to target tissue
- In vivo real-time monitoring of microcirculation



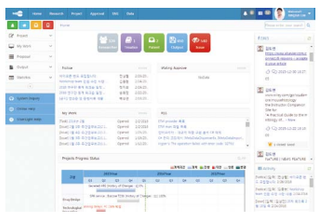
Nanobio Platform for Ultrafine Separation

- Exosome separation by Pseudo-PFF
- Chip function
  - Pseudo-PFF principle is adopted for minimal damage during exosome separation
  - Various resolution improving techniques (ex. drain channel) were introduced
- PS particle separation
  - PS particles were separated using Pseudo-PFF chip
- Exosome separation
  - Size sorting of exosome confirmed through NTA and WB



Drug Library

- Multi project data management :
  Efficient and simple data storage
- Storing chemical compounds, bioactivity data :
  MOL file format, Batch import support
- Robust security policy for CDA(Confidential Disclosure Agreement)
- Low solution price (Opensource framework/toolkit a RDKit and JSME Editor)



Project Landscaping System

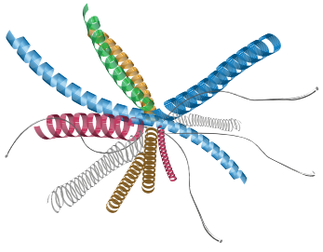
- All Knowledge in One Place :
  Project definition and planning, data
- WBS(Work Breakdown Structure) based project management
- Human Resource and Project process map management
- Improve for Project Management Office(PMO)

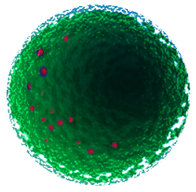
07.

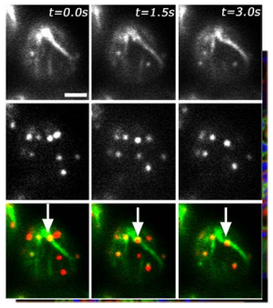
Infra-structure and Services

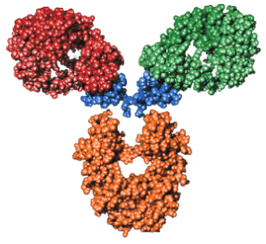
Providing cutting-edge technology to research community

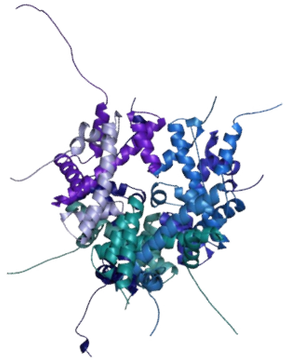
Biocon builds up the infrastructure that is not easily accessible to individual labs and even invents new instruments if necessary. Although these instruments are primarily established for Biocon's own research purpose, they are also open for the researchers outside of Biocon. For last five years, Biocon provided about 5 thousands of service activities to the research community and this activity will be further encouraged and expanded. Some of the Biocon's analytical services are listed below.











Protein

Protein Expression & Purfication Service

Unlike other suppliers of purified proteins, we promise quik and accurate delivery of the proteins, though 1-to-1 consultation with ARS protein and purification experts.

16 Aminoacyl-tRNA synthetase(16 ARSs)

Optimization for Protein Expression & Solubility
- Protein Expression and Solubility Tests available in various E. Coli host strains

Bacterial Expression & Purification
- Customized Target Protein Purification Service (>87%) Guaranteed
- Affinity (6xHis, TRX-6xHis, GST-tagged protein), Ion-Exchange, gel filtration chromatography available

3D Cell Culture

Research with the Closest Cancer Model

UP-Grade your Cancer Research Level with 3D Cell Culture, Closet Properties to Cancer in vivo system.

Why? What is 3D Cell Culture?
- 3D Cell culture strongly resemble cells in a living organism.

Applications of 3D Cell Culture
- In Vitro potency of anti-cancer drugs
- Test protein-protein interations in tumor spheroids
- Screen cancer stem cell inhibitors

Cell Imaging

Choose images you want, Visualize them without distortion

Cell image Analysis Service
- 2D & 3D Imaging
- FRET (Fluorescene Resonant Energe Transfer)
- FRAP (Fluorescene Loss in Photobleaching)
- Three-Dimensional Time-Lapse Imaging
- Multi-Point Time-Lapse Imaging
- Ultra High-Speed Imaging

SPR:Biacore T200

Surface Plasmon Resonance Detection System Biacore T200

With Biacore T200, do the standard analysis for inter-molecular interactions
- Easy for Everyone
- Label-Free
- Real-Time Internation Analysis
- High Quality Service Provided by Professional Operator

Biacore T200 Service from basic to various applications

Broad Coverage
- Protein
- LMW compounds
- Nucleic acid
- Carbohydrates
- Lipids
- Whole cells
- Viruses & bacteria

Reliable DATA Output
- Yes/No Binding
- Binding selecrivity
- Binding affinity
- Binding kinetics
- Active concentration
- Thermodynamics

Antibody

Validated, Short Term, Human Antibody Delvelopment

Antibody Production Service from Mammalian cells
- Ab Production and Purification from mammalian cells after transient transfection of provided Ab DNA
- Production Scale : 500mg - 2g
- Other customized service can be offered

ELISA Kit Development Service
- Sandwich ELISA development from purified Antibodies
- Report validation data: LoD, LoQ, Precision, Accurary and Specificity

Multiplex Bread Assay Service
- Multiplex Assay: We have the Luminex Bead Based Bio-Plex 200 in center.

Antigen & Antibody Quality Check Service
- Check the Purity and Electrophoresis pattern of Antigen of Antibody based on the Lab-on-a-chip using Bioanalyzer

Proteomics

Proteomics Premium Service

Global Proteome Profiling Service
- Protein identification
- Quantitative proteomics (SILAC, mTRAQ, and Label-Free)
- Interactome analysis (Binding partners discovery of target protein)

Post-translation modification (PTM) Analysis Service
- Protein PTM identification (Phosphorylation, acetylation, ubiquitination..)

Drug-Target Profiling Service
- Target protein discovery for drug selected from phenotype screening

Consulting for proteome analysis
- Sample preparation
- Analysis process
- Data interpretation

In Vivo

Validate Your Research in Mouse Models

Animal models for ARS research on shelf
- ARS reporter mouse
- ARS transgenic mouse
- ARS conditional KO mouse
- Inducible Cre mouse

Animal models for Cancer research on shelf
- MMTV-neu mouse
- MMTV-pyVT mouse
- p53 KO mouse

Standardized material for mouse research
- MEF cells from GEM mouse
- Frozen or FFPE tissue from GEM mouse
- Frozen of FFPE cancer/normal tissue

Tissue analysis service for mouse research
- Tissue selctioning/histology/IHC
- Expression analysis from reporter mouse
- Slide imaging

Biobank

Contamination Free Research Meterial Infra

Danation - Cell line banking system
We welcome any cell lines for donation to help build a biobank to help other laboratories. Before any cell lines are accepted, they should checked for contamination by STR analysis.

Management - Processing Preservation
- Organization and documantation
- Storage and stock
- QA / QC monitoring
- A list of all standard operation procedures (SOPs)

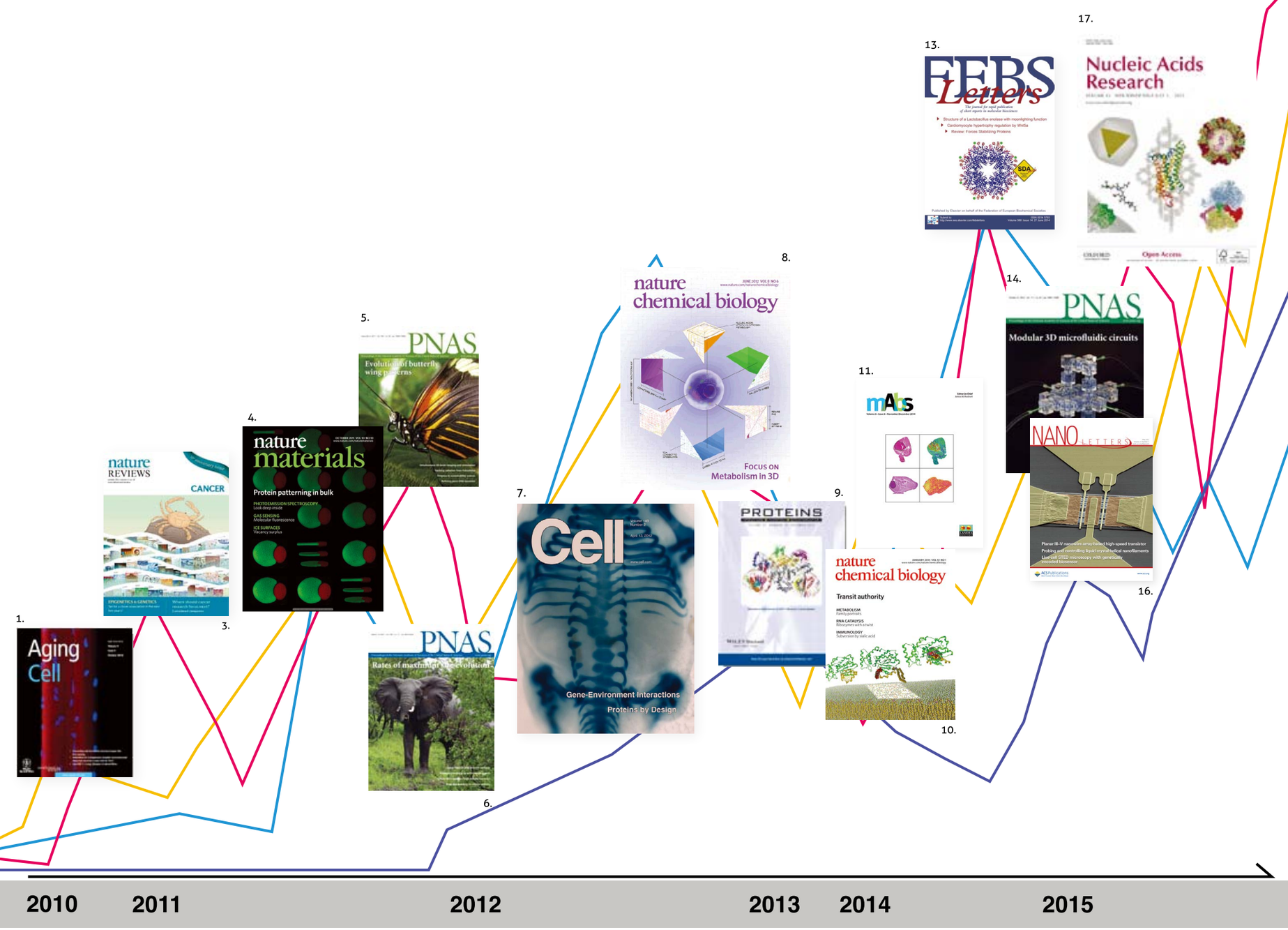
Service - Make an order mycroplasm test- Ordering
- You can purchase any cell line cultured of frozen stock.
- For delivery, you sent the agreement (MTA) and order, we can out the shipment.

Mycoplasma Testing Service
- Please fill out the application form on our service page before sending sample. If you need more information, Please contact our Biobank Service Department.

Achievements

Total 179 research articles and 152 patents

1. **Downregulation of lamin A by tumor suppressor AIMP3/p18 leads to a progeroid phenotype in mice.**
   Aging Cell. 2010 Oct;9(5):810-22
2. **Cancer-associated splicing variant of tumor suppressor AIMP2/p38: pathological implication in tumorigenesis.**
   PLoS Genet. 2011 Mar;7(3):e1001351
3. **Aminoacyl-tRNA synthetases and tumorigenesis: more than housekeeping.**
   Nat Rev Cancer. 2011 Sep 23;11(10):708-18
4. **Programming magnetic anisotropy in polymeric microactuators.**
   Nat Mater. 2011 Oct;10(10):747-52
5. **Dual role of methionyl-tRNA synthetase in the regulation of translation and tumor suppressor activity ofaminoacyl-tRNA synthetase-interacting multifunctional protein-3.**
   PNAS. 2011 Dec 6;108(49):19635-40
6. **Secreted human glycyl-tRNA synthetase implicated in defense against ERK-activated tumorigenesis.**
   PNAS. 2012 Mar 13;109(11):E640-7
7. **Leucyl-tRNA synthetase is an intracellular leucine sensor for the mTORC1-signaling pathway.**
   Cell. 2012 Apr 13;149(2):410-24
8. **Trp-tRNA synthetase bridges DNA-PKcs to PARP-1 to link IFN-γ and p53 signaling.**
   Nat Chem Biol. 2012 Apr15;8(6):547-54
9. **Crystal structure of human cytosolic aspartyl-tRNA synthetase, a component of multi-tRNA synthetase complex.**
   Proteins. 2013 Oct;81(10):1840-6
10. **Chemical inhibition of prometastatic lysyl-tRNA synthetase-laminin receptor interaction.**
    Nat Chem Biol. 2014 Jan;10(1):29-34
11. **A general strategy for generating intact, full-length IgG antibodies that penetrate into the cytosol of living cells.**
    MAbs. 2014;6(6):1402-14
12. **The structural basis for the negative regulation of thioredoxin by thioredoxin-interacting protein.**
    Nat Commun. 2014;5:2958
13. **The crystal structure of arginyl-tRNA synthetase from Homo sapiens.**
    FEBS Lett. 2014 Jun 27;588(14):2328-34
14. **Structure of the ArgRS-GlnRS-AIMP1 complex and its implications for mammalian translation.**
    PNAS. 2014 Oct 21;111(42):15084-9
15. **Structural basis for full-spectrum inhibition of translational functions on a tRNA synthetase.**
    Nat Commun. 2015 Mar 31;6:6402
16. **Liposome-based engineering of cells to package hydrophobic compounds in membrane vesicles for tumor penetration.**
    Nano Lett. 2015 May 13;15(5):2938-44
17. **The BioMart community portal: an innovative alternative to large, centralized data repositories.**
    Nucleic Acids Res. 2015 Jul 1;43(W1):W589-98



FEATURE

Medicinal Bioconvergence Research Center:

Innovation of Drug Discovery through Novel Target Discovery and Convergence Technology

by Prof Sunghoon Kim

Seoul National University, Gwanak-ro, Gwanak-gu, Seoul 151-742, Korea
Email: sungkim@snu.ac.kr, Tel: 82-2-880-8180, Fax: 82-2-875-2621

The extension of life expectancy dramatically increases chronic diseases such as cancer, dementia, diabetes, and cardiovascular diseases. Besides, a pandemic is considered as one of the four major risks at global level based on the recent OECD reports. Nonetheless, new drug discovery stays stagnant during last decade and ironically, pharmaceutical industry suffers from low return of investment in R&D. In 2010, only 21 new drugs were approved by FDA, USA. (see Fig. 1).

Since 2009, the Korean Ministry of Education, Science and Technology (MEST) has initiated the new program named 'Global Frontier Project' that can provide solutions to the challenges in major R&D area. Medicinal Bioconvergence Research Center (Biocon) was selected as one of the three projects to solve current difficulties in new drug discovery. As medicine becomes more personal and stratified, Biocon foresees that the biggest bottleneck in drug discovery would be to secure novel therapeutic targets and biomarkers that can accurately address various human diseases. With this prediction, Biocon is initially focusing on novel therapeutic target discovery and validation that can be used by industry with high probability of success.

With the financial support of about 140 million dollars, this project will continue for a total 9-year period that is divided in three phases. By the end of the project, Biocon is aiming to establish '3D Atlas of Target-Drug Interactome' that shows the total map of the fully validated therapeutic targets with all the necessary attributes that are required for drug screening. (Fig. 2).

