KAST's 20th Anniversary
International Symposium

Food, Health and the Future

식품, 건강, 그리고 미래

Friday 24 October 2014
Council Chamber,
Korea Chamber of Commerce and Industry,
Seoul, Korea

Organized by KAST 한국과학기술한림원 The Korean Academy of Science and Technology

Supported by 미래창조과학부 농림축산식품부 kfi 한국식품연구원 Korea Food Research Institute 차세대융합기술연구원 한국식품과학회 KFN 한국식품영양과학회 KNS 한국영양학회 The Korean Nutrition Society

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Food, Health and the Future
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Greetings from the President, KAST

Dear esteemed colleagues,

On behalf of the Korean Academy of Science and Technology (KAST), it is my great honor and pleasure to welcome all of you for the KAST's 20th Anniversary Symposium on "Food, Health, and the Future" on October 24th 2014.

Aging population is accelerated fast in Korea and the healthcare cost is dramatically escalating. With the strong demand on healthy long life, new concept of functional food is bringing the people's attention such as genetics, epigenetics, nutrition, and personalized foods based on the customized food platform technology development. Along with the development of science and technology, healthy functional food market is growing at a remarkable speed. The importance of communication between scientists in the world for finding the value of food will be emphasized by developing science, contents, value, tradition and their culture. Based on finding the value of each traditional food, science technology will be able to develop a new creative area in the world food market. In Korea, traditional fermented foods such as Chungkukjang, Doenjang and Kochujang have been recognized as healthy functional food by their nutritional and pharmaceutical value. By developing the creating shared value on healthy food, we should increase chances to nourish our life.

In order to discuss and propose better ways to improve health functional food, KAST organized this symposium. I sincerely hope that eminent experts gathered here can share constructive knowledge and opinions on health functional food.

Once again, I would like to extend my deepest gratitude to all our distinguished speakers for their great contribution to this symposium. I hope that you will enjoy a successful meeting in the viewpoint of knowledge exchange and mutual collaboration. I also hope that all the international speakers have a pleasant and memorable stay in Seoul, Korea.

Thank you very much

Sung H. Park

Dr. Sung Hyun Park
President, The Korean Academy of Science and Technology

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Greetings from Organizing Committee

Good morning, respected Minister Dr. Dong Pil Lee, President Sung Hyun Park, members of the Korean Academy of Science and Technology (KAST), and distinguished lecturers and guests, it is my great honor and pleasure to address opening remark for the KAST's 20th Anniversary International Symposium on "Food, Health and the Future" organized by the Division of Agricultural and Fishery Sciences in KAST.

Since its launch in 1994, the Korean Academy of Science and Technology has led the development of science and technology of the nation for 20 years. Through the continuous efforts of the members of the KAST, Korea's science and technology has achieved remarkable growth in many areas reaching to the world's top class. KAST also endeavors to expand its international collaboration through overseas national academies of science and technology.

The Division of Agricultural and Fishery Sciences has organized two-days international conference for this occasion. Yesterday, we had KAST-KFRI Joint Expert Workshop on "Designing Health Food for the Future" at the Korea Food Research Institute (KFRI) in Seongnam City. Last evening we had a dinner meeting with the invited lecturers and news media people in Seoul. We have discussed about the R&D strategy of food and agricultural industries and related research institutes to meet the future market needs. The health promotion and wellness is the prime concern of today's human being, and the science and technology should give the answer for effective and efficient, and also reliable ways to achieve it.

This symposium is aiming at knowledge exchange and idea development applying scientific theories into product R&D, and overview the health functional food R&D status in Korea. On behalf of the organizing committee, I express my sincere thanks to the invited lecturers of this symposium, especially Novel Prize laureate Dr. Robert Huber of Max Planck Institutes, Germany, Dr. Richard A. Flavell, Yale School of Medicine, USA, and Dr. Marika Mikelsaar, University of Tarta, Estonia, who took all the trouble to travel to the remote Far East, Korea.

This symposium is sponsored by the Ministry of Science, ICT and Future Planning, Republic of Korea, and supported by Ministry of Agriculture, Food and Rural Affairs, Korea Food Research Institute, Korean Society of Food Science and Technology, Korean Society of Food and Nutrition, and the Korean Nutrition Society. I must express my special thanks to the Vice President of KAST, Dr. Kyu-Tek Park and his staffs, and the members of organizing committee for preparing the conference successfully.

I wish all of you to have fruitful time in this symposium, and keep your health in good shape.

Thank you very much.

Dr. Cherl-Ho Lee
Chairman, Organizing Committee

Organizing Committee

Chair	**Cherl-Ho Lee** (Fellow, KAST / Korea Food Security Research Foundation)
Vice Chair	**Ki Won Lee** (Associate Member, KAST / Seoul National University)
Members	**Youn-Soo Cha** (Associate Member, KAST / Chonbuk National University) **Dae-Young Kwon** (Fellow, KAST / Korea Food Research Institute) **Jung Han Yoon Park** (Fellow, KAST / Hallym University) **Kun-Young Park** (Chair, Agricultural and Fishery Sciences Division, KAST / Pusan National University) **Dong-Hwa Shin** (Fellow Emeritus, KAST / Chonbuk National University)

PROGRAM

09:30-10:00 **Registration**

- Moderator: **Youn-Soo Cha**
(Associate Member, KAST / Chonbuk National University)

10:00-10:15 **Opening Ceremony**

Opening Remarks
- Cherl-Ho Lee (Chair, Organizing Committee / Korea Food Security Research Foundation)

Welcoming Remarks
- Sung Hyun Park (President, Korean Academy of Science and Technology)

Congratulatory Remarks
- Dong-pil Lee (Minister of Agriculture, Food and Rural Affairs)

10:15-10:20 **Photo Session**

Session 1: Molecular and Cellular Basis of Human Health and Disease (건강과 질병의 분자적 세포적 기초)

- Chair: Kun-Young Park (Chair, Agricultural and Fishery Sciences Division, KAST)

10:20-11:10 **Structural Biology and its Translation into Practice and Business, my Experience**
(구조 생물학의 활용과 비즈니스를 위한 해석)
- Robert Huber (Max Planck Institutes, Nobel Laureates)

11:10-12:00 **Microbiota, Dysbiosis in Health and Disease**
(미생물총과 그 불균형이 조절하는 건강과 질병)
- Richard A. Flavell (Member, NAS / HHMI / Yale School of Medicine)

12:00-13:00 **Luncheon**

Session 2: Current Research on Food for Health (건강 식품의 연구 현황)

- Chair: Jung Han Yoon Park (Fellow, KAST / Hallym University)

13:00-13:40 **Lessons from Centenarians : The Value of Korean Traditional Nutritional and Dietary Pattern**
(100세 장수의 교훈: 전통적인 영양과 식이 양식의 가치)
- Sang Chul Park (Fellow, KAST / Samsung Advanced Institute of Technology)

13:40-14:10 **Probiotic Lactobacilli Improve Health Biomarkers**
(생균 락토바실라이에 의한 건강 지표 개선)
- Marika Mikelsaar (University of Tartu, Estonia)

14:10-14:40 **Epigenetic Interactions between Aging and Nutrition**
(노화와 건강 사이의 후생적 상호 작용)
- Sang Woon Choi (Cha Medical University)

14:40-15:00 **Coffee Break**

Session 3: Health Food for the Future (미래를 위한 건강 식품)

- Chair: Dong-Hwa Shin (Fellow Emeritus, KAST / Chonbuk National University)

15:00-15:30 **Development Strategy and Trend of Functional Food in Korea**
(한국의 건강기능성 식품 개발 전략과 동향)
- Hyun Jin Park (Fellow, KAST / Korea University)

15:30-16:00 **Food, Wellness and New Converging Industry**
(식품과 웰니스 융합신산업)
- Ki Won Lee (Associate Member, KAST / Seoul National University)

16:00-16:30 **Food and Creating Shared Value**
(식품과 공유 가치 창조)
- Dae-Young Kwon (Fellow, KAST / Korea Food Research Institute)

16:30-16:50 **Closing Remarks**
- Kun-Young Park (Chair, Agricultural and Fishery Sciences Division, KAST)

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Youn-Soo Cha, Ph.D.

Professor, Department of Food Science & Human Nutrition,
College of Human Ecology, Chonbuk National University
cha8@jbnu.ac.kr

Education

1989 - 1993	Ph.D., University of Tennessee, Knoxville, U.S.A.: Nutrition;
1984 - 1986	M.S., Sookmyung Women's University, Seoul, Korea
1978 - 1982	B.S., Chonbuk National University, Chonju, Korea

Major Activities

2013. 2 - present time	Vice president for planning affairs, Chonbuk National University
2012. 1 - present time	Secretary International Co-operation, The Korean Nutrition Society
2011. 1 - present time	Editorial Writer, Nutrition Research and Practice
2011. 1 - present time	Audit, The Korean Society of Food Science and Nutrition
2010. 3 - present time	President, Jeonju Makgeolli Research Center of Chonbuk National University
2010. 1 - 2010.12	SCI committee, The Korean Society of Food Science and Nutrition
2009.11 - present time	Associate Member, The Korean Academy of Science and Technology
2009. 4 - present time	Principal Professor of Clinical Trial department, Clinical Trial Center for Functional Foods in Chonbuk National University Hospital
2009. 2 - 2011. 1	Dean, Human Ecology at Chonbuk National University
2009. 1 - 2010.12	Secretary International Co-operation, The Korean Nutrition Society
2008. 1 - 2009.12	Associate Editors, Journal of Medicinal Food
2007. 7 - present time	Vice-President, Obesity Research Center of Chonbuk National University
2007. 4 - present time	Professor, Chonbuk National University
2006. 1 - 2009. 3	International Co-operation Team Manager, Clinical Trial Center for Functional Foods in Chonbuk National University Hospital
2006. 1 - 2007.12	Vice-Chairman, The Korean Society of Exercise Nutrition
2004. 1 - 2007.12	Editorial Board, Journal of Medicinal Food

Honors and Awards

2004	Achievement Award from International Fermented Food Expo
2004	Achievement Award from the Korean Society of Food Science and Nutrition
2009	Appreciation plaque Award from the Korean Society of Food Science and Nutrition
2009	Award for excellent research paper about excellence in Korean style food from the Korean Society of Food Science and Nutrition
2010	20th Award for excellent research paper in science and technology from the Korean Federation of Science and Technology Societies (KOFST)
2012	Academic Award (Nutrilite) from the Korean Society of Food Science and Nutrition

Research Interests

Nutritional Biochemistry (lipid metabolism)

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Session 1

Molecular and Cellular Basis of Human Health and Disease
(건강과 질병의 분자적 세포적 기초)

Chair: Kun-Young Park
(Chair, Agricultural and Fishery Sciences Division, KAST / Pusan National University)

Structural Biology and its Translation into Practice and Business, my Experience
(구조 생물학의 활용과 비즈니스를 위한 해석)
Robert Huber (Max Planck Institutes, Nobel Laureates)

Microbiota, Dysbiosis in Health and Disease
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Richard A. Flavell (Member, NAS / HHMI / Yale School of Medicine)

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Kun-Young Park, Ph.D.

Professor Dept. of Food Science and Nutrition,
Pusan National University,30 Jang Jun-dong,
Keum Jung-Ku, Busan 609-735, Korea

Education

B.S. Dept. of Agricultural Chemistry, Korea University, Seoul, Korea.
M.S. Dept. of Food Technology, Korea University, Seoul, Korea.
Ph.D. Dept. of Food Science and Technology, University of Nebraska, Lincoln, NE, USA.