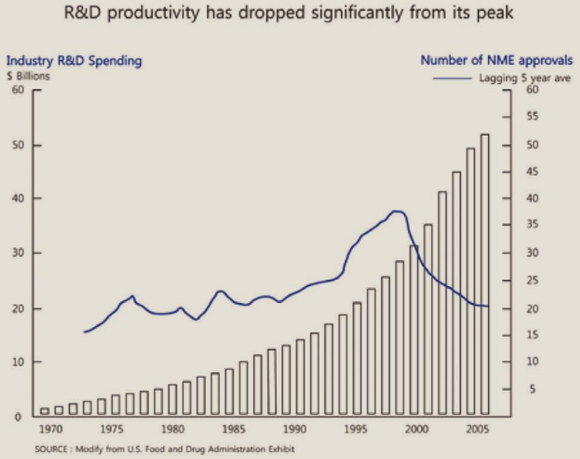


Fig. 1: Decreasing return of investment (ROI) in new drug discovery. Adapted from

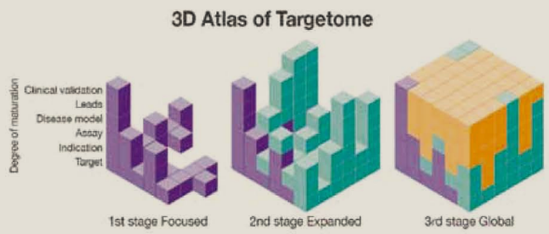


Fig. 2: Generation of fully validated target atlas that can be use for new drug discovery.

Asia Pacific Biotech News 2012

"Published total 179 research articles in top-notched journals and filed 152 patents."

BioCentury, THE BERNSTEIN REPORT ON BIOBUSINESS MARCH 11, 2013 PAGE A5 OF 22

Product Discovery & Development

Neomics' new tricks

By Emily Cukier-Meisner
Senior Writer

Neomics Co. Ltd. is leveraging previously unknown functions of aminoacyl tRNA synthetases and their interacting proteins to build a pipeline of therapeutics and diagnostics for cancer. The most advanced program focuses on detecting and targeting an oncogenic splice variant of AIMP2 that may be overexpressed in lung, colon and ovarian cancers.

Aminoacyl tRNA synthetases (ARSs) have been known for almost four decades as essential housekeeping enzymes that attach the correct amino acid to tRNA during protein synthesis. Since all cells require this process, human ARSs were generally not considered useful therapeutic targets.

Several companies have attempted to target bacterial ARSs with antibiotics, but other than **GlaxoSmithKline plc**'s marketed antibiotic Bactroban mupirocin, these efforts have met with limited success. Investigational compounds targeting bacterial ARSs have fallen by the wayside due to resistance or pipeline reprioritization.

Cubist Pharmaceuticals Inc. was founded to investigate ARS inhibitors but later declared the target "simply not druggable" based on low hit rates and difficulty generating lead compounds (see *BioCentury, Dec. 24, 2001*).

However, the possibility of targeting the pathway in human disease was opened in the late 1990s when Sunghoon Kim of the **Seoul National University** College of Pharmacy and colleagues researched components of eukaryotic ARSs unrelated to protein synthesis.

"It's old research, but in this aspect it is completely new biology and new medicine," said Kim, who is a scientific advisor and founder of Neomics.

Neomics spun out of Seoul National University in 2005 to develop therapeutics and diagnostics related to AIMP2 (aminoacyl tRNA synthetase complex-interacting multifunctional protein 2), which is a non-enzymatic component of the macromolecular protein complex that forms with a subset of the ARSs.

In 2002, Kim and colleagues published in the *Proceedings of the National Academy of Sciences* the finding that AIMP2-knockout mice die neonatally. In a 2003 publication in *Nature Genetics*, the group determined the deaths arose largely from severe overproliferation of epithelial cells in lung alveoli, suggesting that AIMP2 functioned beyond protein synthesis as a potent suppressor of cell proliferation.

Further investigation conducted by Kim's lab and presented in publications over 2003-09 showed that AIMP2 exerts antiproliferative and pro-apoptotic effects through multiple potential mechanisms including promotion of transforming growth factor (TGF) beta-mediated growth arrest, mediation of tumor necrosis factor (TNF) pro-apoptotic signaling, and prevention of p53 ubiquitylation, as summarized in a 2011 review in *Nature Reviews Cancer*.

Though the protein itself generally acts as a tumor suppressor, a splice variant of AIMP2 lacking exon 2 (AIMP2-DX2) is highly expressed in lung cancer and has been shown to compromise the tumor

See next page

Neomics in Biocentury 2013

SciCafé

Nature Science Cafe Asia
Biotech Science & Investment Forum

Novel Cancer Therapeutics Derived from Aminoacyl-tRNA Synthetases

Sunghoon Kim, Ph.D. Professor and Director

Medicinal Bioconvergence Research Center (BIOCON), Dept. Molecular Medicine & Biopharmaceutical Sciences, College of Pharmacy, Graduate School of Convergence Science and Technology, Seoul National University, Korea

Sunghoon Kim is a professor at Seoul National University College of Pharmacy and Graduate School of Convergence Science and Technology, and also a director of "Medicinal Bioconvergence Research Center (Biocon, http://biocon.re.kr)" that is the biggest national project in Korea for novel target and lead discovery. In this project, he is building up the pipeline of druggable "target and lead" packages for industrial development.

In academic community, he is globally recognized as a pioneer in the new biology and translational research of human aminoacyl-tRNA synthetases and their signaling network. He published more than 150 research articles in top-notched journals and filed more than 70 patents. He was nominated as a distinguished university professor and received several prestigious awards in Korea such as the best scientist award (2012), the scientist of the year (2006) and Korea science award (2003).

For educational and professional background, he received bachelor's degree at Seoul National University College of Pharmacy, master's degree at Korea Advanced Institute of Science and Technology Department of Biological Sciences, Korea and PhD degree at Division of Biology and Medicine, Brown University, USA. He worked as post-doctoral fellow at MIT and also as a senior research scientist of Cubist Pharmaceuticals, USA. He also worked as visiting professor at Scripps Institute, and as a founding scientist of ATYR Pharma, USA. He is currently a visiting scientist of Institute of Cell and Material Sciences, Kyoto University, and an advisor of National Center for Drug Screening, China.

Nature Science Cafe Asia 2015


김명희

09.

Research Network & People

Serving as a hub to bridge basic science to drug discovery

Biocon's Network

Biocon is embracing many domestic and foreign institutions in order to keep up the quality of the research. Currently, 60 different institutions and universities are participating in Biocon. As foreign partners, researchers affiliated to 21 institutions in 10 countries work as science advisors as well as research collaborators. Biocon also mediates translational research in collaboration with major leading hospitals in Korea. Through this domestic and global collaborative network with academia, hospital and industry, Biocon will serve as a research hub to bridge basic science to drug discovery through translational research.

Biocon is multi-disciplinary and multi-organizational project while retaining the headquarter office and integration core unit in Seoul National University. Many researchers in diverse areas, who share the same vision, are participating in the Biocon project. Those include professors, medical doctors and principal investigators in national institutes and industries.
The total number of the participating researchers and organizations would vary dynamically depending on the project goal and emerging needs.

Most of the participating PIs joined to Biocon while maintaining their own affiliated institutions. Since the integration core unit (ICU) consists of only full-time specialists in different areas in biology, chemistry and engineering, their roles are to integrate all the new discoveries and technologies into one package, and to facilitate the interactions and communications among the extramural research partners. Thus, the people in ICU functions like a heart to circulate energy among the Biocon researchers.

Advisory Board Members and Research Collaborators

Name	Institution	Country	Nobel Prize
Aaron Ciechanover	Technion	Israel	2004 Nobel Prize in Chemistry
Ada Yonath	Weizmann Inst.	Israel	2009 Nobel Prize in Chemistry
Alex Matter	Exp. Therapeutics Cntr.	Singapore	
Andy Yun	Mass General Hospital	USA	
Chales Lee	Yale Univ. Jackson Lab.	USA	
Ehud Razin	Hebrew Univ.	Israel	
Hiroaki Osada	Riken	Japan	
Hubert Becker	CNRS	France	
John Blenis	Harvard Medical School	USA	
Louis Ignarro	UCLA	USA	1998 Nobel Prize in Physiology or Medicine
Marius Ueffing	University Medical Center, Tübingen	Germany	
Min Guo	Scripps, Florida	USA	
Ming Wei Wang	Shanghai Isnt. Materia Medica	China	
Minoru Yoshida	Riken	Japan	
Motonari Uesugi	Kyoto Univ.	Japan	
Nahum Sonenberg	McGill Univ.	Canada	
Paul Schimmel	Scripps, La Jolla	USA	
Peter Hodder	Scripps, Florida	USA	
Peter Shepherd	Auckland Univ.	New Zealand	
Richard Lerner	Scripps, La Jolla	USA	
Richard Simpson	La Trobe Univ.	Australia	
Robert Huber	Max Planck Inst.	Germany	1988 Nobel Prize in Chemistry
Roger Kornberg	Stanford Univ.	USA	2006 Nobel Prize in Chemistry
Susan Martinis	Univ. of Illinois	USA	
Young Tae Chang	NUS	Singapore	

4 Specialist Groups

Target Identification	
Beom Sik Kang	Kyungpook Natl. Univ.
Kyung Jin Kim	Postech
Key Sun Kim	KIST
Myung Hee Kim	KRIBB
Jaesang Kim	Ewha Univ.
Hyeong Gon Moon	Seoul Natl. Univ. Hosp.
Eun Ok Paek	Hanyang Univ.
Ji Joon Song	KAIST
YoungKee Shin	Seoul Natl. Univ.
Ki Won Lee	Seoul Natl. Univ.
Cheolju Lee	KIST
Young Ho Jeon	Korea Univ.
Hyun Suk Jung	Kangwon Univ.
Yunje Cho	Postech
Yoon La Choi	Sungkyunkwan Univ.
Byung Woo Han	Seoul Natl. Univ.
Won Shik Han	Seoul Natl. Univ. Hosp.
Kwang Yeon Hwang	Korea Univ.
Daehee Hwang	Postech
Murim Choi	Seoul Natl. Univ.
Mi Rim Jin	Daejeon Univ.
Jin Won Huh	Asan Med. Ctr.

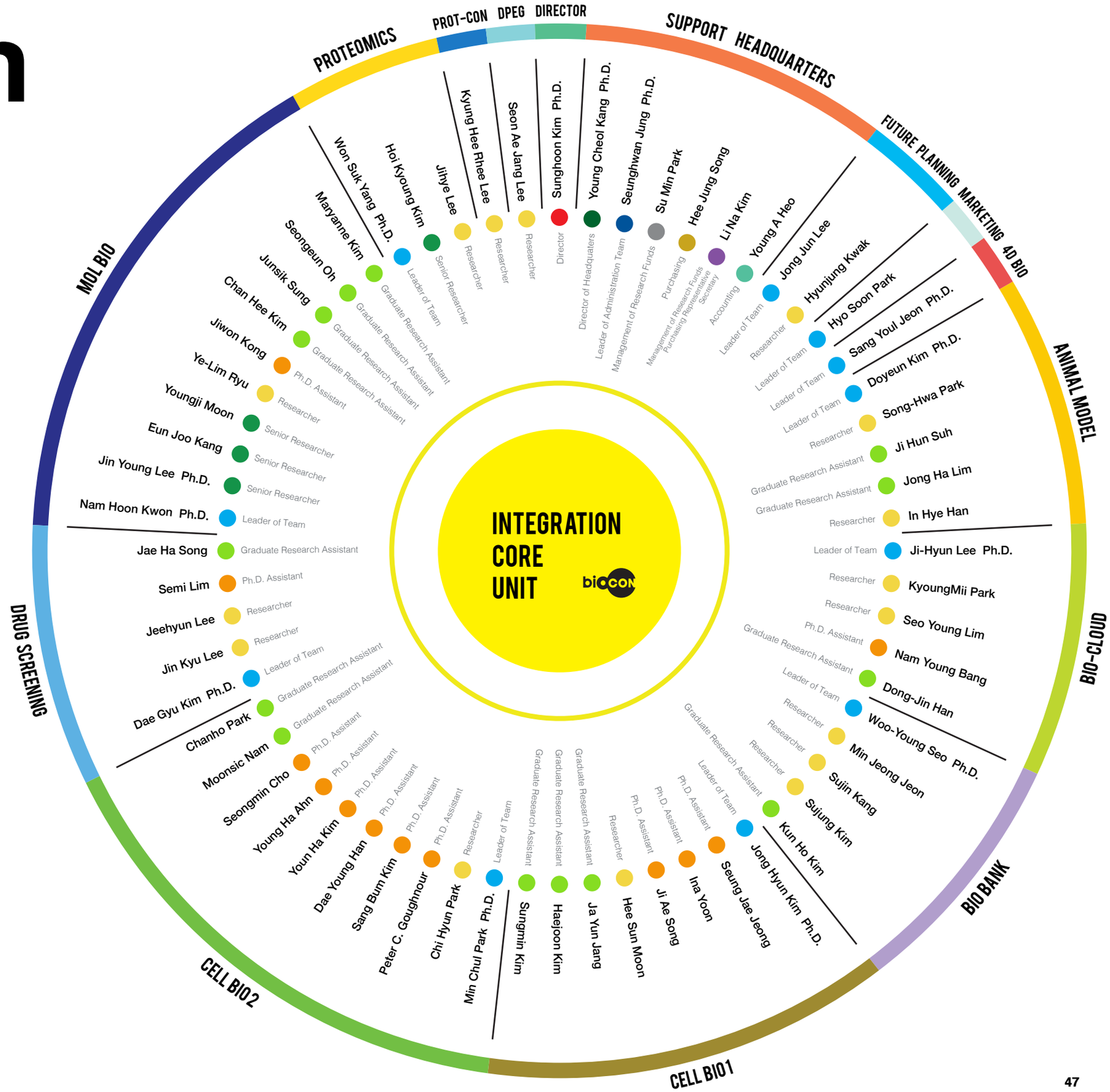
Drug Design	
Taek Jin Kang	Dongguk Univ.
Wan Kyu Kim	Ewha Univ.
Yong Sung Kim	Ajou Univ.
Sung Ho Ryu	Postech
Byung Doo Song	SKAI
Hyun Bo Shim	Ewha Univ.
Bong Yong Lee	Kyung Hee Univ.
Sunkyung Lee	KRICT
Jeewoo Lee	Seoul Natl. Univ.
Hae Ryun Lee	Postech
Heeyeong Cho	KRICT
Yun Heo	Yuhan Coporation
Younghoon Kim	Crystal Genomics
Ji Ho Park	KAIST
Gyoonhee Han	Yonsei Univ.
Kyeong Lee	Dongguk Univ.
Young-Ger Suh	Seoul Natl. Univ.

Drug Screening	
Sunghoon Kwon	Seoul Natl. Univ.
Philhan Kim	KAIST
Seung Bum Park	Seoul Natl. Univ.
Joon Myong Song	Seoul Natl. Univ.
Noo Li Jeon	Seoul Natl. Univ.
Honggu Chun	Korea Univ.
Jin Woo Choi	Wonkwang Univ.
Byung Joon Hwang	SKAI
Seong Keun Kim	Seoul Natl. Univ.
Hee-Sung Park	KAIST
Soo Hyun Kim	Konkuk Univ.

Disease Model	
Kyung Sun Kang	Seoul Natl. Univ.
Young Yun Kong	Seoul Natl. Univ.
Bum Joon Park	Pusan Natl. Univ.
Ho Jun Seol	Samsung Med. Ctr.
Jung Weon Lee	Seoul Natl. Univ.
Ho Lee	Natl. Cancer Ctr.
Young Bum Huh	Kyung Hee Univ.
Yung-Jin Kim	Pusan Natl. Univ.
Youngil Koh	Seoul Natl. Univ.
Dong Ki Lee	Yonsei Univ.
Kang Young Lee	Yonsei Univ.
Kweon Yu	KRIBB

- KIST: Korea Institute of Science and Technology
- KRIBB: Korea Research Institute of Bioscience and Biotechnology
- KAIST: Korea Advanced Institute of Science and Technology
- POSTECH: Pohang University of Science and Technology
- SKAI: Scripps Korea Antibody Institute
- KRICT: Korea Research Institute of Chemical Technology

Integration Core Unit



- Director
- Director of Headquaters
- Leader of Administration Team
- Management of Research Funds
- Purchasing
- Management of Research Funds Purchasing Representative Secretary
- Accounting
- Leader of Team
- Researcher
- Graduate Research Assistant
- Ph.D. Assistant
- Senior Researcher

10.

Cultural Activities

Delivering Biocon's vision to the public via art and culture

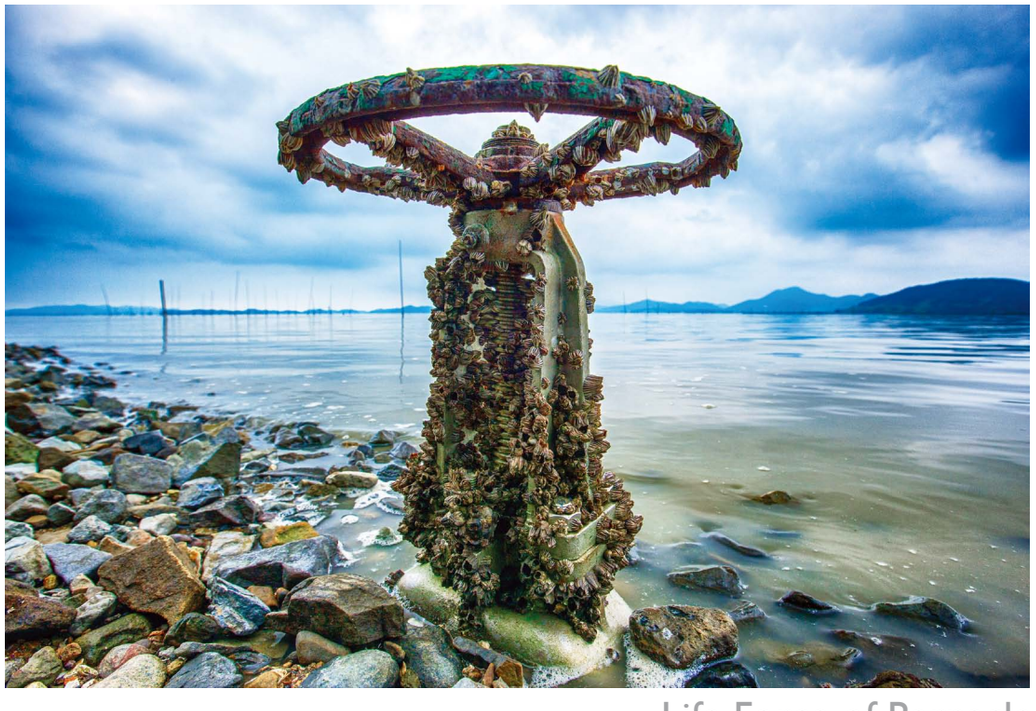
Since Biocon is supported by citizen's taxes, it is necessary to explain why Biocon was established and how Biocon's activities are connected to public. To facilitate the public relationship, Biocon initiated several different activities. First, some of the published research subjects are remade as animations or cartoons, and posted in the sites of social network. Second, Biocon hosted Bio-Art Contest so that anybody can show the beauty of life in their own eyes. Please visit the website for more information. bioart.biocon.re.kr Third, Biocon signed up "memorandum of understanding" with a several different centers (science museum, cultural center and gallery) to co-organize exhibitions, events, and the education of bioscience to public.