Professional Experience

Post-doc, Dept. of Nutrition, Harvard University. Boston. MA. USA
Professor, Dept. of Food Science and Nutrition, Pusan National University
Director, Kimchi Research Institute at Pusan National University
Editor-in-Chief, J Medicinal Food
President, Korean Society of Cancer Prevention
President, Korean Kimchi Association
Dean, College of Human Ecology, Pusan National Univ.
President, The Korean Society of Food and NutritionChair and Fellow, Agricultural and Fishery Sciences/ KAST

Honors & Awards

Academic Award of Korean Society of Food Science and Nutrition (1994) (Korea)
Nulwon Academic Award (1995) (Korea)
JFSN Award for Academic Excellence (2000) (Korea)
Korea Agricultural Technology Award (2001) (Korea)
The Best Research Paper Award (2002) (Korea)
Korea Food Safety Award (2004) (Korea)
Award of Busan-Science-Technology(Bio-Medicine) (2009) (Korea)
Ottugi Academic Award (2009) (Korea)
JMF Award for Outstanding Paper (2010) (Korea)

Publications

Research on Korean traditional foods, such as Kimchi(Korean fermented vegetables), Doenjang(Soybean fermented paste), Kochujang(Red pepper powder-soybean fermented paste), and their chemopreventive effects.
Published approximately 390 research papers and reviews, and have been invited or presented more than 650 papers at domestic or international symposia.

Research Interests

Korean traditional foods and their cancer prevention and antiobesity effect.
Phytochemicals and functional foods, and their cancer prevention and antiobesity effects.

Robert Huber, Ph.D.

Born: February 20, 1937 in München
Grammar school and humanistisches Gymnasium in München

Professional education and positions

Diploma in Chemistry, Technische Universität München, (1960);
Dr. rer. nat., Technische Universität München, (1963);
Habilitation, Technische Universität München, (1968);
Scientific Member of the Max-Planck-Gesellschaft and Director at the Max-Planck-Institutf?r Biochemie, (1972-2005);
Director Emeritus (2005);
Apl. Professor, Technische Universität München, (1976);
Visiting Professor Universitat Autonoma de Barcelona (2001);
Gastprofessor Universität Duisburg-Essen (2005);
Visiting Professor Cardiff University (2007);
Hochschulrat Universität Bayreuth (2007);
Collaborator WCI (world class institute), KRIBB, Korea, Daejeon (2010);
Emeritus of Excellence, Technische Universität München;
Editor: Journal of Molecular Biology.

Societies

Member of the Deutsche Chemische Gesellschaft;
Member of the Gesellschaft für Biologische Chemie;
Honorary Member of the American Society of Biological Chemists;
Honorary Member of the Swedish Society for Biophysics;
Member of EMBO;
Honorary Member of the Japanese Biochemical Society;
Member of the Bayerische Akademie der Wissenschaften;
Member of the Deutsche Akademie der Naturforscher, Leopoldina;
Member of the European Academy of Arts, Sciences and Humanities;
Corresponding Member of the Croatian Academy of Sciences and Arts;
Member of the Accademia Nazionale dei Lincei, Rome;
Member of the 'Orden Pour le Mérite für Wissenschaften und K?nste';
Associate Fellow, Third World Academy of Sciences, Triest;
Foreign Associate, National Academy of Sciences, USA;
Fellow, American Academy of Microbiology;
Foreign Member of the Royal Society, London;
Honorary Member of the Sociedad Espanola de Bioquimica y Biologia Molecular;
Foreign Fellow of the Indian National Science Academy, New Delhi.

Honors

E.K.-Frey Medal, Gesellschaft für Chirurgie, (1972);
Otto-Warburg Medal, Gesellschaft für Biologische Chemie, (1977);

Honors

Emil von Behring Medal, Universität Marburg, (1982);
Keilin Medal, Biochemical Society, London, (1987);
Richard-Kuhn Medal, Gesellschaft Deutscher Chemiker,(1987);
Dr. h.c. Université Catholique de Louvain, (1987);
Nobel Prize in Chemistry, (1988);
E.K.Frey - E. Werle Gedächtnismedaille, (1989);
Dr. h.c. University of Ljubljana, Slovenia (1989);
Kone Award, Association of Clinical Biochemists, United Kingdom, (1990);
Dr. h.c. for Medicine and Surgery, Universitá Tor Vergata, Rome, Italy, (1991);
Rudi Lemberg Travelling Fellowship (1991);
Sir Hans Krebs Medal, Federation of European Biochemical Societies, (1992);
Bayerischer Maximiliansorden für Wissenschaft und Kunst (1993);
The Linus Pauling Medal (1993/94);
Miami Winter Symposia, The Distinguished Service Award (1995);
Max Tishler Prize, Harvard University, USA (1997);
Max-Bergmann-Medaille des Max-Bergmann-Kreises zur Förderung der peptidchemischen Forschung, (1997);
Das Grosse Verdienstkreuz mit Stern und Schulterband der Bundesrepublik Deutschland, (1997);
Dr. h.c. Universidade Nova de Lisboa, Portugal (2000);
Dr. h.c. Universitat Autónoma de Barcelona, Spanien (2000);
Honorary Professor, Ocean University, Qingdao, China (2002);
Dr. h.c. Tsinghua University, Peking, (2003);
Honorary Professor, Peking University, Peking (2003);
Honorary Professor, Sichuan University, Chengdu (2003);
Honorary Professor, Shanghai Second Medical University, Shanghai (2004);
Röntgenplakette der Stadt Remscheid-Lennep, (2004);
Premio Citt? di Firenze sulle Scienze Molecolari, Florenz (2004);
Honorary Professor, Shanghai Jiao Tong University, China (2005);
'Lotte Distinguished Professorship', Seoul National University, Korea (2005);
Profesor Honorario de la Universidad de Sevilla (2006);
Dr. h.c. Nagoya University, Japan (2008);
Distinguished Research Chair Professor, National Taiwan University, Taipei, Taiwan (2009);
Erice Prize- Premio Ettore Majorana, (2009);
Honorary Professor, Huaqiao University, Xiamen, China (2009);
Honorary Director of the Nobel Life Science Research Center, Foshan, China (2009);
Foreign Member of the Korean Academy of Science and Technology, Korea (2010);

Honors

Dr. h.c. Universidad de Buenos Aires, Republica Argentina (2010);
National Medal of the Order 'Manuel Amador Guerrero' of the Republic of Panama (2011);
Dr. h. c. Universitas Vilnensis, Vilnius, Lithuania (2011);
Honorary Professor, Tianjin University of Science and Technology, Tianjin, China (2012);
Honorary President and Chief Scientific Advisor, Tianjin International Joint Academy of Biotechnology & Medicine, Tianjin, China, (2012);
Honorary Professor, Nanjing University, Nanjing, China (2012);
Dr. h. c. Bulgarian Academy of Sciences, Sofia, Bulgaria (2012);
Dr. h. c. Jagiellonian University, Krakow, Poland (2014).

Professional interests

Structure and function of biological macromolecules, in particular those of large complex aggregates.
Systems studied:
Proteases and their natural and synthetic inhibitors;
metalloenzymes (iron, nickel, molybdenum, copper);
proteins of the immune system (antibodies and antibody receptors);
protein hormones and their receptors; protein kinases;
proteins of amino acid biosynthesis (PLP containing enzymes);
proteins of cofactor and vitamin biosynthesis; proteins of energy and electron transport.
Methods development:
Patterson methods in crystallography;
methods of structure determination of proteins and protein ligand complexes by NMR;
synthesis and use of electron rich metal clusters;
crystal annealing and improvement, methods and instruments;
analysis and evaluation of targets for research and application in pharmacology and crop science.
Co-founder and advisor of two Biotech Companies, Proteros (since 1997) and SuppreMol (since 2005).
Scientific advisor of International Pharma and Crop Science Companies.
The list of publications can be found in the Web : http://www.biochem.mpg.de/xray/

Structural Biology and its Translation into Practice and Business, my Experience

Robert Huber

Max-Planck-Institut fuer Biochemie Emeritusgruppe Strukturforschung
D-82152 Martinsried - Germany;
Technische Universität München, TUM Emeritus of Excellence
D-85747 Garching, Germany; Universität Duisburg-Essen, Zentrum für Medizinische Biotechnologie
D-45117 Essen, Germany; Cardiff University, School of Biosciences Cardiff CF10 3US, UK

As a student in the early nineteen sixties, I had the privilege to attend winter seminars organized by my mentor, W. Hoppe, and by M. Perutz, which took place in a small guesthouse in the Bavarian-Austrian Alps. The entire community of a handful of protein crystallographers assembled in a room which served as living and dining room and as auditorium for the lectures.

Today structural biologists organize large congresses with thousands of attendants and there exist many hundreds of laboratories specialized in this field. It appears to dominate biology and biochemistry very visibly if we count covers in scientific journals displaying macromolecular structures.Structural biology was successful, because it was recognized that understanding biological phenomena at the molecular and atomic level requires to see those molecules.

Structural biology revealed the structure of genes and their basic mechanism of regulation, the mechanism of enzymes°Ø function, the structural basis of immune diversity, the mechanisms of energy production in cells by photosynthesis and its conversion into energy- rich chemical compounds and organic material, the mechanism that makes muscle work, the architecture of viruses and multi-enzyme complexes, and many more.

New methods had an essential impact on the development of structural biology. Methods seemed to become available in cadence with the growing complexity of the problems and newly discovered methods brought biological problems within reach for researchers, a co-evolutionary process of the development of methods and answerable problems.

An important additional incentive for structural biology came from its potential application for drug design and development by the use of knowledge of drug receptors at the atomic level. The commercial interest in application spurred this direction of research enormously.

My lecture will start out with the history of protein crystallography and describe the major factors contributing to its development, illustrated with examples contributing to our understanding of the physical and chemical basis behind biological phenomena.I then will let you share my experience with the foundation and development of two biotech companies with different business models, but both based on basic academic research in structural biology: Proteros (www.Proteros.com) offers enabling technology services for Pharma- and Crop science companies imbedding all steps of the workflow molecular and structural biology can provide and commands and uses its platform for the generation of leads from identified targets to in vivo Proof of Concept (PoC). Suppremol (www.Suppremol.com) specializes in the development of novel immunoregulatory therapeutics for the treatment of autoimmune diseases on the basis a

Richard A. Flavell, Ph.D.

Principal Investigator, HHMI
Sterling Professor and Chairman
Yale School of Medicinerichard.flavell@yale.edu

Education

1970	Ph. D., Biochemistry, University of Hull, Great Britain
1967	B.Sc., Biochemistry (Honors), University of Hull, Great Britain

Major Activities

2014	President, International Cytokine and Interferon Society
2002-Present	Sterling Professor of Immunobiology, Yale University School of Medicine.
1995	Darwin Trust Visiting Professor, Department of Cellular and Molecular Biology, University of Edinburgh, Scotland (May through August, 1995).
1988-Present	Investigator, Howard Hughes Medical Institute.
1988-Present	Chairman and Professor of Immunobiology, Yale University School of Medicine. Professor of Biology, Yale University.
1984-1988	Chief Scientific Officer, Biogen N.V. Offices located in Cambridge Massachusetts, USA.
1982-1988	President, Biogen Research Corporation, Cambridge, Massachusetts, USA.
1970-72	Post-doctoral Fellow (in the European Programme of the Royal Society of Great Britain) with Professor Piet Borst, (University of Amsterdam).
1979-1982	Head, Laboratory of Gene Structure and Expression at the National Institute for Medical Research, Mill Hill, London.
1974-1979	Instructor/Assistant Professor of Biochemistry (equivalent), University of Amsterdam.
1972-1973	EMBO Postdoctoral Fellow with Prof. C. Weissmann of the Institut fur Molekularbiologie der Universitat Zurich.

Member of National Academy of Sciences, the Royal Society, Institute of Medicine and European Molecular Biology Organization
**Author of over 1000 peer-reviewed original articles/reviews and book chapters.

Microbiota, Dysbiosis in Health and Disease

Noah Palm, Marcel de Zoete and Richard A Flavell1,2

1Yale University, Immunobiology, New Haven, CT, 2Howard Hughes Medical Institute, Immunobiology, New Haven, CT

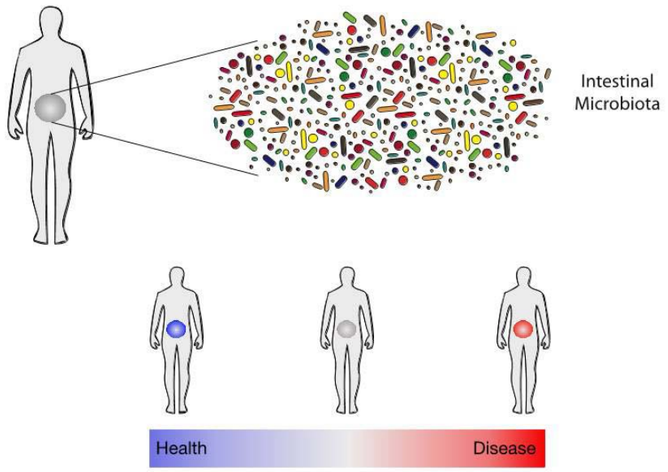
Dysregulation of the immune system and host-microbiota interaction has been associated with the development of a variety of inflammatory as well as metabolic diseases such as obesity and diabetes. Recent studies in our lab have elucidated the important function of inflammasomes as steady-state sensors and regulators of the gut microbiota. Mice with a disrupted inflammasome pathway have been shown to develop a colitogenic microbial community, which resulted in exacerbation of chemical-induced colitis and diet-induced steatohepatitis, obesity and type 2 diabetes.

These disease phenotypes have been associated with dysbiosis resulting from the expansion of "pathobionts" which are believed to be causally driving pathogenesis. A key issue is to identify and isolate such problematic organisms.

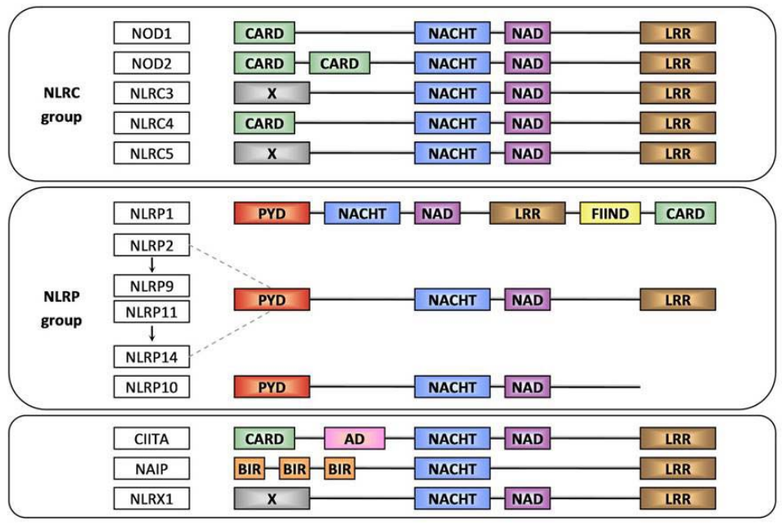
I will discuss a new way we have developed to identify and isolate such organisms from mice and humans. Using this approach, we have shown that predicted "pathobionts" from human patients with inflammatory bowel diseases (IBD) that we isolated by this approach can drive susceptibility to severe IBD in germ free mice whereas predicted harmless microbes from the same patients do not. These data suggest a significant involvement of such microbes in human disease. These approaches should be useful to the study of human microbiota driven diseases.

Keywords: Microbiota, Dysbiosis, Inflammasomes

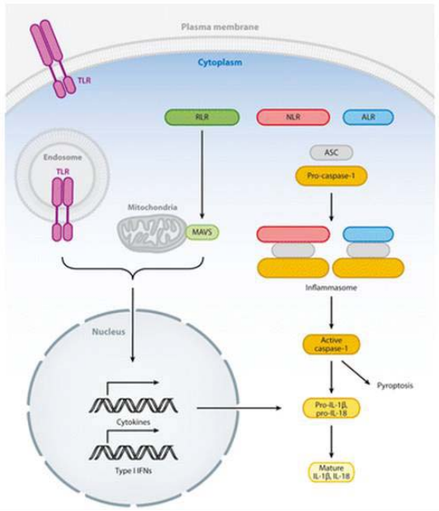
The Intestinal Microbiota and Disease



The NLR family

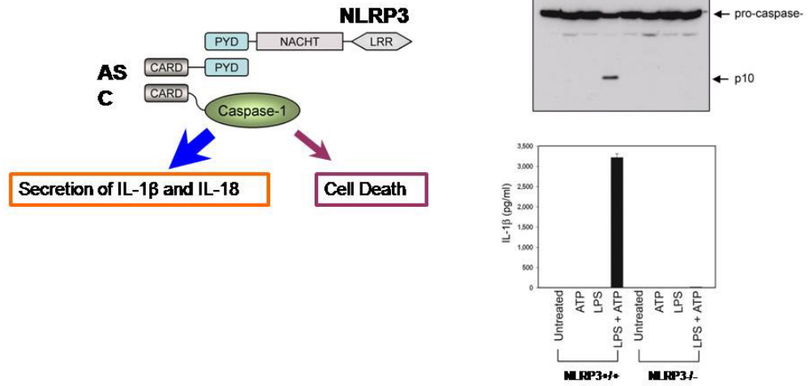


What are the sensors of the innate immune system?

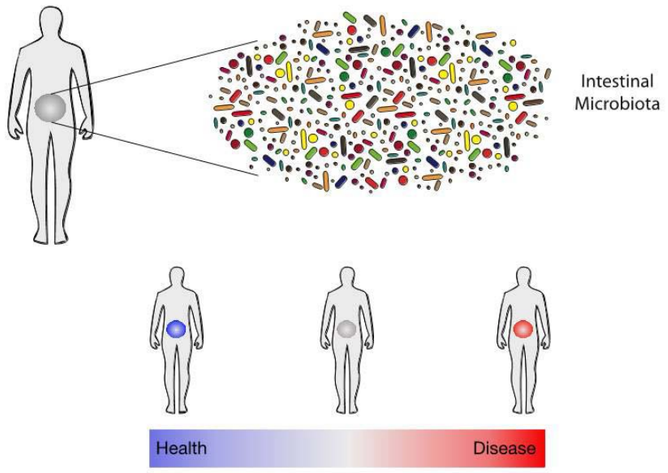


- **Toll-like receptors (TLRs)**
- **RIG-I-like receptors (RLRs)**
- **NOD-like receptors (NLRs)**
- **AIM2-like receptors (ALRs)**

The NLRP3 inflammasome



The Intestinal Microbiota and Disease



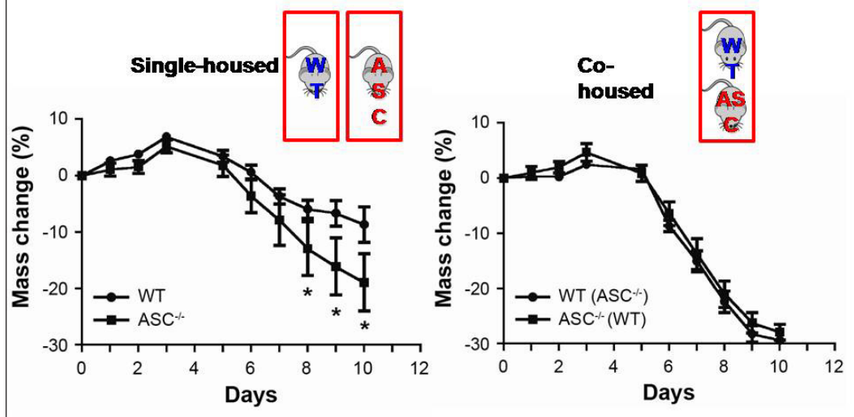
Do inflammasomes
modulate the intestinal microbiome?

Elinav E, Strowig T et al.(2011) Cell

An NLRP6, ASC, Caspase1 to IL-18 Inflammasome regulates the microflora

Elinav E, Strowig T et al.(2011) Cell

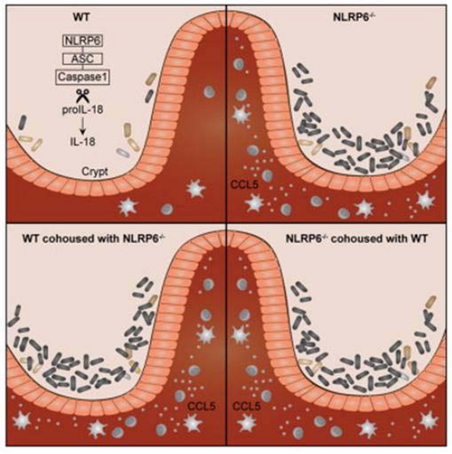
ASC$^{-/-}$ mice develop severe DSS colitis



Allen IC et at. JEM 2010
Dupaul-Chicoine J et al. Immunity 2010
Zaki MH et al. Immunity 2010

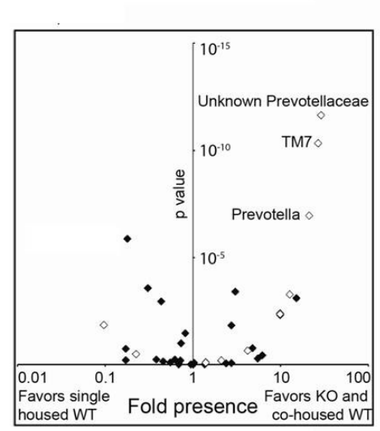
NLRP6, ASC, Caspase1 to IL-18
KO mice all phenocopy DSS susceptibility

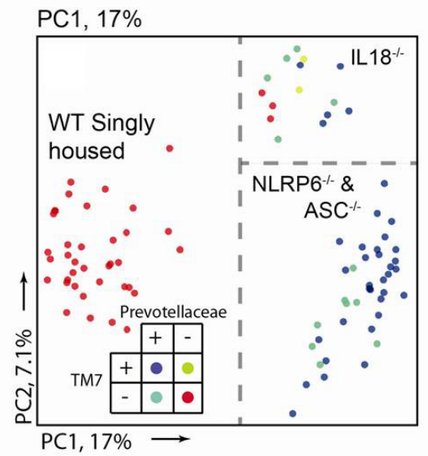
Working model of inflammasome-mediated regulation of gut microbiota and colonic inflammation



Which are the microbes associated with the colitogenic phenotype?