Bio-Art Contest
2015 Winners

Metamorphoses
Dimitri Dimov

Fungus Inhale Vaccination

Min Kyung Park



Life Force of Barnacle

Ji Hyang Lim

Bios

Roberta Trentin

Creator of Abundance

Soo Ah Lee

Cleared Fish Skeleton

Adam P. Summers

The Lonely Ballerina

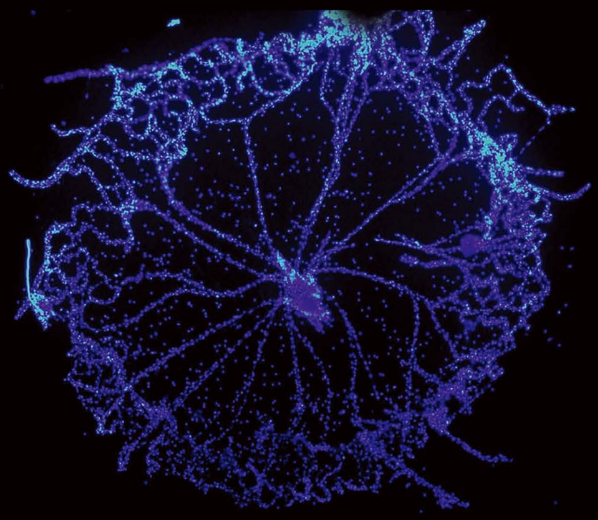
Ryong Kim

Bio-Art Contest

2014 Winners

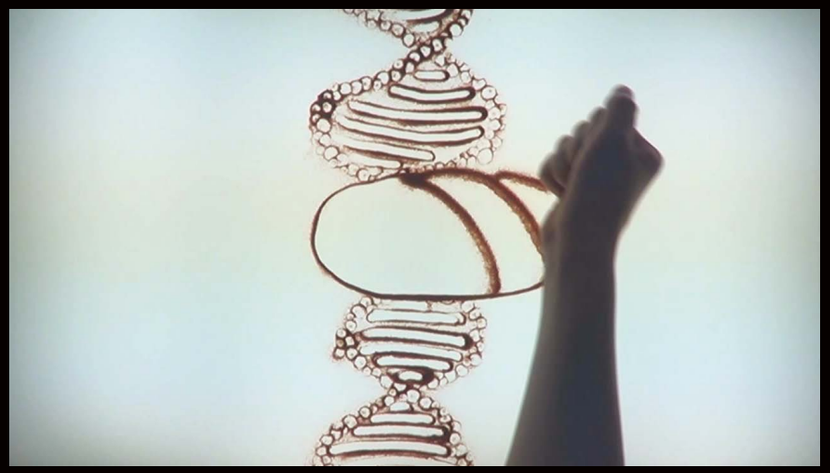
Human Emotions

Ah Reum Lee



Across the Universe

Hyo Jin Park



Find the Miracle

Mi Hyun Kim

365

Seo Youn Choi

Plants Equipment

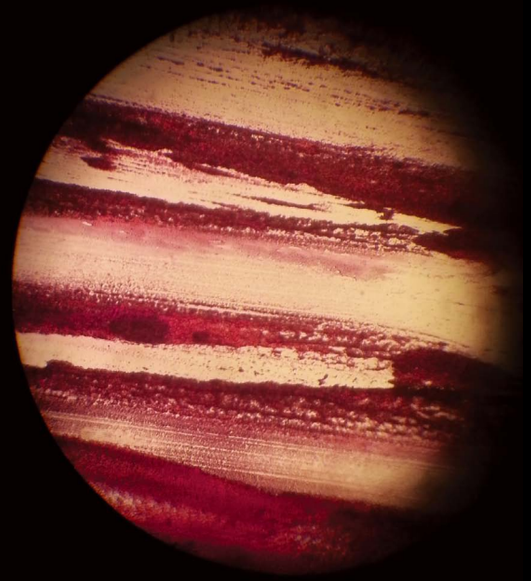
Hyo Jung Son

Nature and Human

Eun Jung Kim

Beauty of Nature

Soo Youn Choi



Jupiter

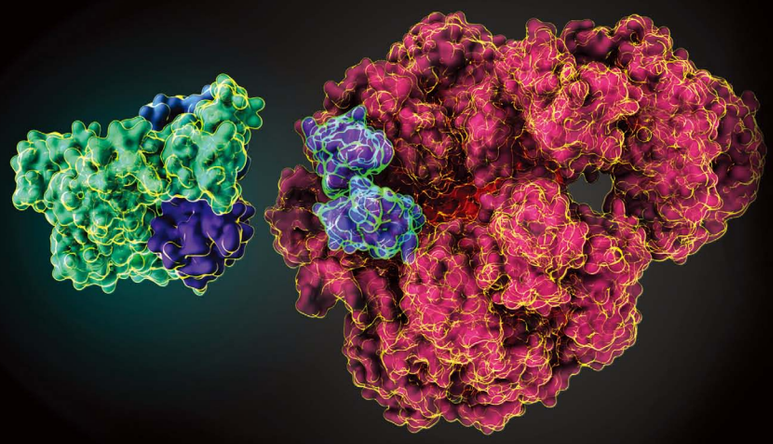
Woo Sang Hong

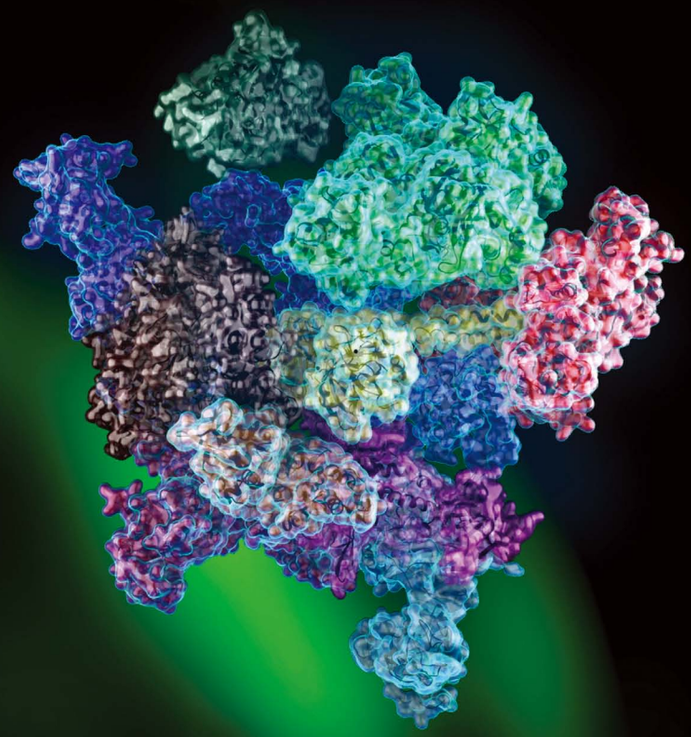
Bio-Art Contest

2013 Winners

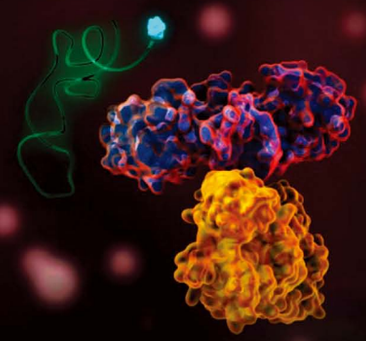
Life of Tree

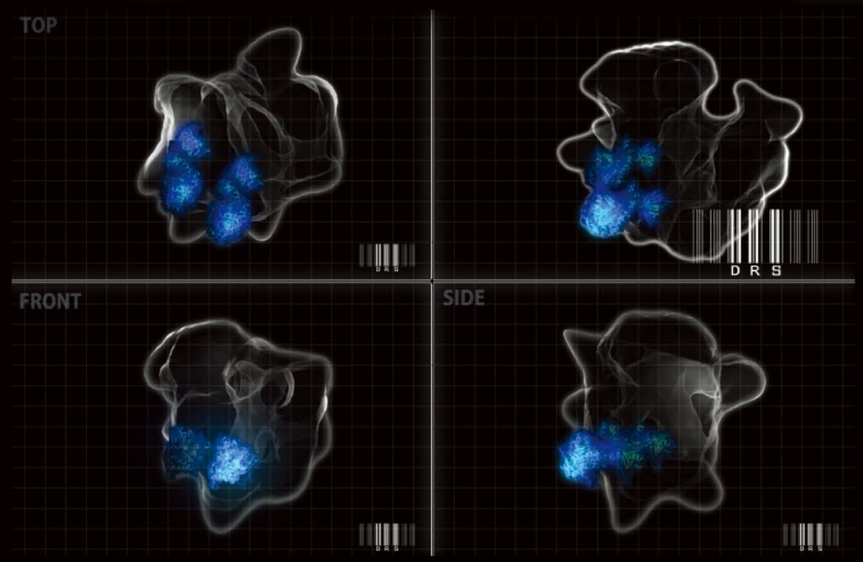
Sung Chul Ha



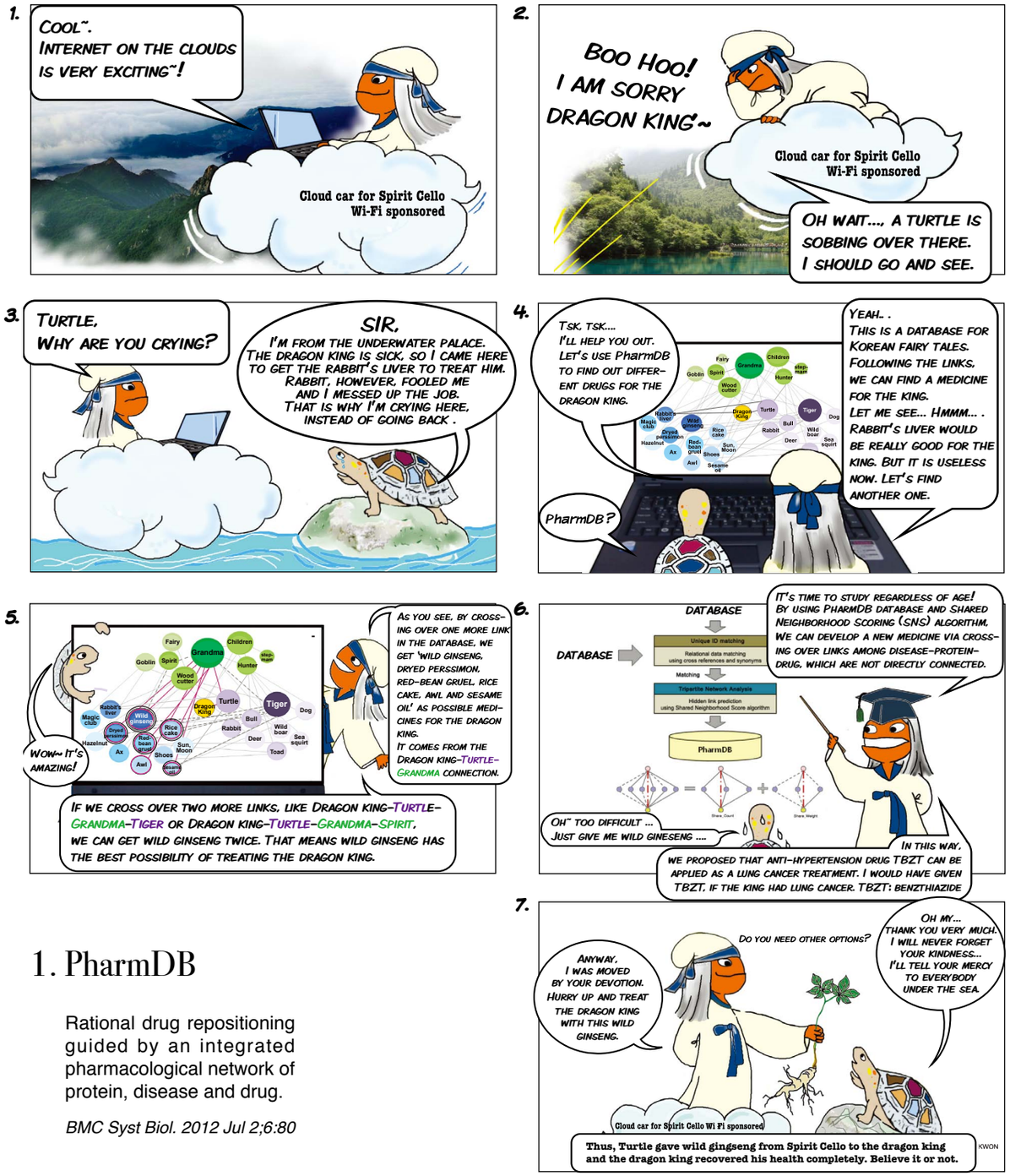


Biomedical Illustration





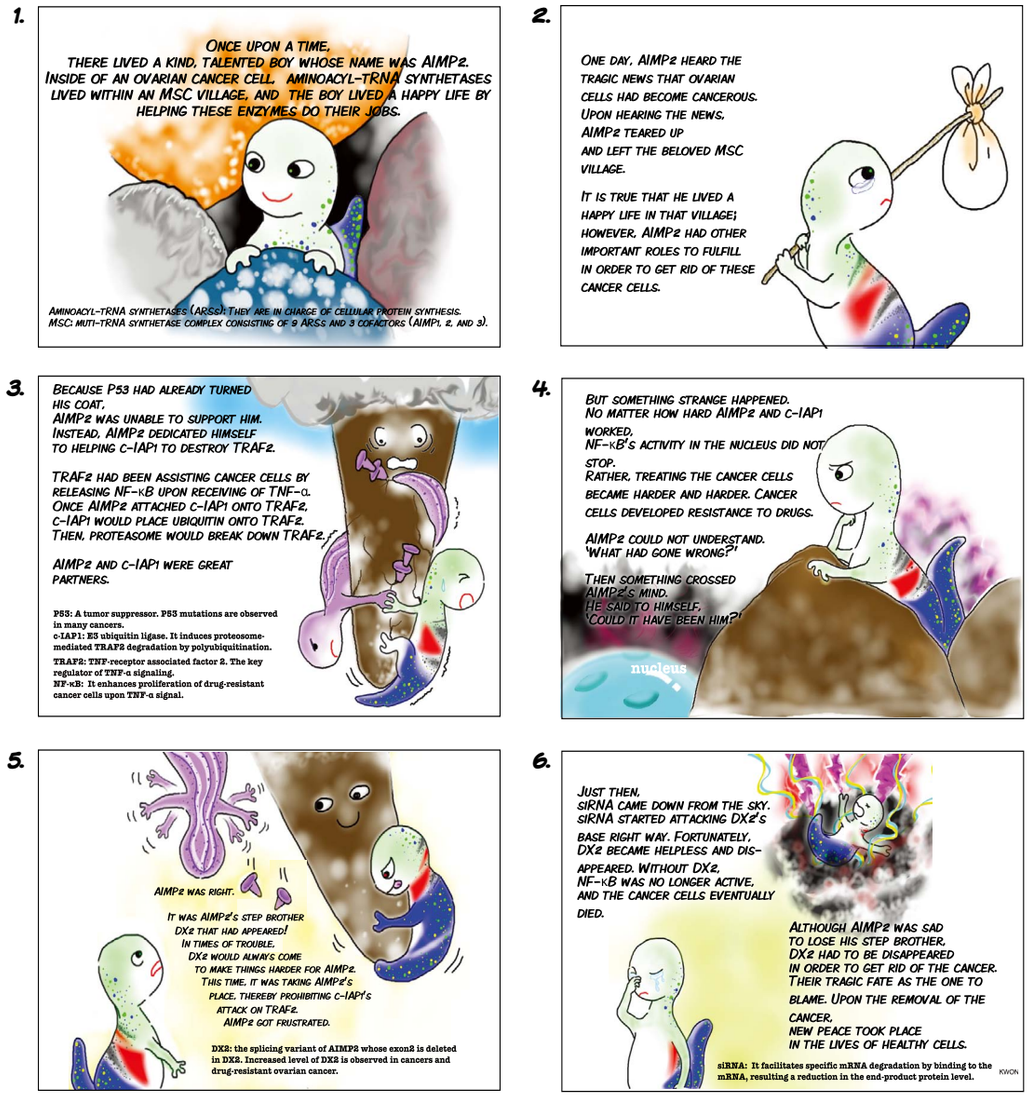
Cartoon



1. PharmDB

Rational drug repositioning guided by an integrated pharmacological network of protein, disease and drug.

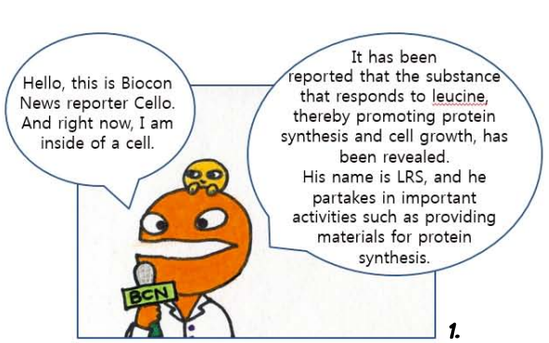
BMC Syst Biol. 2012 Jul 2;6:80

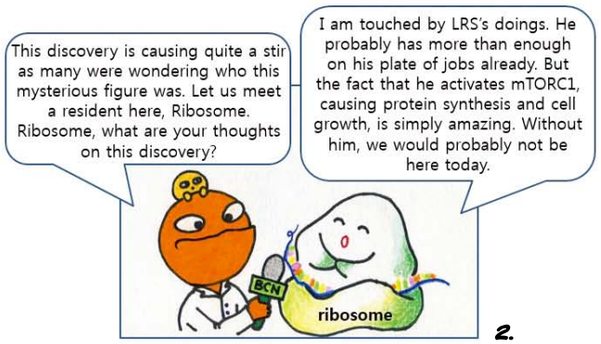


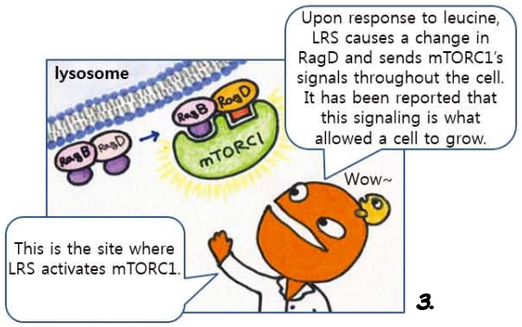
2. DX2 as an Effective Target against Chemoresist Ovarian Cancer

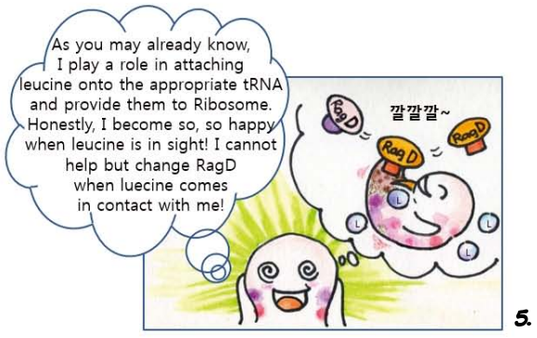
Splicing variant of AIMP2 as an effective target against chemoresistant ovarian cancer.

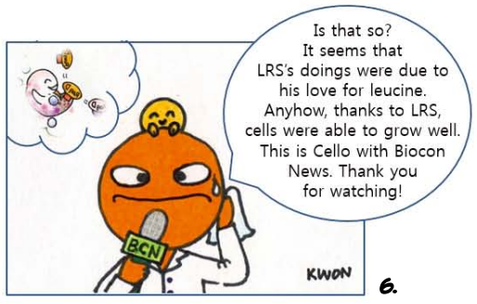
J Mol Cell Biol. 2012 Jun;4(3):164-73.







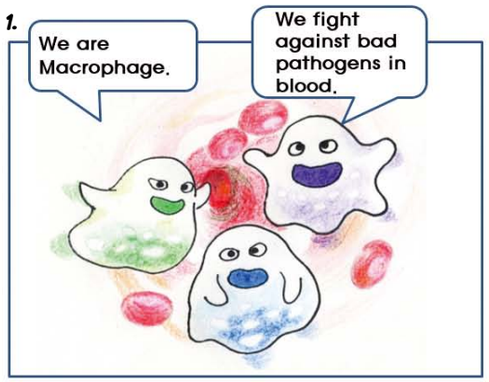


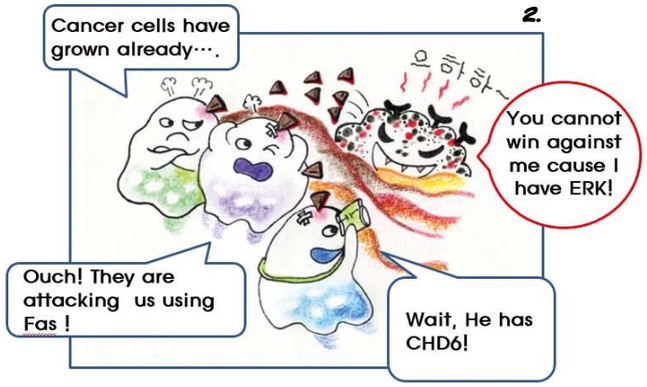


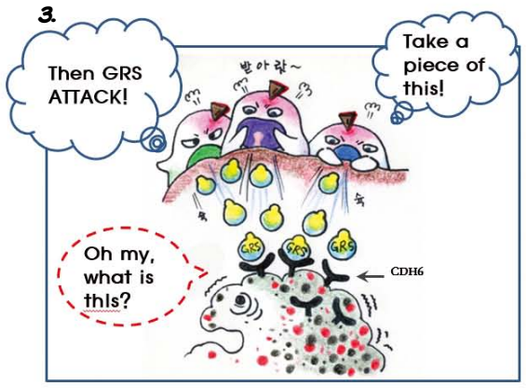
3. LRS as a Leucine Sensor

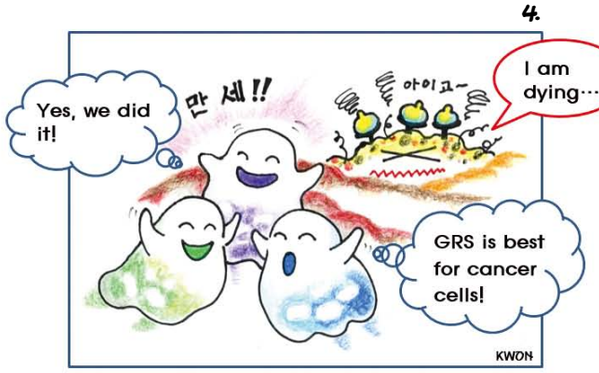
Leucyl-tRNA synthetase is an intracellular leucine sensor for the mTORC1-signaling pathway.

Cell. 2012 Apr 13;149(2):410-24









4. What's GRS?

Secreted human glycyl-tRNA synthetase implicated in defense against ERK-activated tumorigenesis

Proc Natl Acad Sci U S A. 2012 Mar 13;109(11):E640-7

179

Publications

152

Patents

A. Publications

Number	Title	Journal	Year	No,	Issue	Page	Author
1	Fluocinolone Acetonide Is a Potent Synergistic Factor of TGF-β3-Associated Chondrogenesis of Bone Marrow-Derived Mesenchymal Stem Cells for Articular Surface Regeneration.	J Bone Miner Res	2015	30	9	1585-1596	Hara ES, Ono M, Pham HT, Sonoyama W, Kubota S, Takigawa M, Matsumoto T, Young MF, Olsen BR, Kuboki T
2	Crystal structures of immunoglobulin Fc heterodimers reveal the molecular basis for heterodimer formation.	Mol Immunol	2015	65	2	377-383	Choi HJ, Seok SH, Kim YJ, Seo MD, Kim YS
3	In vivo RNAi screen identifies NLK as a negative regulator of mesenchymal activity in glioblastoma.	Oncotarget	2015	6	24	20145-20159	Sa JK, Yoon Y, Kim M, Kim Y, Cho HJ, Lee JK, Kim GS, Han S, Kim WJ, Shin YJ, Joo KM, Paddison PJ, Ishitani T, Lee J, Nam DH
4	Tpl2 induces castration resistant prostate cancer progression and metastasis.	Int J Cancer	2015	136	9	2065-2077	Lee HW, Cho HJ, Lee SJ, Song HJ, Cho HJ, Park MC, Seol HJ, Lee JI, Kim S, Lee HM, Choi HY, Nam DH, Joo KM
5	In vivo quantitation of injected circulating tumor cells from great saphenous vein based on video-rate confocal microscopy.	Biomed Opt Express	2015	6	6	2158-2167	Seo H, Hwang Y, Choe K, Kim P
6	(1)H, (13)C and (15)N resonance assignment of WHEP domains of human glutamyl-prolyl tRNA synthetase.	Biomol NMR Assign	2015	9	1	25-30	Shin C, Hwang GS, Ahn HC, Kim S, Kim KS
7	Longitudinal tracing of spontaneous regression and anti-angiogenic response in individual microadenomas during colon tumorigenesis.	Theranostics	2015	5	7	724-732	Choi JW, Kim P, Kim JK, Kim YR, Fukumura D, Yun SH
8	Noncanonical roles of membranous lysyl-tRNA synthetase in transducing cell-substrate signaling for invasive dissemination of colon cancer spheroids in 3D collagen I gels.	Oncotarget	2015	6	25	21655-21674	Nam SH, Kim D, Lee MS, Lee D, Kwak TK, Kang M, Ryu J, Kim HJ, Song HE, Choi J, Lee GH, Kim SY, Park SH, Kim DG, Kwon NH, Kim TY, Thiery JP, Kim S, Lee JW
9	Transmembrane 4 L six family member 5 (TM4SF5)-mediated epithelial-mesenchymal transition in liver diseases.	Int Rev Cell Mol Biol	2015	319	-	141-163	Lee JW
10	The BioMart community portal: an innovative alternative to large, centralized data repositories.	Nucleic Acids Res	2015	43	W1	W589-598	Smedley D, Haider S, Durinck S, Pandini L, Provero P, Allen J, Arnaiz O, Awedh MH, Baldock R, Barbiera G, Bardou P, Beck T, Blake A, Bonierbale M, Brookes AJ, Bucci G, Buetti I, Burge S, Cabau C, Carlson JW, Chelala C, Chrysostomou C, Cittaro D, Collin O, Cordova R, Cutts RJ, Dassi E, Di Genova A, Djari A,Esposito A, Estrella H, Eyras E, Fernandez-Banet J, Forbes S, Free RC, Fujisawa T, Gadaleta E, Garcia-Manteiga JM, Goodstein D, Gray K, Guerra-Assunção JA, Haggarty B, Han DJ, Han BW, Harris T, Harshbarger J, Hastings RK, Hayes RD, Hoede C, Hu S, Hu ZL, Hutchins L, Kan Z, Kawaji H, Keliet A, Kerhornou A,Kim S, Kinsella R, Klopp C, Kong L, Lawson D, Lazarevic D, Lee JH, Letellier T, Li CY, Lio P, Liu CJ, Luo J, Maass A, Mariette J, Maurel T, Merella S, Mohamed AM, Moreews F, Nabihoudine I, Ndegwa N, Noirot C, Perez-Llamas C, Primig M, Quattrone A, Quesneville H, Rambaldi D, Reecy J, Riba M, Rosanoff S, Saddiq AA, Salas E, Sallou O, Shepherd R, Simon R, Sperling L, Spooner W, Staines DM, Steinbach D, Stone K, Stupka E, Teague JW, Dayem Ullah AZ, Wang J, Ware D, Wong-Erasmus M, Youens-Clark K, Zadissa A, Zhang SJ, Kasprzyk A
11	Crystal structure of the protein At3g01520, a eukaryotic universal stress protein-like protein from Arabidopsis thaliana in complex with AMP.	Proteins	2015		-		Kim DJ, Bitto E, Bingman CA, Kim HJ, Han BW, Phillips GN Jr
12	Discovery of orally available runt-related transcription factor 3 (RUNX3) modulators for anticancer chemotherapy by epigenetic activation and protein stabilization.	J Med Chem	2015	58	8	3512-3521	Yang JS, Lee C, Cho M, Kim H, Kim JH, Choi S, Oh SJ, Kang JS, Jeong JH, Kim HJ, Han G
13	Liposome-based engineering of cells to package hydrophobic compounds in membrane vesicles for tumor penetration.	Nano Lett	2015	15	5	2938-2944	Lee J, Kim J, Jeong M, Lee H, Goh U, Kim H, Kim B, Park JH