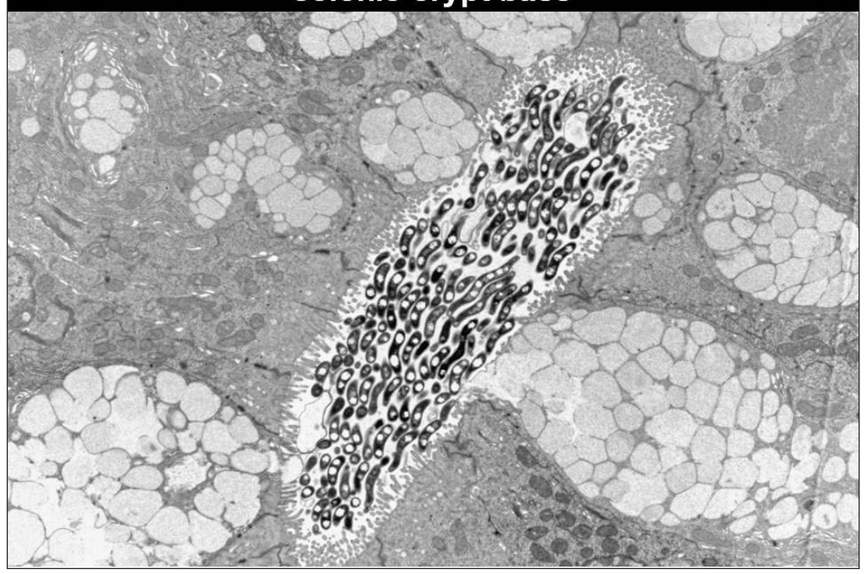
Distinct alterations in defined microflora communities in NLRP6 inflammasome-deficient mice



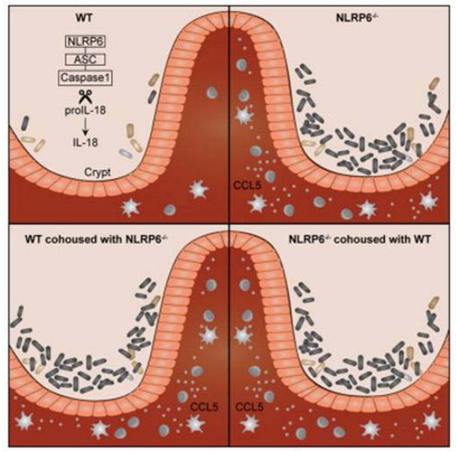


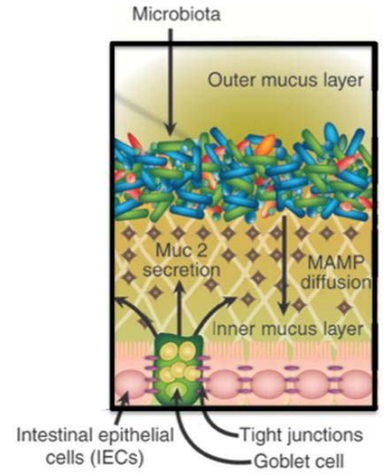
Site of NLRP6 inflammasome dysregulation is the colonic crypt base

Site of NLRP6 inflammasome dysregulation is the colonic crypt base

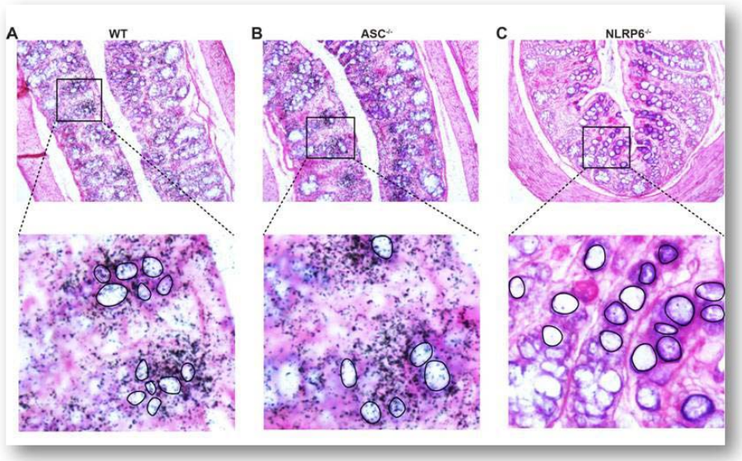


Working model of inflammasome-mediated regulation of gut microbiota and colonic inflammation



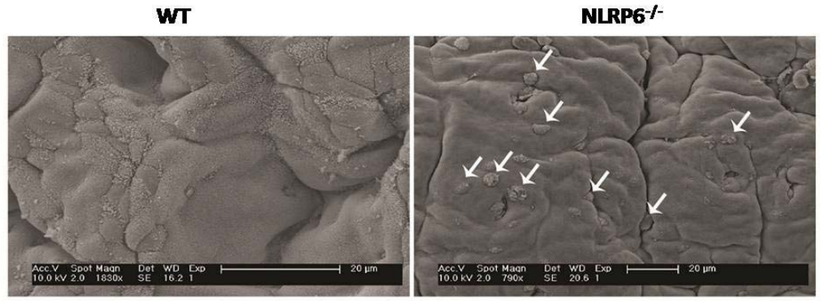


NLRP6 is expressed in goblet cells



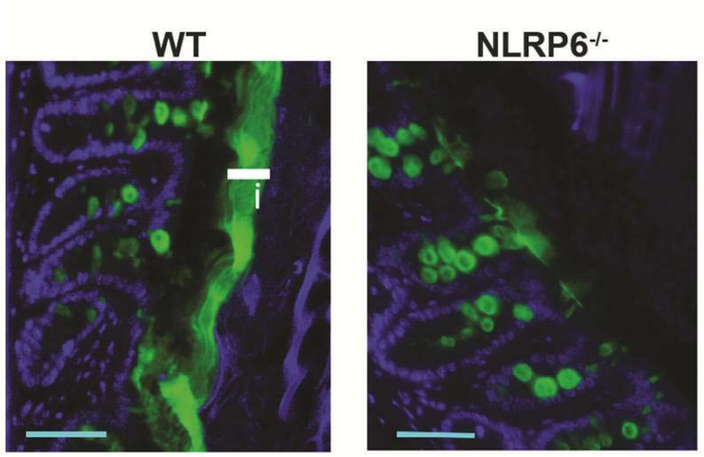
Wlodarska, M et al(2014), Cell

NLRP6 mediates goblet cell granule exocytosis

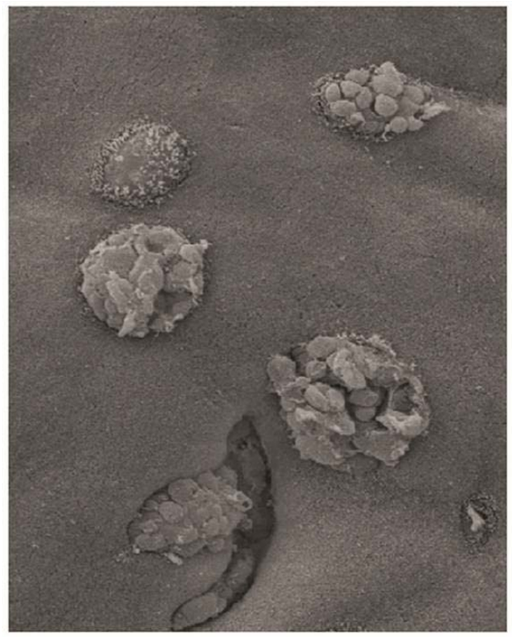


Wlodarska, M et al, (2014), Cell

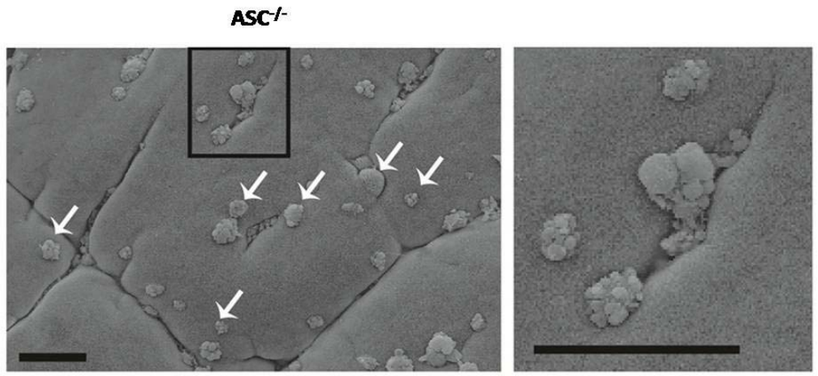
NLRP6 mediates goblet cell function



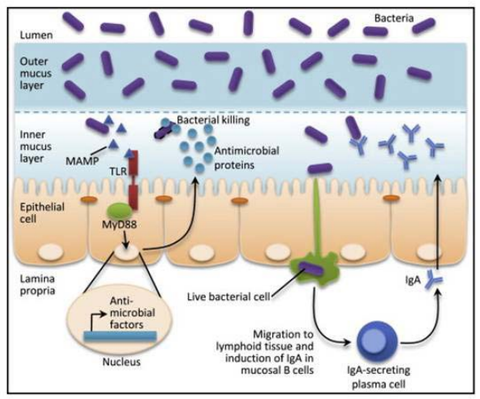
Wlodarska, M et al (2014) **Cell**



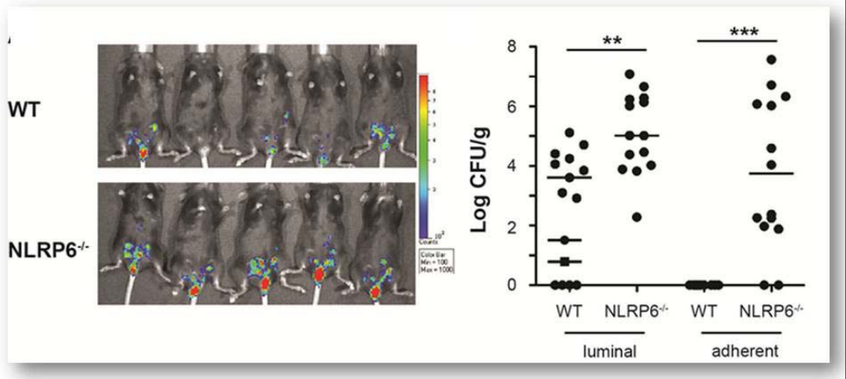
NLRP6 inflammasome mediates goblet cell function