14	Self-renewal and circulating capacities of metastatic hepatocarcinoma cells required for collaboration between TM4SF5 and CD44.	BMB Rep	2015	48	3	127-127	Lee D, Lee JW
15	Structural basis for full-spectrum inhibition of translational functions on a tRNA synthetase.	Nat Commun	2015	6	-	6402	Fang P, Yu X, Jeong SJ, Mirando A, Chen K, Chen X, Kim S, Francklyn CS, Guo M
16	Comprehensive data resources and analytical tools for pathological association of aminoacyl tRNA synthetases with cancer.	Database	2015	in-press	-	-	Lee JH, You S, Hyeon do Y, Kang B, Kim H, Park KM, Han B, Hwang D, Kim S
17	Interaction of tetraspan(in) TM4SF5 with CD44 promotes self-renewal and circulating capacities of hepatocarcinoma cells.	Hepatology	2015	61	6	1978-1997	Lee D, Na J, Ryu J, Kim HJ, Nam SH, Kang M, Jung JW, Lee MS, Song HE, Choi J, Lee GH, Kim TY, Chung JK, Park KH, Kim SH, Kim H, Seo H, Kim P, Youn H, Lee JW
18	Twist1 and AP-1 cooperatively upregulate integrin α5 expression to induce invasion and the epithelial-mesenchymal transition.	Carcinogenesis	2015	36	3	327-337	Nam EH, Lee Y, Moon B, Lee JW, Kim S
19	High-throughput, miniaturized clonogenic analysis of a limiting dilution assay on a micropillar/microwell chipwith brain tumor cells.	Small	2014	10	24	5098-5105	Lee DW, Choi YS, Seo YJ, Lee MY, Jeon SY, Ku B, Nam DH
20	miR-543 and miR-590-3p regulate human mesenchymal stem cell aging via direct targeting of AIMP3/p18.	Age	2014	36	6	9724	Lee S, Yu KR, Ryu YS, Oh YS, Hong IS, Kim HS, Lee JY, Kim S, Seo KW, Kang KS
21	A novel in vitro permeability assay using three-dimensional cell culture system.	J Biotechnol	2014	205	-	93-105	Lee JB, Son SH, Park MC, Kim TH, Kim MG, Yoo SD, Kim S
22	A general strategy for generating intact, full-length IgG antibodies that penetrate into the cytosol of living cells.	MAbs	2014	6	6	1402-1414	Choi DK, Bae J, Shin SM, Shin JY, Kim S, Kim YS
23	DNA end recognition by the Mre11 nuclease dimer : Insights into resection and repair of damaged DNA.	EMBO J	2014	33	20	2422-2435	Sung S, Li F, Park YB, Kim JS, Kim AK, Song OK, Kim J, Che J, Lee SE, Cho Y
24	Selective photosensitizer delivery into plasma membrane for effective photodynamic therapy.	J Control Release	2014	191	-	98-104	Kim J, Santos OA, Park JH
25	Promiscuous methionyl-tRNA synthetase mediates adaptive mistranslation to protect cells against oxidative stress.	J Cell Sci	2014	127	Pt 19	4234-4245	Lee JY, Kim DG, Kim BG, Yang WS, Hong J, Kang T, Oh YS, Kim KR, Han BW, Hwang BJ, Kang BS, Kang M, Kim MH, Kwon NH, Kim S
26	Structure of the ArgRS–GlnRS–AIMP1 complex and its implications for mammalian translation.	Proc Natl Acad Sci USA	2014	111	42	15084-15089	Fu Y, Kim Y, Jin KS, Kim HS, Kim JH, Wang D, Park M, Jo CH, Kwon NH, Kim D, Kim MH, Jeon YH, Hwang KY, Kim S, Cho Y
27	AIMP1 negatively regulates adipogenesis by inhibiting PPARγ.	J Cell Sci	2014	127	Pt 20	4483-4493	Kim JH, Lee JH, Park MC, Yoon I, Kim K, Lee M, Choi HS, Han JM, Kim S
28	Crystal structure of human protein N-terminal glutamine amidohydrolase, an initial component of the N-end rulepathway.	PLoS One	2014	9	10	e111142	Park MS, Bitto E, Kim KR, Bingman CA, Miller MD, Kim HJ, Han BW, Phillips GN Jr
29	An ankyrin repeat domain of AKR2 drives chloroplast targeting through coincident binding of two chloroplastlipids.	Dev Cell	2014	30	5	598-609	Kim DH, Park MJ, Gwon GH, Silkov A, Xu ZY, Yang EC, Song 5, Song K, Kim Y, Yoon HS, Honig B, Cho W, Cho Y, Hwang I

30	Snail1 induced in breast cancer cells in 3D collagen I gel environment suppresses cortactin and impairs effective invadopodia formation.	Biochim Biophys Acta	2014	1843	9	2037-2054	Lee MS, Kim S, Kim BG, Won C, Nam SH, Kang S, Kim HJ, Kang M, Ryu J, Song HE, Lee D, Ye SK, Jeon NL, Kim TY, Cho NH, Lee JW
31	TM4SF5-mediated protein-protein networks and tumorigenic roles.	BMB Rep	2014	47	9	483-487	Lee JW
32	Pontin is required for pre-TCR signaling at the β-selection checkpoint in T cell development.	Biochem Biophys Res Commun	2014	447	1	44-50	Boo K, Baek SH, Lee H
33	Cross talk between the TM4SF5/focal adhesion kinase and the interleukin-6/STAT3 pathways promotes immune escape of human liver cancer cells.	Mol Cell Biol	2014	34	16	2946-2960	Ryu J, Kang M, Lee MS, Kim HJ, Nam SH, Song HE, Lee D, Lee JW
34	TM4SF5 suppression disturbs integrin α5-related signalling and muscle development in zebrafish.	Biochem J	2014	462	1	89-101	Choi YJ, Kim HH, Kim JG, Kim HJ, Kang M, Lee MS, Ryu J, Song HE, Nam SH, Lee D, Kim KW, Lee JW
35	Synthesis and biological evaluation of novel thieno[2,3-d]pyrimidine-based FLT3 inhibitors as anti-leukemicagents.	Eur J Med Chem	2014	85	-	399-407	Yang JS, Park CH, Lee C, Kim H, Oh C, Choi Y, Kang JS, Yun J, Jeong JH, Kim MH, Han G
36	Translational validation of personalized treatment strategy based on genetic characteristics of glioblastoma.	PLoS One	2014	9	8	e103327	Oh YT, Cho HJ, Kim J, Lee JH, Rho K, Seo YJ, Choi YS, Jung HJ, Song HS, Kong DS, Seol HJ, Lee JI, Yoon Y, Kim S, Nam D, Joo KM
37	Characterization of the interaction between lysyl-tRNA synthetase and laminin receptor by NMR.	FEBS Lett	2014	588	17	2851-2858	Cho HY, Ul Mushtaq A, Lee JY, Kim DG, Seok MS, Jang M, Han BW, Kim S, Jeon YH
38	Genetically engineered mouse models for drug development and preclinical trials.	Biomol Ther	2014	22	4	267-274	Lee H
39	Structure and backbone dynamics of vanadate-bound PRL-3: comparison of 15N nuclear magnetic resonance relaxation profiles of free and vanadate-bound PRL-3.	Biochemistry	2014	53	29	4814-4825	Jeong KW, Kang DI, Lee E, Shin A, Jin B, Park YG, Lee CK, Kim EH, Jeon YH, Kim EE, Kim Y
40	Correlations between transmembrane 4 L6 family member 5 (TM4SF5), CD151, and CD63 in liver fibroticphenotypes and hepatic migration and invasive capacities.	PLoS One	2014	9	7	e102817	Kang M, Ryu J, Lee D, Lee MS, Kim HJ, Nam SH, Song HE, Choi J, Lee GH, Kim TY, Lee H, Kim SJ, Ye SK, Kim S, Lee JW
41	Structural basis of the phosphorylation dependent complex formation of neurodegenerative disease protein Ataxin-1 and RBM17.	Biochem Biophys Res Commun	2014	449	4	399-404	Kim E, Lee Y, Choi S, Song JJ
42	Structural basis of the heterodimerization of the MST and RASSF SARAH domains in the Hippo signalling pathway.	Acta Crystallogr D Biol Crystallogr	2014	70	Pt 7	1944-1953	Hwang E, Cheong HK, Ul Mushtaq A, Kim HY, Yeo KJ, Kim E, Lee WC, Hwang KY, Cheong C, Jeon YH
43	Molecular basis for unidirectional scaffold switching of human Plk4 in centriole biogenesis.	Nat Struct Mol Biol	2014	21	8	696-703	Park SY, Park JE, Kim TS, Kim JH, Kwak M4, Ku B, Tian L, Murugan RN, Ahn M, Komiya S, Hojo H, Kim NH, Kim BY, Bang JK, Erikson RL, Lee KW, Kim SJ, Oh BH, Yang W, Lee KS
44	Discovery of thienopyrimidine-based FLT3 inhibitors from the structural modification of known IKKb inhibitors.	Bioorg Med Chem Lett	2014	24	15	2655-2660	Park CH, Lee C, Yang JS, Joe BY, Chun K, Kim H, Kim HY, Kang JS, Lee JI, Kim MH, Han G
45	Cation-selective electropreconcentration.	Lab Chip	2014	14	11	1811-1815	Shin IH, Kim KJ, Kim J, Kim HC, Chun H

46	Selective photosensitizer delivery into plasma membrane for effective photo-dynamic therapy.	J Control Release	2014	191		-	98-104	Kim J, Santos OA, Park JH
47	In vivo analysis of THz wave irradiation induced acute inflammatory response in skin by laser-scanning confocalmicroscopy.	Opt Express	2014	22		10	11456-11475	Hwang Y, Ahn J, Mun J, Bae S, Jeong YU, Vinokurov NA, Kim P
48	Phenotypic screening to identify small-molecule enhancers for glucose uptake: target identification and rationaloptimization of their efficacy.	Angew Chem Int Ed Engl	2014	53		20	5102-5106	Koh M, Park J, Koo JY, Lim D, Cha MY, Jo A, Choi JH, Park SB
49	Curcumin suppresses proliferation of colon cancer cells by targeting CDK2.	Cancer Prev Res	2014	7		4	466-474	Lim TG, Lee SY, Huang Z, Lim do Y, Chen H, Jung SK, Bode AM, Lee KW, Dong Z
50	A novel adenoviral vector-mediated mouse model of Charcot-Marie-Tooth type 2D (CMT2D).	J Mol Histol	2014	45		5	121-128	Seo AJ, Shin YH, Lee SJ, Kim D, Park BS, Kim S, Choi KH, Jeong NY, Park C, Jang JY, Huh Y, Jung J
51	Construction of a large synthetic human Fab antibody library on yeast cell surface by optimized yeast mating.	J Microbiol Biotechnol	2014	24		3	408-420	Baek DS, Kim YS
52	Inference of dynamic networks using time-course data.	Brief Bioinform	2014	15		2	212-228	Kim Y, Han S, Choi S, Hwang D
53	Anti-inflammatory effects of α-galactosylceramide analogs in activated microg-lia: involvement of the p38 MAPKsignaling pathway.	PLoS One	2014	9		2	e87030	Jeong YH, Kim Y, Song H, Chung YS, Park SB, Kim HS
54	Rational perturbation of the fluorescence quantum yield in emission-tunable and predictable fluorophores (Seoul-Fluors) by a facile synthetic method involving C-H activation.	Angew Chem Int Ed Engl	2014	53		5	1346-1350	Choi EJ, Kim E, Lee Y, Jo A, Park SB
55	Synthesis and library construction of privileged tetra-substituted Δ5-2-oxopiperazine as β-turn structure mimetics.	ACS Comb Sci	2014	16		1	24-32	Kim J, Lee WS, Koo J, Lee J, Park SB
56	The structural basis for the negative regulation of thioredoxin by thioredoxin-interacting protein.	Nat Commun	2014	5		-	2958	Hwang J, Suh HW, Jeon YH, Hwang E, Nguyen LT, Yeom J, Lee SG, Lee C, Kim KJ, Kang BS, Jeong JO, Oh TK, Choi I, Lee JO, Kim MH
57	Chemical inhibition of prometastatic lysyl-tRNA synthetase–laminin receptor interaction.	Nat Chem Biol	2014	10		1	29-34	Kim DG, Lee JY, Kwon NH, Fang P, Zhang Q, Wang J, Young NL, Guo M, Cho HY, Mushtaq AU, Jeon YH, Choi JW, Han JM, Kang HW, Joo JE, Hur Y, Kang W, Yang H, Nam DH, Lee MS, Lee JW, Kim ES, Moon A, Kim K, Kim D, Kang EJ, Moon Y, Rhee KH, Han BW, Yang JS, Han G1, Yang WS, Lee C, Wang MW, Kim S
58	The P110 subunit of PI3-K is a therapeutic target of acacetin in skin cancer.	Carcinogenesis	2014	35		1	123-130	Jung SK, Kim JE, Lee SY, Lee MH, Byun S, Kim YA, Lim TG , Reddy K, Huang Z, Bode AM, Lee HJ, Lee KW, Dong Z
59	A heterodimeric Fc-based bispecific antibody simultaneously targeting VEG-FR-2 and Met exhibits potent antitumor activity.	Mol Cancer Ther	2013	12		12	2748-2759	Choi HJ, Kim YJ, Lee S, Kim YS
60	Reinvestigation of aminoacyl-tRNA synthetase core complex by affinity purification-mass spectrometry reveals TARSL2 as a potential member of the complex.	PLoS One	2013	8		12	e81734	Kim K, Park SJ, Na S, Kim JS, Choi H, Kim YK, Paek E, Lee C
61	Esculetin suppresses proliferation of human colon cancer cells by directly targeting β-catenin.	Cancer Prev Res	2013	6		12	1356-1364	Lee SY, Lim TG, Chen H, Jung SK, Lee HJ, Lee MH, Kim DJ, Shin A, Lee KW, Bode AM, Surh YJ, Dong Z

62	Isoangustone A, a novel licorice compound, inhibits cell proliferation by targeting PI3K, MKK4, and MKK7 in human melanoma.	Cancer Prev Res	2013	6		12	1293-1303	Song NR, Lee E, Byun S, Kim JE, Mottamal M, Park JH, Lim SS, Bode AM, Lee HJ, Lee KW, Dong Z
63	Benzo[a]pyrene-7,8-diol-9,10-epoxide inhibits gap junction intercellular communication via phosphorylation of tumor progression locus 2 in WB-F344 rat liver epithelial cells.	Mol Carcinog	2013	54		5	351-358	Lee BK, Chung MY, Lee KW
64	Privileged substructure-based diversity-oriented synthesis pathway for diverse pyrimidine-embedded polyheterocycles.	Org Lett	2013	15		22	5814-5817	Kim H, Tung TT, Park SB
65	Aminopropyl carbazole analogues as potent enhancers of neurogenesis.	Bioorg Med Chem	2013	21		22	7165-7174	Yoon HJ, Kong SY, Park MH, Cho Y, Kim SE, Shin JY, Jung S, Lee J, Farhanullah, Kim HJ, Lee J
66	Tpl2 kinase impacts tumor growth and metastasis of clear cell renal cell carcinoma.	Mol Cancer Res	2013	11		11	1375-1386	Lee HW, Joo KM, Lim JE, Cho HJ, Cho HJ, Park MC, Seol HJ, Seo SI, Lee JI, Kim S, Jeong BC, Nam DH
67	Measurement of lipid droplet accumulation kinetics in chlamydomonas reinhardtii using Seoul-Fluor.	Energies	2013	6		11	5703-5716	Park JW, Na SC, Lee Y, Lee S, Park SB, Jeon NL
68	Conformational changes in human prolyl-tRNA synthetase upon binding of the substrates proline and ATP and the inhibitor halofuginone.	Acta Crystallogr D Biol Crystallogr	2013	69		Pt 10	2136-2145	Son J, Lee EH, Park M, Kim JH, Kim J, Kim S, Jeon YH, Hwang KY
69	CDK2 and mTOR are direct molecular targets of isoangustone A in the suppression of human prostate cancer cell growth.	Toxicol Appl Pharmacol	2013	272		1	12-20	Lee E, Son JE, Byun S, Lee SJ, Kim YA, Liu K, Kim J, Lim SS, Park JH, Dong Z, Lee KW, Lee HJ
70	Crystal structure of human cytosolic aspartyl-tRNA synthetase, a component of multi-tRNA synthetase complex.	Proteins	2013	81		10	1840-1846	Kim KR, Park SH, Kim HS, Rhee KH, Kim BG, Kim DG, Park MS, Kim HJ, Kim S, Han BW
71	High-throughput on-chip leukemia diagnosis.	Int J Lab Hematol	2013	35		5	480-490	Park S, Moon HS, Lee DS, Kim HC, Chun H
72	Total synthesis of eryvarin H and its derivatives and their biological activity as ERRγ inverse agonist.	Org Biomol Chem	2013	11		35	5782-5786	Koo JY, Oh S, Cho SR, Koh M, Oh WK, Choi HS, Park SB
73	Chemical suppression of an oncogenic splicing variant of AIMP2 induces tumour regression.	Biochem J	2013	454		3	411-416	Lee HS, Kim DG, Oh YS, Kwon NH, Lee JY, Kim D, Park SH, Song JH, Lee S, Han JM, Park BJ, Lee J, Kim S
74	Synthesis and biological evaluation of α-galactosylceramide analogues with heteroaromatic rings and varying positions of a phenyl group in the sphingosine backbone.	J Med Chem	2013	56		17	7100-7109	Kim Y, Oh K, Song H, Lee DS, Park SB
75	Discovery of Octahydroindenes as PAR1 Antagonists.	ACS Med Chem Lett	2013	4		11	1054-1058	Lee S, Song JH, Park CM, Kim JS, Jeong JH, Cho WY, Lim DC
76	Identification of upstream regulators for prognostic expression signature genes in colorectal cancer.	BMC Syst Biol	2013	7		86	1-10	Bae T, Rho K, Choi JW, Horimoto K, Kim W, Kim S
77	Inverse agonist of nuclear receptor ERRγ mediates antidiabetic effect through inhibition of hepatic gluconeogenesis.	Diabetes	2013	62		9	3093-3102	Im DK, Gang GT, Ryu D, Koh M, Kim YN, Kim SS, Park J, Kim YH, Sim T, Lee IK, Choi CS, Park SB, Lee CH, Koo SH, Choi HS
78	Crystal structure of the protein from Arabidopsis thaliana gene At5g06450, a putative DnaQ-like exonuclease domain-containing protein with homohexameric assembly.	Proteins	2013	81		9	1669-1675	Smith DW, Han MR, Park JS, Kim KR, Yeom T, Lee JY, Kim do J, Bingman CA, Kim HJ, Jo K, Han BW, Phillips GN Jr