Wlodarska et al , (2014) Cell

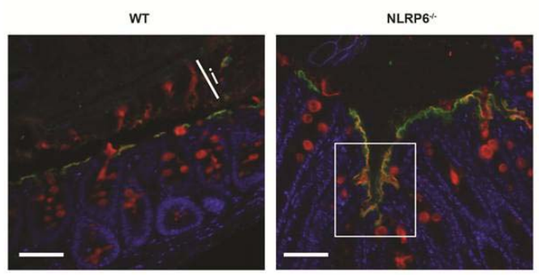


Consequences of intestinal infection



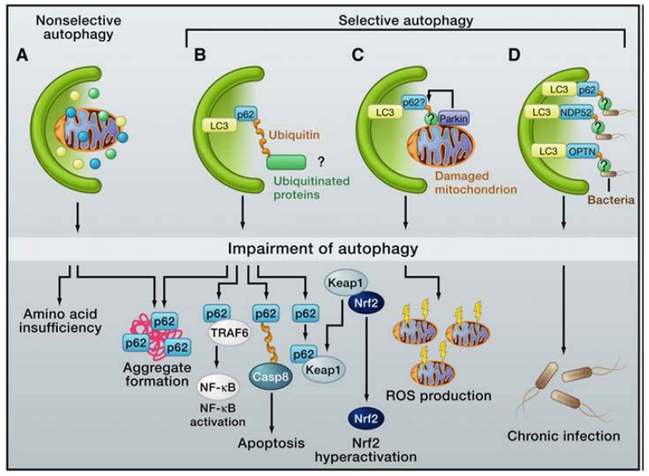
Wlodarska, M et al,(2014), Cell

Consequences of intestinal infection



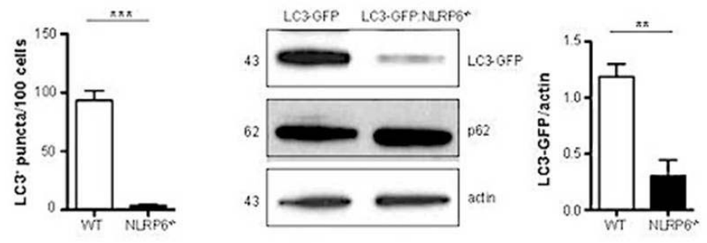
Wlodarska et al,(2014) Cell

Defective Autophagy in Inflammasome Mice



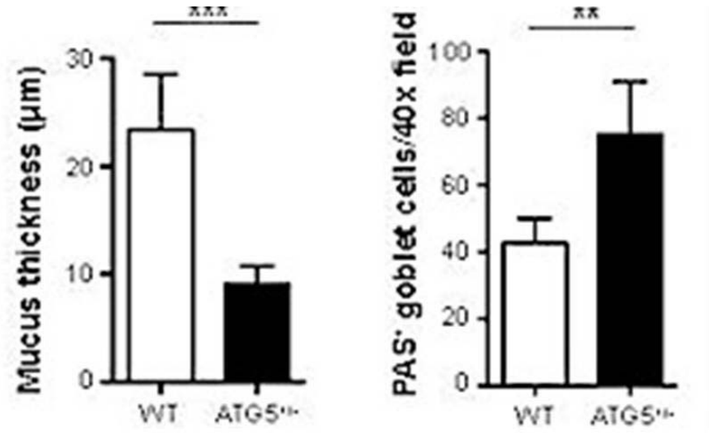
Mizushima & Komatsu, Cell 2011

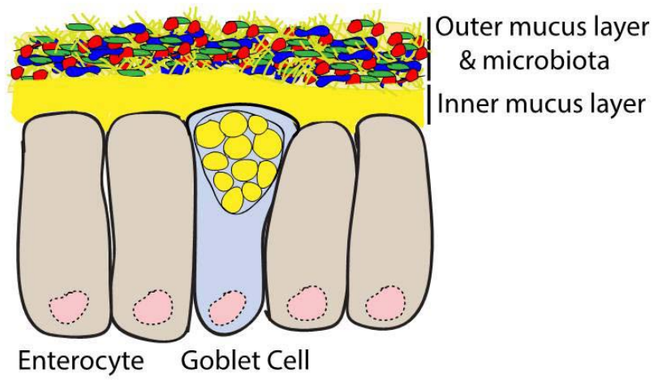
Defective Autophagy in Goblet Cells of NLRP6-/- mice



Wlodarska, M et al (2014), Cell

Mucus layer is defective in Autophagy Deficient Mice





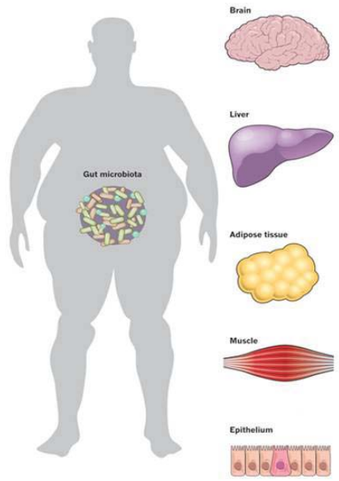
Immune-metabolic interaction in the development of MeS

Metabolism → Immune system

- Obesity is associated with a chronic, low-grade inflammatory state
- Excessive nutrient / metabolic intermediate → activation of inflammatory pathways

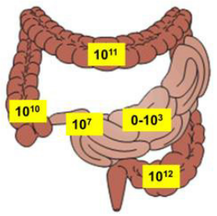
Immune system → Metabolism

- Brain → satiety control
- Liver and adipose tissue inflammation → insulin resistance
- Control the homeostasis of microbial ecology in the gastrointestinal tract



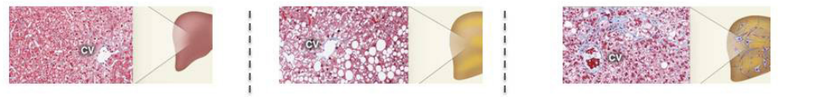
Adapted from Tremaroli *et al.* Nature 2012

Altered microbiota (dysbiosis) is implicated in the pathogenesis of systemic disease



Atopic Dermatitis and Allergy
Rheumatoid Arthritis
Gastric malignancy
Inflammation induced cancer
Obesity
Diabetes mellitus
Metabolic Syndrome

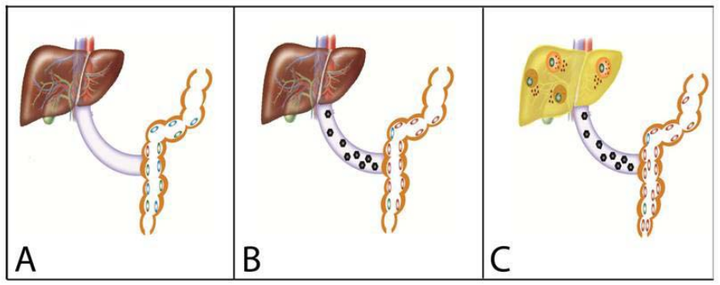
Non-alcoholic fatty liver disease (NAFLD)



STEATOSIS (NAFLD)	STEATOHEPATITIS (NASH)	CIRRHOSIS
30% general population 75-100% obese	20-30% progress to NASH	Mortality Portal hypertension Hepatocellular carcinoma

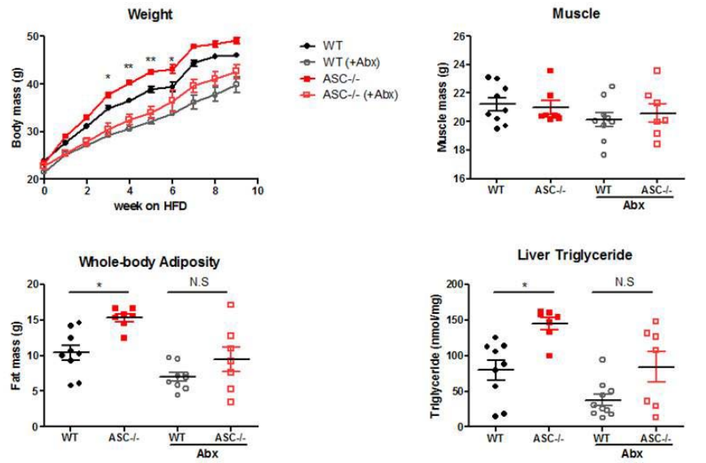
J.C. Cohen et al., ***Science***. (2011)
C.K. Argo et al., ***J. Hepatol***. (2009)

Working model of inflammasome-mediated regulation of gut microbiota and NAFLD progression

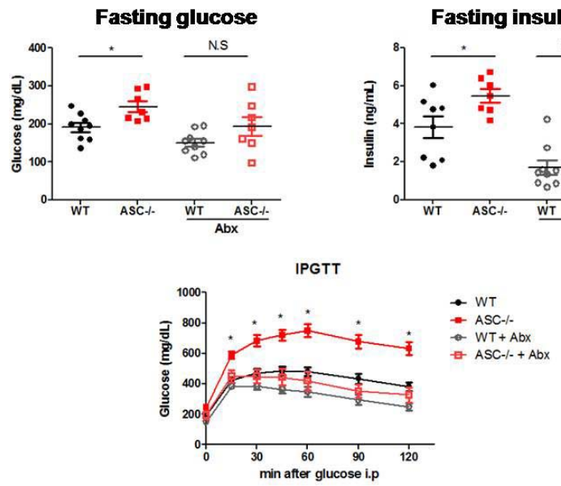


NLRP6, ASC, Caspase1 to IL-18 KO mice all phenocopy metabolic syndrome

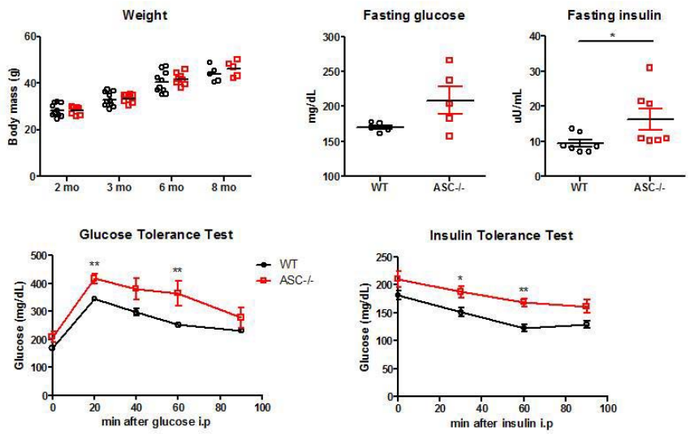
Antibiotic treatment suppresses development of HFD-induced obesity in ASC KO



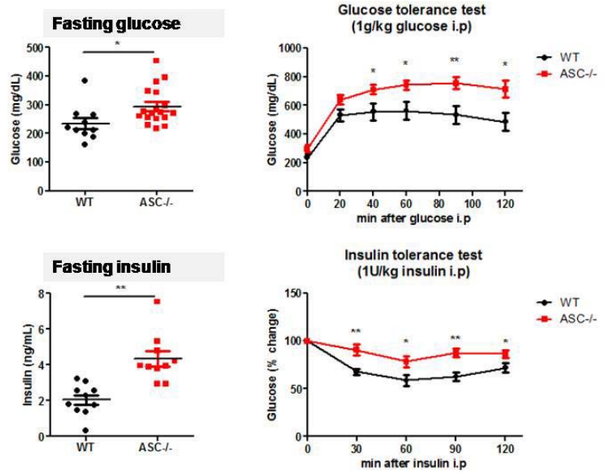
Antibiotic treatment rescues the impaired glucose metabolism in ASC KO



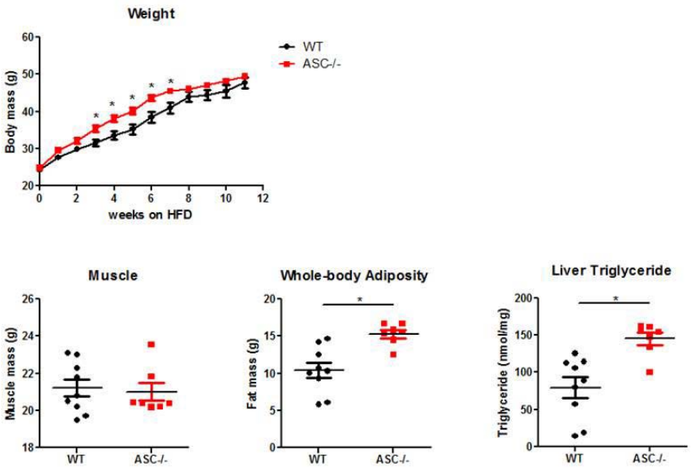
Impaired glucose metabolism in chow-fed ASC KO



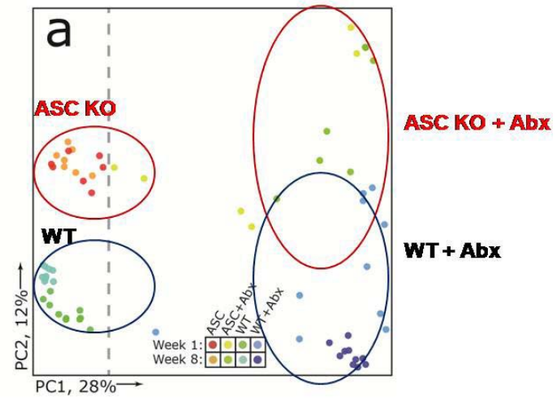
ASC KO develop exacerbated glucose intolerance and insulin resistance on HFD



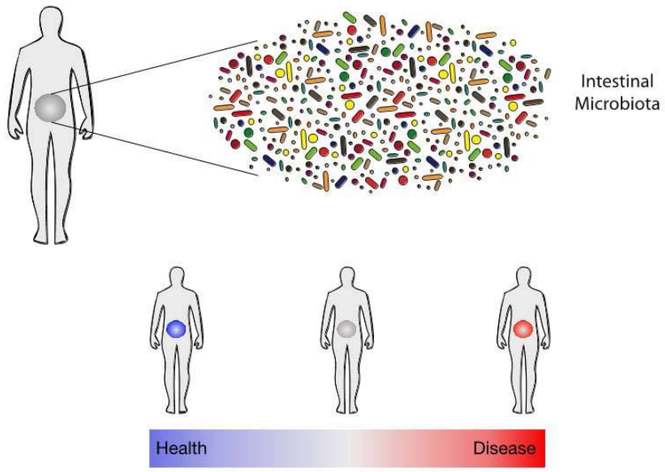
ASC KO are prone to high fat diet (HFD)-induced obesity



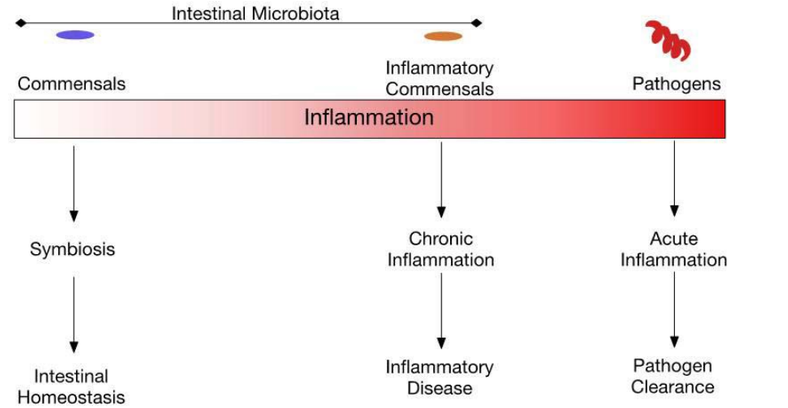
Altered gut microbiota composition in HFD-fed ASC KO



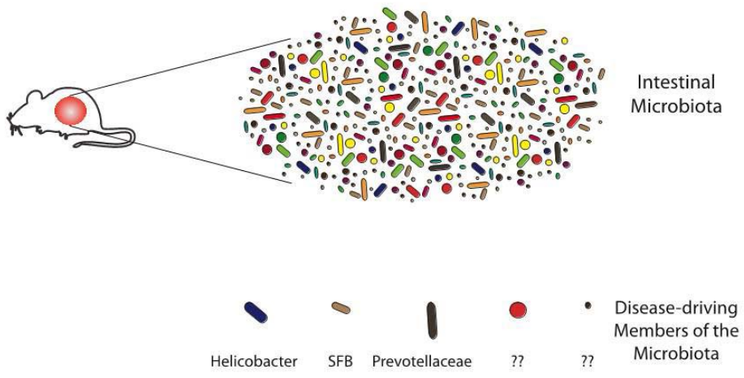
The Intestinal Microbiota and Disease



Disease-driving Members of the Intestinal Microbiota

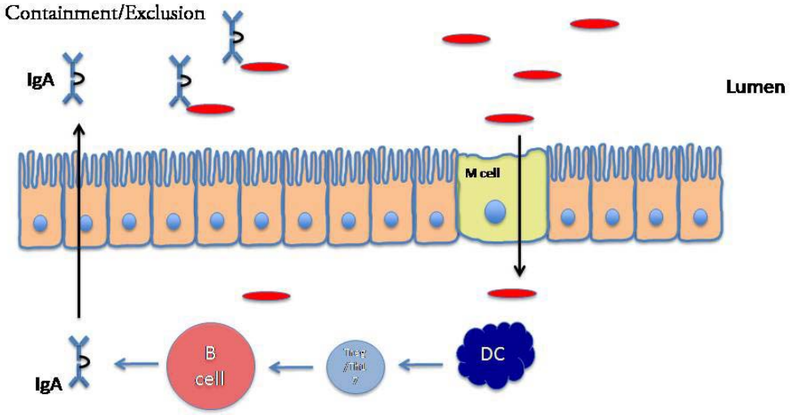


Disease-driving Members of the Intestinal Microbiota: Mice

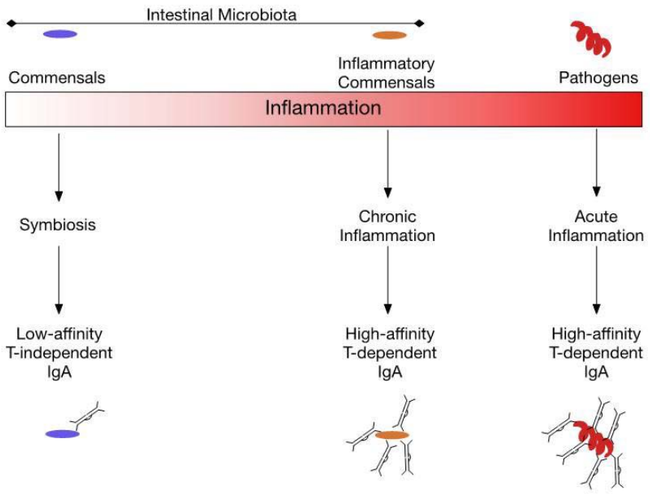


Immunoglobulin A

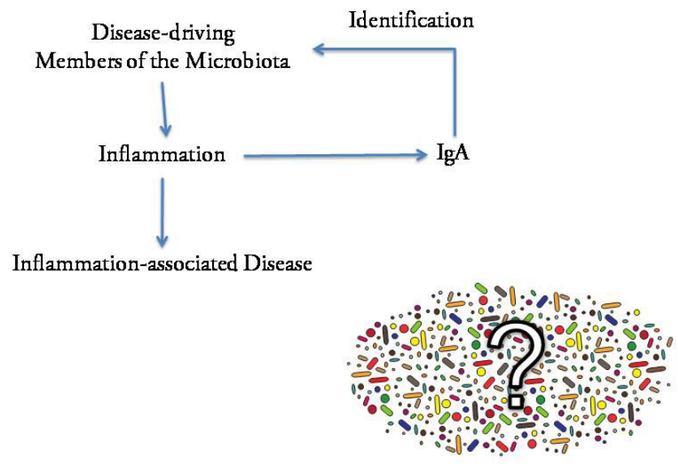
- Most abundant Ig isotype
- 2-5 g secreted each day
- Regulation of microbiota composition
- Neutralizes toxins
- Containment/Exclusion



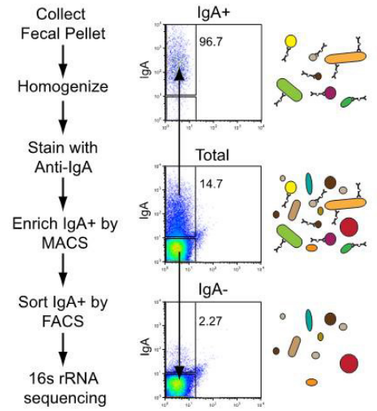
Disease-driving Members of the Intestinal Microbiota



IgA as a tag to identify disease-driving members of the microbiota

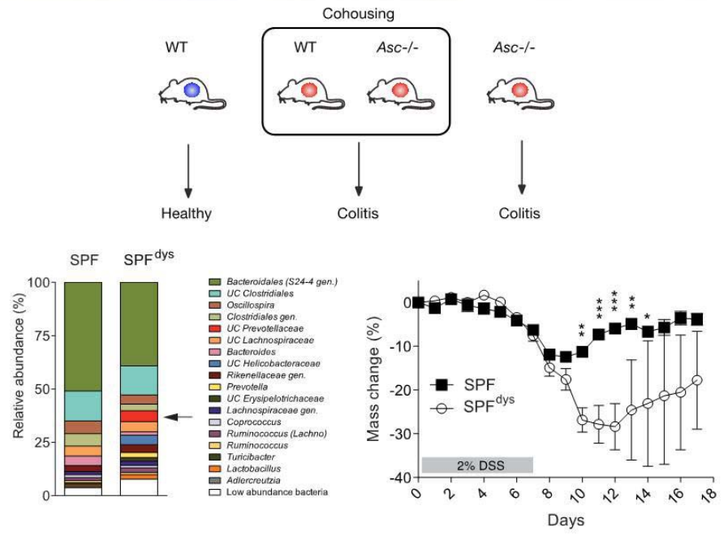


Identification of IgA-coated intestinal bacteria (IgA-SEQ)

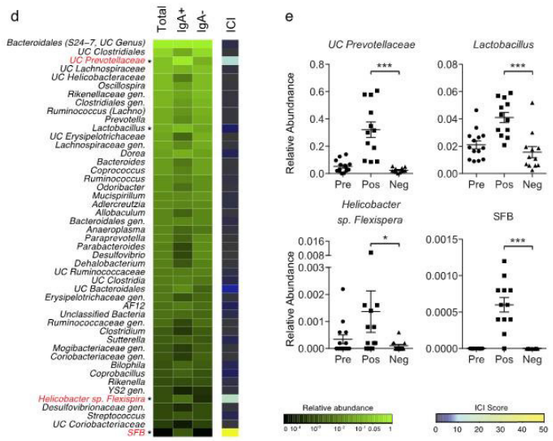


$$\text{IgA Coating Index (ICI)} = \frac{\text{Rel. Abundance in IgA+}}{\text{Rel. Abundance in IgA-}}$$

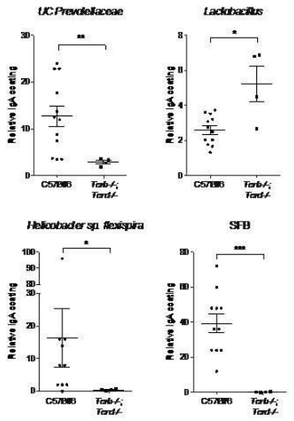
Inflammasome-mediated colitogenic dysbiosis



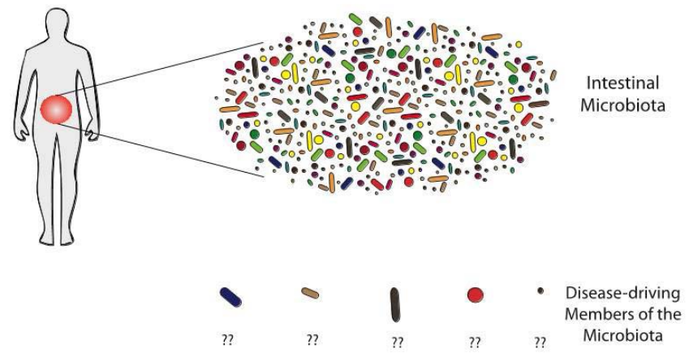
IgA-coating marks colitogenic members of the microbiota in mice with inflammasome-mediated dysbiosis