79	Structural insights into the regulation of sialic acid catabolism by the Vibrio vulnificus transcriptional repressor NanR.	Proc Natl Acad Sci USA	2013	110	30	E2829-E2837	Hwang J, Kim BS, Jang SY, Lim JG, You DJ, Jung HS, Oh TK, Lee JO, Choi SH, Kim MH
80	USP8 is a novel target for overcoming gefitinib resistance in lung cancer.	Clin Cancer Res	2013	19	14	3894-904	Byun S, Lee SY, Lee J, Jeong CH, Farrand L, Lim S, Reddy K, Kim JY, Lee MH, Lee HJ, Bode AM, Won Lee K, Dong Z
81	Prognostic significance of CD151 overexpression in non-small cell lung cancer.	Lung Cancer	2013	81	1	109-116	Kwon MJ, Seo J, Kim YJ, Kwon MJ, Choi JY, Kim TE, Lee DH, Park S, Shin YK, Han J, Choi YL
82	Structure-activity relationship of human glutaminyl cyclase inhibitors having an N-(5-methyl-1H-imidazol-1-yl)propyl thiourea template.	Bioorg Med Chem	2013	21	13	3821-3830	Tran PT, Hoang VH, Thorat SA, Kim SE, Ann J, Chang YJ, Nam DW, Song H, Mook-Jung I, Lee J, Lee J
83	Exploiting the mechanism of cellular glucose uptake to develop an image-based high-throughput screening system in living cells.	Chem Commun	2013	49	45	5138-5140	Jo A, Park J, Park SB
84	Discovery of autophagy modulators through the construction of a high-content screening platform via monitoring of lipid droplets	Chemical Science	2013	4	8	3282-3287	Eunha Kim
85	Synthesis of molecular frameworks containing two distinct heterocycles connected in a single molecule with enhanced three-dimensional shape diversity	Chemistry	2013	19	22	7100-7108	Lim D, Park SB
86	Cell-based dose responses from open-well microchambers.	Anal Chem	2013	85	10	5249-5254	Hamon M, Jambovane S, Bradley L, Khademhosseini A, Hong JW
87	Optimization of Seoul-Fluor-based lipid droplet bioprobes and their application in microalgae for bio-fuel study.	Mol Biosyst	2013	9	5	952-956	Lee Y, Na S, Lee S, Jeon NL, Park SB
88	Engineering of functional, perfusable 3D microvascular networks on a chip.	Lab Chip	2013	13	8	1489-1500	Kim S, Lee H, Chung M, Jeon NL
89	From noncovalent to covalent bonds: a paradigm shift in target protein identification.	Mol Biosyst	2013	9	4	544-550	Park J, Koh M, Park SB
90	C1-Ten is a protein tyrosine phosphatase of insulin receptor substrate 1 (IRS-1), regulating IRS-1 stability and muscle atrophy	Mol Cell Biol	2013	33	8	1608-1620	Koh A, Lee MN, Yang YR, Jeong H, Ghim J, Noh J, Kim J, Ryu D, Park S, Song P, Koo SH, Leslie NR, Berggren PO, Choi JH, Suh PG, Ryu SH
91	A novel method using an acedan-based Zn(DPA) probe to monitor ATP localization in an in vivo system.	J Mol Histol	2013	44	2	241-247	Lee SJ, Rao AS, Shin YH, Chung HJ, Huh Y, Ahn KH, Jung J
92	Structural basis of protein complex formation and reconfiguration by polyglutamine disease protein Ataxin-1 andCapicua.	Genes Dev	2013	27	6	590-595	Kim E, Lu HC, Zoghbi HY, Song JJ
93	Disruption of sorting nexin 5 causes respiratory failure associated with undifferentiated alveolar epithelial type Icells in mice.	PLoS One	2013	8	3	e58511	Im SK, Jeong H, Jeong HW, Kim KT, Hwang D, Ikegami M, Kong YY
94	The COOH-terminus of TM4SF5 in hepatoma cell lines regulates c-Src to form invasive protrusions via EGFRTyr845 phosphorylation.	Biochim Biophys Acta	2013	1833	3	629-642	Jung O, Choi YJ, Kwak TK, Kang M, Lee MS, Ryu J, Kim HJ, Lee JW.
95	In vivo high spatiotemporal resolution visualization of circulating T lymphocytes in high endothelial venules oflymph nodes.	J Biomed Opt	2013	18	3	036005	Choe K, Hwang Y, Seo H, Kim P

96	A systems approach for decoding mitochondrial retrograde signaling pathways.	Sci Signal	2013	6	264	rs4	Chae S, Ahn BY, Byun K, Cho YM, Yu MH, Lee B, Hwang D, Park KS
97	Essential role of Cenexin1, but not Odf2, in ciliogenesis.	Cell Cycle	2013	12	4	655-662	Chang J, Seo SG, Lee KH, Nagashima K, Bang JK, Kim BY, Erikson RL, Lee KW, Lee HJ, Park JE, Lee KS
98	Wnt/β-catenin signaling is a key downstream mediator of MET signaling in glioblastoma stem cells.	Neuro Oncol	2013	15	2	161-171	Kim KH, Seol HJ, Kim EH, Rheey J, Jin HJ, Lee Y, Joo KM, Lee J, Nam DH
99	Deacetylated αβ-tubulin acts as a positive regulator of Rheb GTPase through increasing its GTP-loading.	Cell Signal	2013	25	2	539-551	Lee MN, Koh A, Park D, Jang JH, Kwak D, Jeon H, Kim J, Choi EJ, Jeong H, Suh PG, Ryu SH
100	Patient-specific orthotopic glioblastoma xenograft models recapitulate the histopathology and biology of humanglioblastomas in situ.	Cell Rep	2013	3	1	260-273	Joo KM, Kim J, Jin J, Kim M, Seol HJ, Muradov J, Yang H, Choi YL, Park WY, Kong DS, Lee JI, Ko YH, Woo HG, Lee J, Kim S, Nam DH
101	Structural switch of lysyl-tRNA synthetase between translation and transcription.	Mol Cell	2013	49	1	30-42	Ofir-Birin Y, Fang P, Bennett SP, Zhang HM, Wang J, Rachmin I, Shapiro R, Song J, Dagan A, Pozo J, Kim S, Marshall AG, Schimmel P, Yang XL, Nechushtan H, Razin E, Guo M
102	Cardiomyocyte specific deletion of Crif1 causes mitochondrial cardiomyopathy in mice.	PLoS One	2013	8	1	e53577	Shin J, Lee SH, Kwon MC, Yang DK, Seo HR, Kim J, Kim YY, Im SK, Abel ED, Kim KT, Park WJ, Kong YY
103	Potentiometric multichannel cytometer microchip for high-throughput microdispersion analysis.	Anal Chem	2013	85	1	362-368	Kim J1, Kim EG, Bae S, Kwon S, Chun H.
104	Overexpression, crystallization and preliminary X-ray crystallographic analysis of the variable lymphocytereceptor 2913 ectodomain fused with internalin B.	Acta Crystallogr Sect F Struct Biol Cryst Commun	2013	69	1	39-41	Lee JY, Kim HS, Baek IW, Back JM, Han MR, Kong SY, Kim JH, Kirchdoerfer RN, Kim JO, Cooper MD, Wilson IA, Kim HJ, Han BW
105	Validation of a scoring system for predicting malignancy in patients diagnosed with atypical ductal hyperplasiausing an ultrasound-guided core needle biopsy.	J Breast Cancer	2012	15	4	407-411	Kim J, Han W, Go EY, Moon HG, Ahn SK, Shin HC, You JM, Chang JM, Cho N, Moon WK, Park IA, Noh DY
106	Cellular internalization mechanism and intracellular trafficking of filamentous M13 phages displaying a cell-penetrating transbody and TAT peptide.	PloS One	2012	7	12	e51813	Kim A, Shin TH, Shin SM, Pham CD, Choi DK, Kwon MH, Kim YS
107	Secretion of ATP from Schwann cells through lysosomal exocytosis during Wallerian degeneration.	Biochem Biophys Res Commun	2012	429	3-4	163-167	Shin YH, Lee SJ, Jung J
108	A systems approach to rheumatoid arthritis.	PloS One	-	7	12	e51508	You S, Cho CS, Lee I, Hood L, Hwang D, Kim WU
109	Tetraspan TM4SF5-dependent direct activation of FAK and metastatic potential of hepatocarcinoma cells.	J Cell Sci	2012	125	24	5960-5973	Jung O, Choi S, Jang SB, Lee SA, Lim ST, Choi YJ, Kim HJ, Kim DH, Kwak TK, Kim H, Kang M, Lee MS, Park SY, Ryu J, Jeong D, Cheong HK, Kim HJ, Park KH, Lee BJ, Schlaepfer DD, Lee JW
110	Lithographically encoded polymer microtaggant using high-capacity and error-correctable QR code for anti-counterfeiting of drugs.	Adv Mater	2012	24	44	5924-5949	Han S, Bae HJ, Kim J, Shin S, Choi SE, Lee SH, Kwon S, Park W.
111	AIMP3/p18 controls translational initiation by mediating the delivery of charged initiator tRNA to initiationcomplex.	J Mol Biol	2012	423	4	475-481	Kang T, Kwon NH, Lee JY, Park MC, Kang E, Kim HH, Kang TJ, Kim S
112	Phospholipase signalling networks in cancer.	Nat Rev Cancer	2012	12	11	782-792	Park JB, Lee CS, Jang JH, Ghim J, Kim YJ, You S, Hwang D, Suh PG, Ryu SH

113	HCF-1 self-association via an interdigitated Fn3 structure facilitates transcriptional regulatory complexformation.	Proc Natl Acad Sci USA	2012	109	43	17430-17435	Park J, Lammers F, Herr W, Song JJ
114	Identification of CD23 as a functional receptor for the proinflammatory cytokine AIMP1/p43.	J Cell Sci	2012	125	19	4620-4629	Kwon HS, Park MC, Kim DG, Cho K, Park YW, Han JM, Kim S
115	Interaction of two translational components, lysyl-tRNA synthetase and p40/37LRP, in plasma membrane promotes laminin-dependent cell migration.	FASEB J	2012	26	10	4142-4159	Kim DG, Choi JW, Lee JY, Kim H, Oh YS, Lee JW, Tak YK, Song JM, Razin E, Yun SH, Kim S
116	Clinical and functional anatomy of the urethral sphincter.	Int Neurourol J	2012	16	3	102-106	Jung J, Ahn HK, Huh Y
117	Discovery of a highly selective FLT3 kinase inhibitor from phenotypic cell viability profiling.	Med Chem Commun	2012	4	1	228-232	Lee S, Jo A, Park SB
118	Notch1 counteracts WNT/β-catenin signaling through chromatin modification in colorectal cancer.	J Clin Invest	2012	122	9	3248-3259	Kim HA, Koo BK, Cho JH, Kim YY, Seong J, Chang HJ, Oh YM, Stange DE, Park JG, Hwang D, Kong YY
119	Cancer association study of aminoacyl-tRNA synthetase signaling network in glioblastoma.	PLoS One	2012	7	8	e40960	Kim YW, Kwon C, Liu JL, Kim SH, Kim S.
120	In vitro formation and characterization of a perfusable three-dimensional tubular capillary network in microfluidicdevices.	Lab Chip	2012	12	16	2815-2822	Yeon JH, Ryu HR, Chung M, Hu QP, Jeon NL
121	Cell adhesion-dependent serine 85 phosphorylation of paxillin modulates focal adhesion formation andhaptotactic migration via association with the C-terminal tail domain of talin.	J Biol Chem	2012	287	33	27499-27509	Kwak TK, Lee MS, Ryu J, Choi YJ, Kang M, Jeong D, Lee JW
122	CDA: combinatorial drug discovery using transcriptional response modules.	PLoS One	2012	7	8	e42573	Lee JH, Kim DG, Bae TJ, Rho K, Kim JT, Lee JJ, Jang Y, Kim BC, Park KM, Kim S
123	CRIF1 is essential for the synthesis and insertion of oxidative phosphorylation polypeptides in the mammalian mitochondrial membrane.	Cell Metab	2012	16	2	274-283	Kim SJ, Kwon MC, Ryu MJ, Chung HK, Tadi S, Kim YK, Kim JM, Lee SH, Park JH, Kweon GR, Ryu SW, Jo YS, Lee CH, Hatakeyama H, Goto Y, Yim YH, Chung J, Kong YY, Shong M
124	The diagnostic utility of the GNAS mutation in patients with fibrous dysplasia: meta-analysis of 168 sporadiccases.	Hum Pathol	2012	43	8	1234-1242	Lee SE, Lee EH, Park H, Sung JY, Lee HW, Kang SY, Seo S, Kim BH, Lee H, Seo AN, Ahn G, Choi YL
125	Crystal structure of tandem ACT domain-containing protein ACTP from Galdieria sulphuraria.	Proteins	2012	80	8	2105-2109	Bitto E, Kim do J, Bingman CA, Kim HJ, Han BW, Phillips GN Jr
126	Srs2 possesses a non-canonical PIP box in front of its SBM for precise recognition of SUMOylated PCNA.	J Mol Cell Biol	2012	4	4	258-261	Kim SO, Yoon H, Park SO, Lee M, Shin JS, Ryu KS, Lee JO, Seo YS, Jung HS, Choi BS
127	Breast density change as a predictive surrogate for response to adjuvant endocrine therapy in hormone receptorpositive breast cancer.	Breast Cancer Res	2012	14	4	R102	Kim J, Han W, Moon HG, Ahn S, Shin HC, You JM, Han SW, Im SA, Kim TY, Koo H, Chang J, Cho N, Moon W, Noh DY
128	Rational drug repositioning guided by an integrated pharmacological network of protein, disease and drug.	BMC Syst Biol	2012	6	80	1-10	Lee HS, Bae T, Lee JH, Kim DG, Oh YS, Jang Y, Kim JT, Lee JJ, Innocenti A, Supuran CT, Chen L, Rho K, Kim S