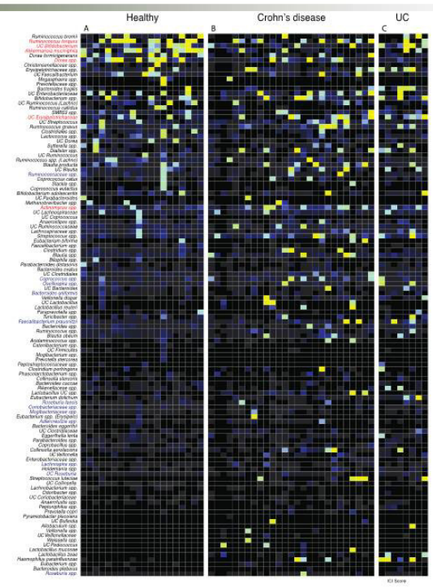
High IgA coating is largely T cell-dependent in mice with dysbiosis



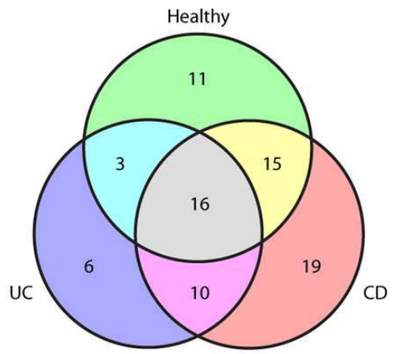
Disease-driving members of the microbiota: Humans



IgA-SEQ in humans



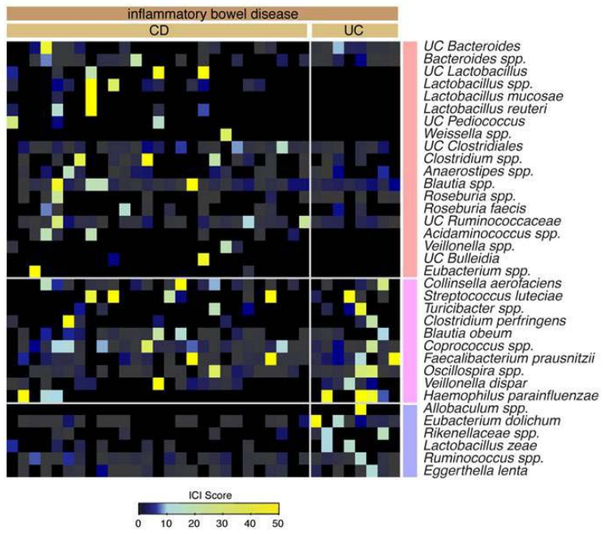
35 highly IgA-coated bacteria are unique to IBD patients



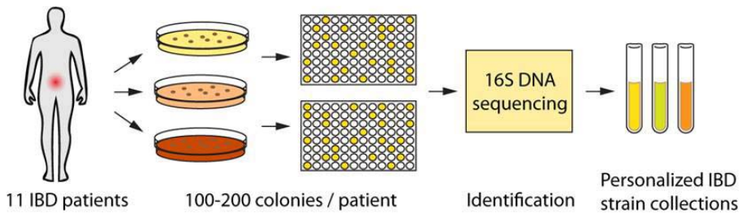
What effect do IBD-associated IgA-inducing (IgA coated) bacteria have on IBD development and severity?

Hypothesis:
IBD-associated IgA-inducing bacteria may selectively drive inflammation.

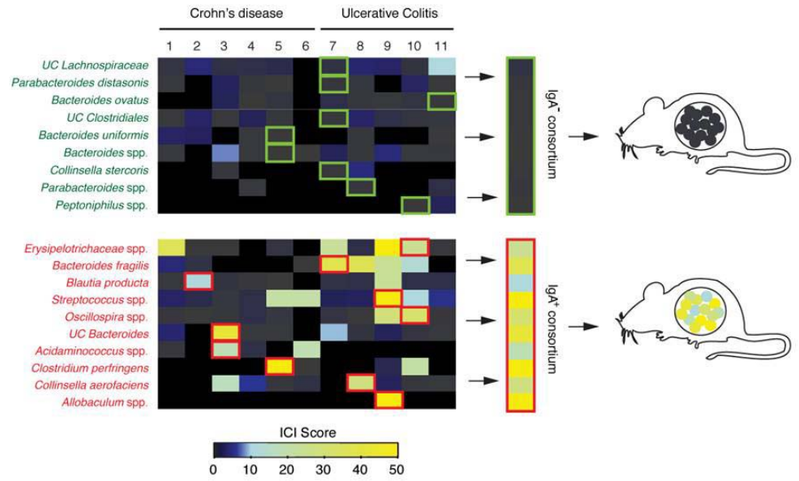
Distribution of IgA-coated bacteria among IBD patients



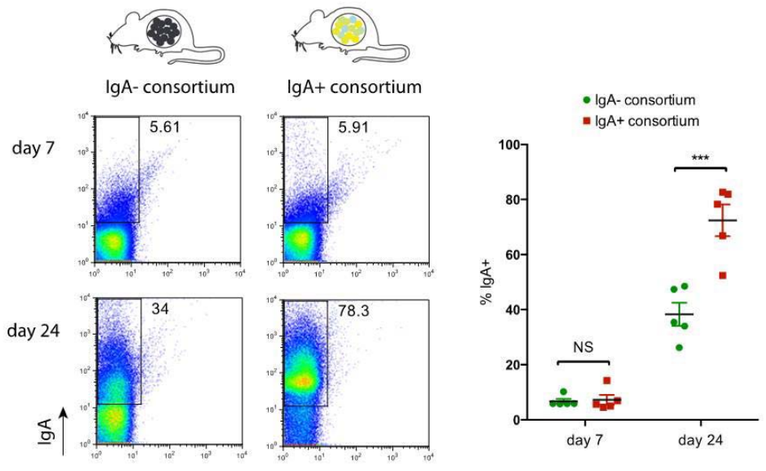
Establishing Personalized IBD Strain collections



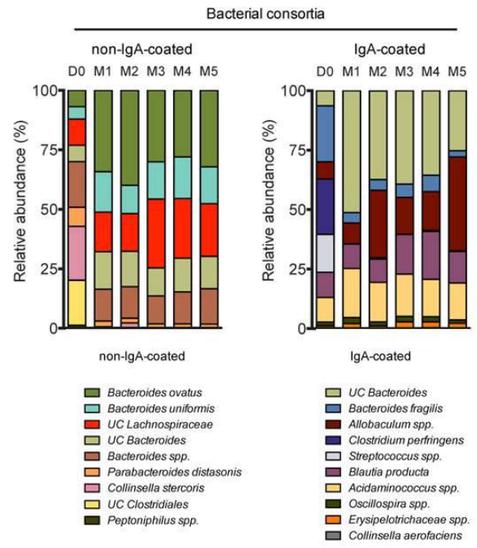
IgA- and IgA+ bacterial consortia



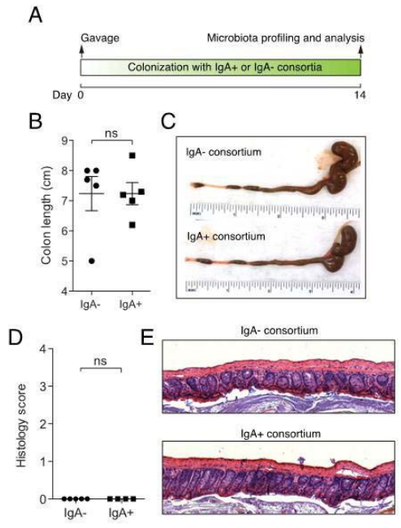
IgA+ bacteria selectively induce specific IgA responses in GF mice



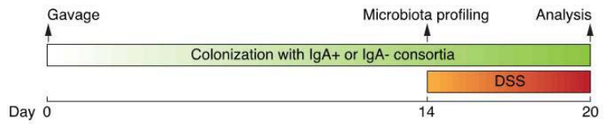
Colonization of germ-free mice with IgA- and IgA+ consortia

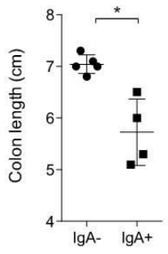


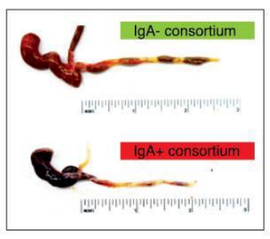
IgA+ bacteria do not induce spontaneous intestinal pathology at early timepoints



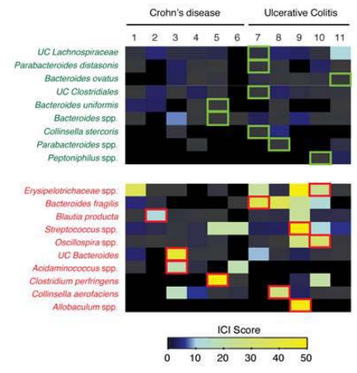
IgA+ bacteria selectively increase susceptibility to DSS-colitis







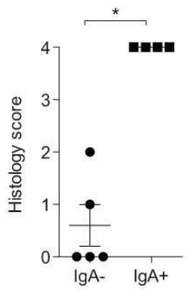
Bacteria from the same species display differential coating in different patients

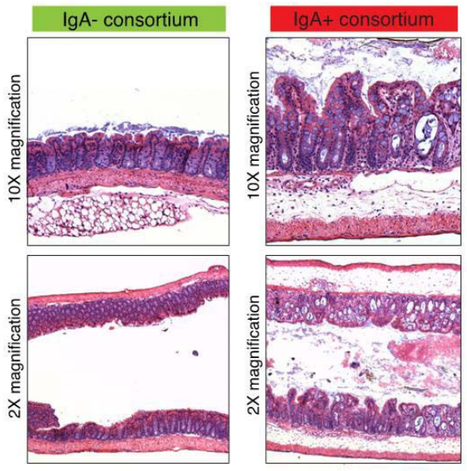


Why??

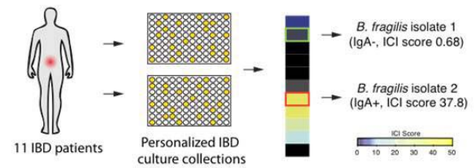
- Host Genetics
- Host Environment
- Bacterial Genetics

IgA+ bacteria selectively increase susceptibility to DSS-colitis

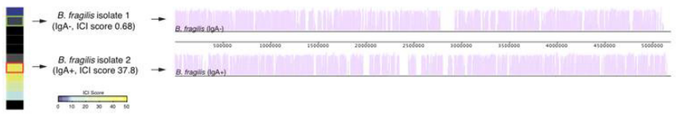




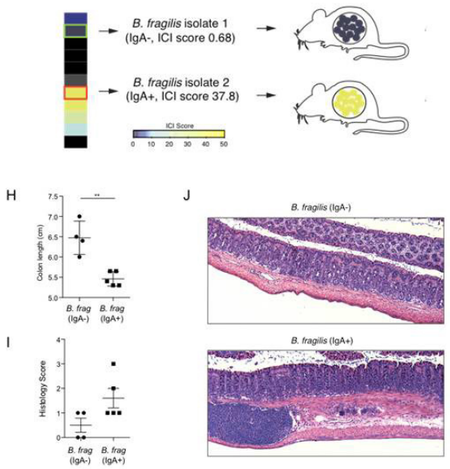
Selection of high- and low-coated *B. fragilis* isolates



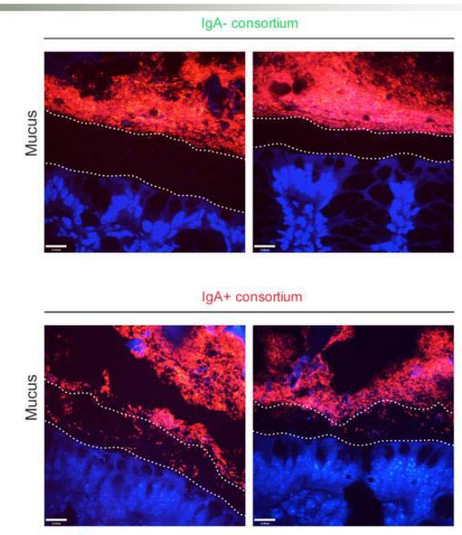
High- and low-coated B. fragilis isolates represent genetically distinct bacterial strains