129	Lithographic compartmentalization of emulsion droplet templates for microparticles with multiple nanostructuredcompartments.	Chem Commun	2012	48	49	6091-6093	Kim J, He L, Song Y, Yin Y, Kwon S
130	Splicing variant of AIMP2 as an effective target against chemoresistant ovarian cancer.	J Mol Cell Biol	2012	4	3	164-173	Choi JW, Lee JW, Kim JK, Jeon HK, Choi JJ, Kim DG, Kim BG, Nam DH, Kim HJ, Yun SH, Kim S
131	Discovery and target identification of an antiproliferative agent in live cells using fluorescence difference in two-dimensional gel electrophoresis.	Angew Chem Int Ed Engl	2012	51	22	5447-5451	Park J, Oh S, Park SB
132	Osmotic stress regulates mammalian target of rapamycin (mTOR) complex 1 via c-Jun N-terminal Kinase (JNK)-mediated Raptor protein phosphorylation.	J Biol Chem	2012	287	22	18398-18407	Kwak D, Choi S, Jeong H, Jang JH, Lee Y, Jeon H, Lee MN, Noh J, Cho K, Yoo JS, Hwang D, Suh PG, Ryu SH
133	Free-floating amphiphilic picoliter droplet carriers for multiplexed liquid loading in a microfluidic channel.	Microfluid and Nanofluidics	2012	13	3	511-518	Sangkwon Han, Hosuk Lee
134	Cross-talk between TGFβ1 and EGFR signalling pathways induces TM4SF5 expression and epithelial-mesenchymal transition.	Biochem J	2012	443	3	691-700	Kang M, Choi S, Jeong SJ, Lee SA, Kwak TK, Kim H, Jung O, Lee MS, Ko Y, Ryu J, Choi YJ, Jeong D, Lee HJ, Ye SK, Kim SH, Lee JW
135	Mutated IDH1 is a favorable prognostic factor for type 2 gliomatosis cerebri.	Brain Pathol	2012	22	3	307-317	Kwon MJ, Kim ST, Kwon MJ, Kong DS, Lee D, Park S, Kang SY, Song JY, Nam DH, Kato Y, Choi YL, Suh YL
136	Secretomics for skeletal muscle cells: a discovery of novel regulators?	Adv Biol Regul	2012	52	2	340-350	Yoon JH, Kim J, Song P, Lee TG, Suh PG, Ryu SH
137	Oxidative stress-induced biomarkers for stem cell-based chemical screening.	Prev Med	2012	54	Suppl	S42-S49	Yang SR, Rahman I, Trosko JE, Kang KS
138	CD49f enhances multipotency and maintains stemness through the direct regulation of OCT4 and SOX2.	Stem Cells	2012	30	5	876-887	Yu KR, Yang SR, Jung JW, Kim H, Ko K, Han DW, Park SB, Choi SW, Kang SK, Schöler H, Kang KS
139	Mind bomb-1 in dendritic cells is specifically required for Notch-mediated T helper type 2 differentiation.	PLoS one	2012	7	4	e36359	Jeong HW, Kim JH, Kim JY, Ha SJ, Kong YY
140	Leucyl-tRNA synthetase is an intracellular leucine sensor for the mTORC1-signaling pathway.	Cell	2012	149	2	410-424	Han JM, Jeong SJ, Park MC, Kim G, Kwon NH, Kim HK, Ha SH, Ryu SH, Kim S
141	Asymmetric mode of Ca^{2+}-S100A4 interaction with nonmuscle myosin IIA generates nanomolar affinity required for filament remodeling.	Structure	2012	20	4	654-666	Elliott PR, Irvine AF, Jung HS, Tozawa K, Pastok MW, Picone R, Badyal SK, Basran J, Rudland PS, Barraclough R, Lian LY, Bagshaw CR, Kriajevska M,Barsukov IL
142	A prognostic model for lymph node-negative breast cancer patients based on the integration of proliferation and immunity.	Breast Cancer Res Treat	2012	132	2	499-509	Oh E, Choi YL, Park T, Lee S, Nam SJ, Shin YK
143	Chemical modulators working at pharmacological interface of target proteins.	Bioorg Med Chem	2012	20	6	1893-1901	Jeon YH, Lee JY, Kim S
144	Secreted human glycyl-tRNA synthetase implicated in defense against ERK-activated tumorigenesis.	Proc Natl Acad Sci USA	2012	109	11	E640-E647	Park MC, Kang T, Jin D, Han JM, Kim SB, Park YJ, Cho K, Park YW, Guo M, He W, Yang XL, Schimmel P, Kim S
145	Variable lymphocyte receptor recognition of the immunodominant glycoprotein of Bacillus anthracis spores.	Structure	2012	20	3	479-486	Kirchdoerfer RN, Herrin BR, Han BW, Turnbough CL Jr, Cooper MD, Wilson IA

146	Crystal structure of the NurA-dAMP-Mn2+ complex.	Nucleic Acids Res	2012	40	5	2258-2270	Chae J, Kim YC, Cho Y
147	Crystal structure of LeuD from Methanococcus jannaschii.	Biochem Biophys Res Commun	2012	19	2	160-164	Lee EH, Cho YW, Hwang KY
148	Clinical significance of CD151 overexpression in subtypes of invasive breast cancer.	Br J Cancer	2012	106	5	923-930	Kwon MJ, Park S, Choi JY, Oh E, Kim YJ, Park YH, Cho EY, Kwon MJ, Nam SJ, Im YH, Shin YK, Choi YL
149	Structural analysis and serological test of arginine periplasmic binding protein 2 from Chlamydophilapneumoniae.	Biochem Biophys Res Commun	2012	418	3	518-524	Park SH, Chang JE, Hawkes HJ, Kang YH, Hwang KY
150	Antagonistic regulation of transmembrane 4 L6 family member 5 attenuates fibrotic phenotypes in CCl(4) -treated mice.	FEBS J	2012	279	4	625-635	Kang M, Jeong SJ, Park SY, Lee HJ, Kim HJ, Park KH, Ye SK, Kim SH, Lee JW
151	Gefitinib resistance of cancer cells correlated with TM4SF5-mediated epithelial-mesenchymal transition.	Biochim Biophys Acta	2012	1823	2	514-523	Lee MS, Kim HP, Kim TY, Lee JW
152	Dissection of the dimerization modes in the DJ-1 superfamily.	Mol Cells	2012	33	2	163-171	Jung HJ, Kim S, Kim YJ, Kim MK, Kang SG, Lee JH, Kim W, Cha SS
153	JNK signaling activity regulates cell-cell adhesions via TM4SF5-mediated p27(Kip1) phosphorylation.	Cancer Lett	2012	314	2	198-205	Kim H, Jung O, Kang M, Lee MS, Jeong D, Ryu J, Ko Y, Choi YJ, Lee JW
154	Mechanism of anchoring of OmpA protein to the cell wall peptidoglycan of the gram-negative bacterial outer membrane.	FASEB J	2012	26	1	219-228	Park JS, Lee WC, Yeo KJ, Ryu KS, Kumarasiri M, Hesek D, Lee M, Mobashery S, Song JH, Kim SI, Lee JC, Cheong C, Jeon YH, Kim HY
155	Heteroaromatic moieties in the sphingosine backbone of α-galactosylceramides for noncovalent interactionswith CD1d.	ACS Med Chem Lett	2012	3	2	151-154	Kim Y, Kim J, Oh K, Lee DS, Park SB
156	Dual role of methionyl-tRNA synthetase in the regulation of translation and tumor suppressor activity ofaminoacyl-tRNA synthetase-interacting multifunctional protein-3.	Proc Natl Acad Sci USA	2011	108	49	19635-19640	Kwon NH, Kang T, Lee JY, Kim HH, Kim HR, Hong J, Oh YS, Han JM, Ku MJ, Lee SY, Kim S
157	Benzothiazole-containing hydroxamic acids as histone deacetylase inhibitors and antitumor agents.	Bioorg Med Chem Lett	2011	21	24	7509-7512	Oanh DT, Hai HV, Park SH, Kim HJ, Han BW, Kim HS, Hong JT, Han SB, Hue VT, Nam NH
158	Survival and differentiation of mammary epithelial cells in mammary gland development require nuclear retention of Id2 due to RANK signaling.	Mol Cell Biol	2011	31	23	4775-4788	Kim NS, Kim HT, Kwon MC, Choi SW, Kim YY, Yoon KJ, Koo BK, Kong MP, Shin J, Cho Y, Kong YY
159	Metformin represses self-renewal of the human breast carcinoma stem cells via inhibition of estrogen receptor-mediated OCT4 expression.	PLoS One	2011	6	11	e28068	Jung JW, Park SB, Lee SJ, Seo MS, Trosko JE, Kang KS
160	Crystal structure of human Mre11: understanding tumorigenic mutations.	Structure	2011	19	11	1591-1602	Park YB, Chae J, Kim YC, Cho Y
161	Bilateral inhibition of HAUSP deubiquitinase by a viral interferon regulatory factor protein.	Nat Struct Mol Biol	2011	18	12	1336-1344	Lee HR, Choi WC, Lee S, Hwang J, Hwang E, Guchhait K, Haas J, Toth Z, Jeon YH, Oh TK, Kim MH, Jung JU
162	Crystal structure of Arabidopsis thaliana 12-oxophytodienoate reductase isoform 3 in complex with 8-isoprostaglandin A(1).	Proteins	2011	79	11	3236-3241	Han BW, Malone TE, Kim do J, Bingman CA, Kim HJ, Fox BG, Phillips GN Jr

163	Sphingosylphosphorylcholine attenuated β-amyloid production by reducing BACE1 expression and catalysis in PC12 cells.	Neurochem Res	2011	36	11	2083-2090	Yi H, Lee SJ, Lee J, Myung CS, Park WK, Lim HJ, Lee GH, Kong JY, Cho H
164	One target, different effects: a comparison of distinct therapeutic antibodies against the same targets.	Exp Mol Med	2011	43	10	539-549	Shim H
165	Overexpression, crystallization and preliminary X-ray crystallographic analysis of the C-terminal cytosolic domain of mouse anoctamin 1.	Acta Crystallogr Sect F Struct Biol Cryst Commun	2011	67	Pt 10	1250-1252	Park SH, Chung HK, Kim do J, Han MR, Park MS, Oh U, Kim HJ, Han BW
166	Programming magnetic anisotropy in polymeric microactuators.	Nat Mater	2011	10	10	747-752	Kim J, Chung SE, Choi SE, Lee H, Kim J, Kwon S
167	Crystal structure of Mycobacterium tuberculosis Rv3168: a putative aminoglycoside antibiotics resistance enzyme.	Proteins	2011	79	10	2983-2987	Kim S, Nguyen CM, Kim EJ, Kim KJ
168	Targeted disruption of Mcm10 causes defective embryonic cell proliferation and early embryo lethality.	Biochim Biophys Acta	2011	1813	10	1777-1783	Lim HJ, Jeon Y, Jeon CH, Kim JH, Lee H
169	Aminoacyl-tRNA synthetases and tumorigenesis: more than housekeeping.	Nat Rev Cancer	2011	11	10	708-718	Kim S, You S, Hwang D
170	VEGF inhibitor (Iressa) arrests histone deacetylase expression: single-cell cotransfection imaging cytometry for multi-target-multi-drug analysis.	J Cell Physiol	2011	226	8	2115-2122	Tak YK, Naoghare PK, Han E, Song JM
171	In situ fabrication and actuation of polymer magnetic microstructures.	JMEMS Letters	2011	20	1	785-787	Jiyun Kim, Sung-Eun Choi, Kim, L.N.
172	Determination of UV-induced DNA damages to suppress protein expression using reporter gene assay-based single cell cotransfection imaging cytometry.	Toxicol Lett	2011	204	1	25-31	Tak YK, Kim WY, Han E, Kim MJ, Kim JA, Lim CY, Song JM
173	Crystal structure of the Mre11-Rad50-ATPγS complex: understanding the interplay between Mre11 and Rad50.	Genes Dev	2011	25	10	1091-1104	Lim HS, Kim JS, Park YB, Gwon GH, Cho Y
174	Solution structure of the Z beta domain of human DNA-dependent activator of IFN-regulatory factors and its binding modes to B- and Z-DNAs.	Proc Natl Acad Sci USA	2011	108	17	6921-6926	Kim K, Khayrutdinov BI, Lee CK, Cheong HK, Kang SW, Park H, Lee S, Kim YG, Jee J, Rich A, Kim KK, Jeon YH
175	Cancer-associated splicing variant of tumor suppressor AIMP2/p38: pathological implication in tumorigenesis.	PLoS Genet	2011	7	3	e1001351	Choi JW, Kim DG, Lee AE, Kim HR, Lee JY, Kwon NH, Shin YK, Hwang SK, Chang SH, Cho MH, Choi YL, Kim J, Oh SH, Kim B, Kim SY, Jeon HS, Park JY,Kang HP, Park BJ, Han JM, Kim S
176	Polymer based chemical delivery to multichannel capillary patterned cells.	Lab Chip	2011	11	4	605-608	Lee SH, Heinz AJ, Choi SE, Park W, Kwon S
177	TopBP1 deficiency causes an early embryonic lethality and induces cellular senescence in primary cells.	J Biol Chem	2011	286	7	5414-5422	Jeon Y, Ko E, Lee KY, Ko MJ, Park SY, Kang J, Jeon CH, Lee H, Hwang DS
178	High-content screening of drug-induced cardiotoxicity using quantitative single cell imaging cytometry onmicrofluidic device.	Lab Chip	2011	11	1	104-114	Kim MJ, Lee SC, Pal S, Han E, Song JM
179	Active guidance of 3D microstructures.	Small	2010	6	23	2668-2672	Lee SH, Choi SE, Heinz AJ, Park W, Han S, Jung Y, Kwon S

B. Patents

Registration

No.	Patent No.	Country	Title	Date
1	101551696	Rep. of Korea	A novel TM4SF5 specific monoclonal antibody and use thereof	2015-09-03
2	101551299	Rep. of Korea	Neuropilin specific tumor penetrating peptide and fusion protein fused with the same	2015-09-02
3	101522954	Rep. of Korea	CH3 domain mutant pairs for the high yield formation of heterodimeric Fc of antibody, method of production and use thereof	2015-05-19
4	101514320	Rep. of Korea	Novel pharmaceutical composition for preventing or treating cancer	2015-04-16
5	02497471	Europe	Use of benzo-heterocycle derivatives for preventing and treating cancer or for inhibiting cancer metastasis	2015-04-15
6	101491108	Rep. of Korea	Direct preparation of functional insulin producing cell from human dermal fibroblasts	2015-02-02
7	05628807	Japan	Method for controlling cancer metastasis or cancer cell migration by modulating the cellular level of lysyl-tRNA synthetase	2014-10-10
8	101441503	Rep. of Korea	Zinc finger library and engineered zinc finger protein screening using the same	2014-09-11
9	101427328	Rep. of Korea	Method for Identification of proteins	2014-07-31
10	101426056	Rep. of Korea	Device for in vitro blood vessel formation and vascular permeability assay using the same	2014-07-28
11	101425032	Rep. of Korea	Novel use of leucyl-tRNA synthetase	2014-07-24
12	101419836	Rep. of Korea	Composition comprising Δ5-2-oxopiperazine derivative for inducing differentiation of mesenchymal stem cells into chondrocytes	2014-07-09
13	08771611	U.S.A.	System and methods of log-scale concentration gradients	2014-07-08
14	5564642	Japan	Method for screening anticancer substance inhibiting function of TM4SF5 and anticancer composition containing chalcone-based compound	2014-06-27
15	101410904	Rep. of Korea	Method for screening of anti-cancer agent and inflammatory disease agent	2014-06-17
16	08746285	U.S.A.	Programmable fluidic droplet generation	2014-06-10
17	2671987	Canada	Method for screening anti-cancer compounds inhibiting function of TM4SF5 and anti-cancer compounds containing chalcone compounds	2014-06-03
18	101378410	Rep. of Korea	Pharmaceutical composition for the preventing or treating brain tumor or glioblastoma having resistance of Temodal containing Benzydamine as an active ingredient	2014-03-20
19	101368871	Rep. of Korea	Composition for diagnosing, treating and preventing hepatic disease	2014-02-24
20	101366613	Rep. of Korea	Pharmaceutical composition for the preventing or treating brain tumor or glioblastoma having resistance of Temodal containing Azathioprine as an active ingredient	2014-02-18
21	2108655	France	Immune modulating peptide	2013-11-20
22	02348049	Europe	Application of AMIP1 polypeptide	2013-10-02
23	08431393	U.S.A.	AIMP2-DX2 gene and its uses	2013-04-30
24	ZL200910207747.3	China	Immune modulating peptide	2013-04-17
25	5232091	Japan	Immune modulating peptide	2013-03-29
26	1020130029283	Rep. of Korea	Benzopyran derivatives	2013-03-19
27	254901	India	Immune modulating peptide	2013-01-02
28	101190141	Rep. of Korea	Pharmaceutical compositioin containing AMPK-activating compound	2012-10-05
29	101150967	Rep. of Korea	Fluorescent glucose analogue and usage thereof	2012-05-22
30	101149878	Rep. of Korea	Newcompoundshavingaspirochiralcarbon,processfor preparing the same and pharmaceutical composition comprising the same	2012-05-18
31	101401199	Rep. of Korea	Device and method of generating in vitro blood vessels	2012-04-18
32	101134194	Rep. of Korea	Methodofpreparinghetero-biarylpyridinederivativecompounds,andhetero-biarylpyridinederivative compounds prepared thereby	2012-03-30
33	04932005	Japan	Method for screening anti-cancer compounds inhibiting functions of TM4SF5 and anti-cancer composition containing chalcone compounds	2012-02-24
34	101398079	Rep. of Korea	Method for screening an agent preventing or treating cancer using glycyl-tRNA synthetase and cadherin	2011-10-10
35	101334793	Rep. of Korea	Fluorescent compounds for lipid droplet selective staining	2011-09-02
36	02348049	Europe	Novel application of AIMP1 polypeptide	2011-05-05
37	101453141	Rep. of Korea	Method for controlling cancer metastasis or cancer cell migration by modulating the cellular level of lysyl trna synthetase	2011-03-03
38	08431393	U.S.A.	AIMP2-DX2 and its uses	2011-01-21

Application

No.	Patent No.	Country	Title	Date
1	1020150075073	Rep. of Korea	Aminoacyl-tRNAsynthetaseenrichednanoparticleandanti-cancercompositioncomprisingthereof	2015-05-28
2	1020150074892	Rep. of Korea	Novel Lysyl-tRNA synthetase fragment and microvesicle comprising the same	2015-05-28
3	1020150066882	Rep. of Korea	Apparatus for separating fine endoplasmic reticulum using electrophoresis	2015-05-13
4	1020150066835	Rep. of Korea	Apparatus comprising nanoporous membrane for separating organic molecule	2015-05-13
5	1020150066864	Rep. of Korea	Apparatus for separating fine endoplasmic reticulum by electrophoresis sample pH adjustment	2015-05-13
6	1020150058333	Rep. of Korea	Vectors for measuring multiple protein-protein interactions simultaneously	2015-04-24
7	1020150058335	Rep. of Korea	Yeast strain with dual reporter system for barcode transfer assay	2015-04-24
8	10-2015-0054577	Rep. of Korea	A composition for specifically degrading nuclear proteins and a method using the same	2015-04-17
9	PCT/ KR2015/003807	PCT	Pharmaceuticalcompositionfortreatingandpreventingleukemia,containingthienopyrimidinederivativeorpharmaceuticallyacceptablesaltthereof	2015-04-15
10	14670390	U.S.A.	Method for screening EMT inhibitor	2015-03-26
11	1020150037979	Rep. of Korea	Method for measuring multiple protein-protein interactions simultaneously between two yeast library	2015-03-19
12	13824875.2	Europe	Novel monoclonal antibody which is specifically bound to TM4SF5 protein and use thereof	2015-03-03
13	1020150027617	Rep. of Korea	Compositions comprising tryptophanyl-tRNA synthetase for treating or preventing diseases caused by bacterial infections and for enhancing immune responses	2015-02-26
14	14613014	U.S.A.	Novel monoclonal antibody which is specifically bound to TM4SF5 protein and use thereof	2015-02-13
15	13816643.4	Europe	Pharmaceutical composition comprising azathioprine as active ingredient for preventing or treating brain tumors or temodal-resistant glioblastomas	2015-02-10
16	1020150014616	Rep. of Korea	Anti-EPRS monoclonal antibody and uses thereof	2015-01-29
17	1020150014617	Rep. of Korea	Anti-CRS monoclonal antibody and uses thereof	2015-01-29
18	1020150008668	Rep. of Korea	Crystal of FAN1-5' FLAP DNA complex and method of manufacturing the same	2015-01-19
19	1020150008537	Rep. of Korea	Crystal structure of human Mus81-Eme1-DNA complex and preparing method thereof	2015-01-19
20	14594448	U.S.A.	Pharmaceutical composition for the preventing or treating brain tumor or glioblastoma having resistance of Temodal containing Azathioprine as an active ingredient	2015-01-12
21	1020150000243	Rep. of Korea	Method for screening EMT inhibitor	2015-01-02
22	1020140194204	Rep. of Korea	Anti-KRS monoclonal antibody and uses thereof	2014-12-30
23	PCT/ KR2014/012980	PCT	Anti-KRS monoclonal antibody and uses thereof	2014-12-29
24	1020140160710	Rep. of Korea	Production methods of functional cell-derived membrane vesicles using membrane fusogenic liposomes including functionalized phospholipids and functional cell-derived membrane vesicles producing thereto	2014-11-08
25	13778232.2	Europe	Use of novel aminopyridine derivative to prevent or treat cancer	2014-11-03
26	14518753	U.S.A.	Use of novel aminopyridine derivative to prevent or treat cancer	2014-10-20
27	201380020787.1	China	Use of novel aminopyridine derivative to prevent or treat cancer	2014-10-20
28	14518753	U.S.A.	Use of a novel aminopyridine derivative to prevent or treat cancer	2014-10-20
29	1020140140098	Rep. of Korea	Peptide complexes for determining the activity of kinase and use thereof	2014-10-16
30	PCT/ KR2014/009733	PCT	Peptide complex for measuring kinase activity and use thereof	2014-10-16
31	2015506906	Japan	Use of a novel aminopyridine derivative to prevent or treat cancer	2014-10-15
32	1020140135813	Rep. of Korea	The composition for the prevention and treatment of cancers, or inhibition of metastasis containing binding inhibitor of TM4SF5 protein and c-Src protein	2014-10-08
33	1020140114142	Rep. of Korea	Production methods of functional cell-derived membrane vesicles using membrane fusogenic liposomes including functionalized phospholipids and functional cell-derived membrane vesicles producing thereto	2014-08-29
34	1020140100605	Rep. of Korea	Method and apparatus for separating microvesicle	2014-08-05
35	PCT/ KR2014/006627	PCT	Method for screening cancer therapeutic agent using modified arginyl-tRNA synthetase	2014-07-22
36	1020140077076	Rep. of Korea	The composition against abnormal cell growth through decreased methionine content and its metabolism	2014-06-24
37	1020140077075	Rep. of Korea	The composition against abnormal cell migration through reduced methionine level	2014-06-24
38	1020140076674	Rep. of Korea	Novel heterocyclic compounds	2014-06-23

39	1020140076763	Rep. of Korea	The crystal structure of the NanR and ManNAc-6P complex, and uses thereof	2014-06-23
40	14310879	U.S.A.	The crystal structure of the NanR and ManNAc-6P complex, and uses thereof	2014-06-20
41	1020140072240	Rep. of Korea	Neuropilin-1 specific binding and tumor-penetrating peptide and its fusion protein	2014-06-13
42	PCT/ KR2014/005105	PCT	Novel pharmaceutical composition for preventing or treating cancer	2014-06-11
43	PCT/ KR2014/004933	PCT	Novel maleic acid derivative, production method for same and anti-cancer composition comprising same	2014-06-03
44	1020140067225	Rep. of Korea	Novel Maleic acid derivatives, preparation method thereof, and anti-cancer compositions containing them	2014-06-02
45	201280059263.9	China	Method for screening an agent preventing or treating cancer using glycyl-tRNA synthetase and cadherin	2014-05-30
46	PCT/ KR2014/004571	PCT	trans-tumoral peptide specific to neuropilin and fusion protein having same peptide fused therein	2014-05-22
47	201280056503.X	China	Novel use of leucyl tRNA synthetase	2014-05-16
48	1020140058634	Rep. of Korea	AIMP2-DX2-34S protein and method for manufacturing the same	2014-05-15
49	1020140056973	Rep. of Korea	Screening method for metastasis inhibitor of cancer using cell or spheroid cell mass regulated expression of lysyl-tRNA synthetase in 3-dimensional collagen gels environments	2014-05-13
50	PCT/ KR2014/004276	PCT	Method for screening cancer metastasis inhibitor using culture of cells or spheroidically aggregated cells in which lysyl-tRNA synthetase is regulated to be expressed or unexpressed	2014-05-13
51	1020140055349	Rep. of Korea	Monitering method for metastasis of cancer using cancer cell cultured in 3-dimensional collagen gels environments	2014-05-09
52	PCT/ KR2014/004146	PCT	Method for monitoring metastasis of cancer cells using cells cultured in three-dimensional collagen environment	2014-05-09
53	1020140045064	Rep. of Korea	A pharmaceutical composition for treatment or prevention of leukemia comprising thienopyrimidine analogues or a pharmaceutical acceptable salt thereof	2014-04-15
54	14249975	U.S.A.	Method for screening an agent preventing or treating cancer using glycyl-tRNA synthetase and cadherin	2014-04-10
55	2014534489	Japan	Method for screening an agent preventing or treating cancer using glycyl-tRNA synthetase and cadherin	2014-04-08
56	201280049088.5	China	Novelanilinederivativesandusethereof	2014-04-04
57	14223188	U.S.A.	Novel use of leucyl tRNA synthetase	2014-03-24
58	2014531729	Japan	Novel use of leucyl tRNA synthetase	2014-03-20

59	PCT/ KR2014/002196	PCT	Method for screening therapeutic agent for cancers by using AIMP2-DX2 and PL4/ARF interaction	2014-03-14
60	14172055	U.S.A.	Novelanilinederivativesandusethereof	2014-02-04
61	2014523855	Japan	Novelanilinederivativesandusethereof	2014-01-30
62	1020130166596	Rep. of Korea	Anti-HRS monoclonal antibody and uses thereof	2013-12-30
63	1020130167032	Rep. of Korea	Anti-YRS monoclonal antibody and uses thereof	2013-12-30
64	1020130166827	Rep. of Korea	Anti-WRS monoclonal antibody and uses thereof	2013-12-30
65	1020130167854	Rep. of Korea	Anti-TRS monoclonal antibody and uses thereof	2013-12-30
66	1020130166816	Rep. of Korea	Anti-NRS monoclonal antibody and uses thereof	2013-12-30
67	1020130167851	Rep. of Korea	Anti-AIMP1/p43 monoclonal antibody and uses thereof	2013-12-30
68	1020130166546	Rep. of Korea	Anti-GRS monoclonal antibody and uses thereof	2013-12-30
69	PCT/ KR2013/011802	PCT	Crystal structure of denatured eprs protein, and crystallization method therefor	2013-12-18
70	PCT/ KR2013/010861	PCT	CH3 domain variant pair inducing formation of heterodimer of heavy chain constant region of antibody at high efficiency, method for preparing same, and use thereof	2013-11-27
71	1020130124255	Rep. of Korea	Apparatus for measuring the activity of phosphorylation reaction	2013-10-17
72	1020130120164	Rep. of Korea	The composition for the prevention and treatment of cancers, or inhibition of metastasis containing binding inhibitor of TM4SF5 protein and c-Src protein	2013-10-08
73	1020137025016	Rep. of Korea	Crystal structure and peptide inhibitors of hausp deubiquitinase	2013-09-23
74	1020130105411	Rep. of Korea	Novel compound having isoxazole core and pharmaceutical composition for diabetes containing the same molecular skeletons	2013-09-03
75	61/872086	U.S.A.	Novel use of tryptophanyl-tRNA synthetase	2013-08-30
76	13824875.2	Europe	A novel TM4SF5 specific monoclonal antibody and use thereof	2013-08-05
77	PCT/ KR2013/006286	PCT	Crystallization method for TRX-TXNI complex denatured protein, and three-dimensional structure thereof	2013-07-23
78	1020130082514	Rep. of Korea	Method for crystallization of TRX-TXNIP complex mutein and 3d structure thereof	2013-07-12
79	13816643.4	Europe	Pharmaceutical composition comprising azathioprine as active ingredient for preventing or treating brain tumors or temodal-resistant glioblastomas	2013-07-10
80	113340692	Saudi Arabia	Methodforscreeninganti-tumoragent	2013-07-01
81	1020130065520	Rep. of Korea	Composition for inhibiting senescence of adult stem cells by increasing of mirna expression	2013-06-07

82	1020130058619	Rep. of Korea	Ttans-tumoral peptide specific to neuropilin and fusion protein having same peptide fused therein	2013-05-23
83	PCT/ KR2013/004455	PCT	Antibody able to suppress osteoclast differentiation	2013-05-21
84	1020130055211	Rep. of Korea	Method for screening cancer metastasis inhibitor using culture of cells or spheroidically aggregated cells in which lysyl-tRNA synthetase is regulated to be expressed or unexpressed	2013-05-15
85	1020130054262	Rep. of Korea	Method for monitoring metastasis of cancer cells using cells cultured in three-dimensional collagen environment	2013-05-14
86	13778232.2	Europe	Use of a novel amiopyridine derivative to prevent or treat cancer	2013-04-19
87	27506906	Japan	Use of a novel amiopyridine derivative to prevent or treat cancer	2013-04-19
88	1020130029283	Rep. of Korea	Benzopyran derivatives	2013-03-19
89	1020130021769	Rep. of Korea	Method for producing glycyl-tRNA synthetase enriched microvesicle	2013-02-28
90	1020120148212	Rep. of Korea	Crystal structure and crystallization of modified EPRS protein	2012-12-18
91	12840047.0	Europe	Method for screening an agent preverntng or treating cancer using glycyl-tRNA synthetase and caderin	2012-10-10
92	26534489	Japan	Method for screening an agent preverntng or treating cancer using glycyl-tRNA synthetase and caderin	2012-10-10
93	12833330.9	Europe	Novel use of leucyl tRNA synthetase	2012-09-24
94	26531729	Japan	Novel use of leucyl tRNA synthetase	2012-09-23
95	12819363.8	Europe	Novelanilinederivativesandusethereof	2012-08-06
96	1020120085685	Rep. of Korea	Novel aniline derivatives and use thereof	2012-08-06
97	26523855	Japan	Novel aniline derivatives and use thereof	2012-08-06
98	12819363.8	Europe	Novel aniline derivatives and use thereof	2012-08-05
99	1020120073003	Rep. of Korea	Method for preparing RNAi library	2012-07-04
100	1020120072944	Rep. of Korea	Method for preparing chimeric ribonucleic acid, cDNA and its derivatives	2012-07-04
101	1020120071889	Rep. of Korea	Method for screening anti-tumor agent	2012-07-02
102	1020120053868	Rep. of Korea	A novel antibody inhibiting osteoclastogenesis	2012-05-21
103	13465709	U.S.A.	Use of Benzo-heterocycle derivatives for preventing and treating cancer or for inhibiting cancer metastasis	2012-05-07
104	24537820	Japan	Use of Benzo-heterocycle derivatives for preventing and treating cancer or for inhibiting cancer metastasis	2012-05-07

105	1020120041623	Rep. of Korea	Novel aminopyridine derivatives and use thereof	2012-04-20
106	12164605.3	Europe	Device and method of generating in vitro blood vessels	2012-04-18
107	1020120038781	Rep. of Korea	Direct preparation of functional insulin producing cell from human dermal fibroblasts	2012-04-13
108	14223188	U.S.A.	Novel use of leucyl tRNA synthetase	2012-03-24
109	PCT/ US2012/026198	PCT	Crystal structure and peptide inhibitors of HAUSP deubiquitinase	2012-02-22
110	1020120008503	Rep. of Korea	Composition containing indole and indazole derivatives for inhibition of cancer metastasis	2012-01-27
111	08793299.2	Europe	Method for controlling cancer metastasis or cancer cell migration by modulating the cellular level of lysyl tRNA synthetase	2011-03-18
112	PCT/ KR2011/001103	PCT	CD49F promoting proliferation, multipotency and reprotramming of adult stem cells through PI3K/AKT/GSK3 pathway	2011-02-18
113	13059006	U.S.A.	Method for controlling cancer metastasis or cancer cell migration by modulating the cellular level of lysyl tRNA synthetase	2011-02-14
114	13011386	U.S.A.	Antibody specific to the AIMP2-DX2	2011-01-21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