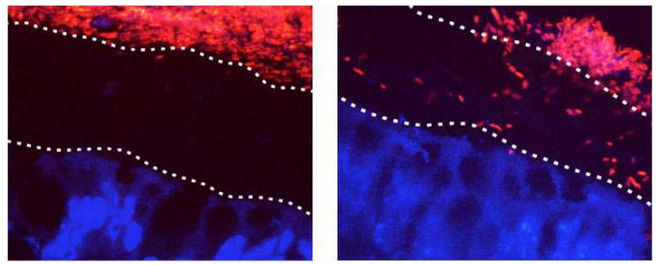
High IgA coating marks 'inflammatory' bacterial strains that selectively exacerbate intestinal inflammation



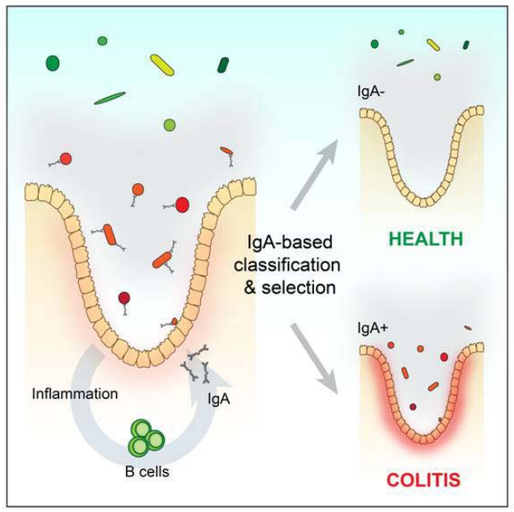
IgA+ consortia colonizes the mucus layer



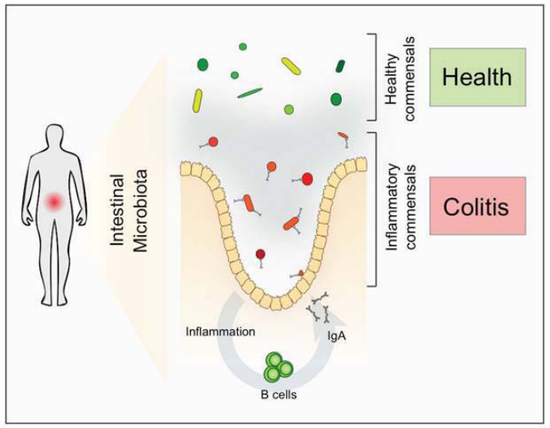
IgA+ consortia colonizes the mucus layer



Conclusion



Conclusion



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ChengCheng Jin
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Erin Brown

Richard Flavell lab, Yale University School of Medicine
Roni Nowarski
Jorge Henao-Mejia

Session 2

Current Research on Food for Health
(건강 식품의 연구 현황)

Chair: Jung Han Yoon Park
(Fellow, KAST / Hallym University)

Lessons from Centenarians :
The Value of Korean Traditional Nutritional and Dietary Pattern
(100세 장수의 교훈: 전통적인 영양과 식이 양식의 가치)

Sang Chul Park (Fellow, KAST / Samsung Advanced Institute of Technology)

Probiotic Lactobacilli Improve Health Biomarkers
(생균 락토바실라이에 의한 건강 지표 개선)

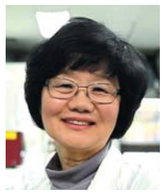
Marika Mikelsaar (University of Tartu, Estonia)

Epigenetic Interactions between Aging and Nutrition
(노화와 건강 사이의 후생적 상호 작용)

Sang Woon Choi (Cha Medical University)

KAST's 20th Anniversary International Symposium

Food, Health and the Future
(식품, 건강, 그리고 미래)



Jung Han Yoon Park, Ph.D.

Department of Food Science and Nutrition, Hallym University
jyoon@hallym.ac.kr

Education

1972	B.S., Food and Nutrition in Ewha Womans University
1977	M.S., Nutrition in University of Minnesota, USA
1982	Ph.D., Nutritionin University of Minnesota, USA

Major Activities

2013 - 2012	President, The Korean Nutrition Society
2012 - 2012	President, The Korean Society of Cancer Prevention
2011 - 2012	Editor in- Chief, Journal of Medicinal Food
2010 - 2010	Vice President, Korea Federation of Women's Science & Technology Associations
2008 -	First Editor, British Journal of Nutrition
2008 -	Editorial Board Member, Nutrition Research
2007 - 2009	Executive Board Member, Korea Science and Engineering Foundation
2007 - 2008	Dean, College of Natural Sciences, Hallym University
2006 -	Fellow, The Korean Academy of Science and Technology
1994 -	Professor and Associate Professor, Department of Food Science and Nutrition, Hallym University
1989 - 1994	Associate professor and Assistant Professor, Creighton University School ofMedicine, USA
1985 - 1989	Assistant Professor and Instructor, University of Nebraska Medical Center, USA

Honors and Awards

2013.10. 23	Gangwon-Do Culture Award
2013.10. 14	Minister of Health and Welfare Award
2013. 02. 21	Hallym Outstanding Research Award
2012. 12. 31	Minister of Education, Science, and Technology Award
2011. 05. 19	Hallym Academic Achievement Award
2010. 11. 19	Mokwoon Life Science Award, The Korean Academy of Science and Technology
2009. 12	2009 Distinguished Evaluator in Basic Science, National Research Foundation of Korea
2008. 11	2008 the Best 50 Research Project Award, Korea Research Foundation
2007. 12	Selected as the 12 Global Leaders, Korea-England Woman Scientist Forum
2006. 10. 19	NUTRILITE award, Korean Society of Food Science and Nutrition
2005. 10. 28	50 Outstanding Research Project Award, Korea Science and Engineering Foundation
2004. 12. 21	2003 Outstanding Paper Award, The Korean Nutrition Society
2004. 05. 13	Il-Song Outstanding Research Paper Award, Il-Song Memorial Project Committee
2003. 05. 15	Il-Song Outstanding Instructor of Research Paper Award, Il-Song Memorial Project Committee
2002. 03. 06	Il-Song Outstanding Research Paper Award, Il-Song Memorial Project Committee

Research Interests

Mechanisms by which diet-induced obesity stimulates tumor growth and metastasis

Sang Chul Park, Ph.D.

Executive Vice President,
The Samsung Advanced Institute of Technology
scpark@snu.ac.kr

Education

1973	MD, Seoul National University Medical School(SNUMC)
1980	PHD, Graduate School, Seoul National University

Professional Experiences

1980 - 2011	Professor, Dep. Biochemistry & Molecular Biology, SNUMC
2011 - 2012	Professor & Director, Lee Gil Ya Cancer & Diabetes Institute, Gachon University
1994 - 1996	Vice Dean for Student Affair, SNUMC
1998 - 2000	President, Korean Society for Gerontology
2000 - 2002	President. Intern. Assoc. Biomedical Gerontology
1998 - 2000	Director Board of Academic Affairs, Korean Association of Medical Sciences
1998 - 2001	Director for Academic Affairs, Korean Academy of Basic Medical Scientists
1998 - 2000	Dean of Research Affair, Seoul National University
2000 - 2003	President, Federation of Korean Gerontological Societies
2000 - Present	Fellow, The Korean Academy of Science and Technology
2002 - 2003	President, Korean Society of Biochem & Molecular Biology
2005 - 2006	President, Korean Society of Molecular & Cellular Biology
2006 - 2011	Director, Institute on Ageing, Seoul National University
2013 - Present	Executive Vice President, Well Aging Research Center, Samsung Advanced Institute of Technology

Lessons from Centenarians : The Value of Korean Traditional Nutritional and Dietary Pattern

Sang Chul Park

Executive Vice President,

The Samsung Advanced Institute of Technology

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In order to trace the value of Korean traditional foods for human well being and longevity, we have carried out the nutritional and diet survey for the aged people including centenarians and also have screened the health-supporting potential of the food materials and cooking process.

Thereby we could tentatively conclude as follows.

1.Regional data showed that not only the foods but also the life style including physical activities would have been required to maintain the health status of the long lived people, which would confirm the combined effects of nutrition, exercise, relationship, social participation for human longevity.

2. Korean traditional foods are enriched with abundant antimutagenic, antioxidative, anticarcinogenic, lipid lowering, peroxide scavenging and immune enhancing potentials.

3. Traditional foods can compensate the nutritional shortage of vegetable foods by fermentation process, which would overcome the unbalanced food composition for health.

4. Traditional methods for cooking would prevent the formation of mutagens during cooking process.

5. Traditional dietary pattern indicated the optimum consumption of calorie rather than restriction, which would ensure the activity of the long lived people

These data implicate that Korean traditional habits of food and cooking can already provide the nutritional diversity, cooking safety, nutritional compensation by harmonious interaction with microbiota, which would definitely contribute to health and longevity.

Marika Mikelsaar, Ph.D.

Professor emeritus, Project leader, University of Tartu, Estonia
marika.mikelsaar@ut.ee

Education	1992	DSci at University of Tartu
	1969	PhD at University of Tartu
	1963	Higher education: MD at Medical faculty of University of Tartu
Major Activities	2010 - 2014	University of Tartu, Faculty of Medicine, Department of Microbiology, leading scientist in medical biotechnology, professor emeritus
	2004 - 2010	University of Tartu, Faculty of Medicine, Department of Microbiology, Chair of Medical Microbiology and Virology; Professor extraordinarius
	1993 - 2003	University of Tartu, Faculty of Medicine, Department of Microbiology; Professor & Head of dept
	1979 - 1993	Senior researcher by University of Tartu, Faculty of Medicine, Dept. General &Molecular Pathology
	1969 - 1979	Researcher by University of Tartu, Faculty of Medicine, Dept. General & Molecular Pathology
	1965 - 1968	Ph D studies by University of Tartu, Dept. microbiology
	1963 - 1965	residency by University of Tartu, Dept. microbiology
Administrative responsibilities	2013 - 2014	Board member of International Association for Gnotobiology
	2010 - 2012	President of Society for Microbial Ecology in Health and Disease
	2008 - 2010	Board member of Society for Microbial Ecology in Health and Disease
	1995 - 1999	academic secretary of the medical council of Tartu university
	1993 - 2002	member of the medical council of Tartu university
International Awards	2007	European Union Women Inventors and Innovators Network Recognition Award in Berlin for antimicrobial and antioxidative probiotic Lactobacillus fermentum ME-3 DSM14241, patented in EU, USA, Russia
	2008	In South-Korea, Söul, the golden medal of Worldwide Female Investigators and Inventors for probiotic cheese comprising L. plantarum Tensia DSM 21380 aimed for reduction of blood pressure

M. Mikelsaar has published more than 100 international papers and chapters in Lactic acid bacteria publications with more than 2300 citations, her h-index is 25. She is a specialist inmedical microbiology, human microbial ecology, biomedicine and biotechnology. Team of Professor Mikelsaar has succeeded in development of functional food with probiotics that decrease the risk of some human chronic diseases. The selected by her strains of lactobacilli naturally preserve food and feed from contamination. Her current research focuses for the impact of microbiota and probiotics of Lactobacillus sp. on host metabolic and immunologic functions in health and disease.

Probiotic Lactobacilli Improve Health Biomarkers

Marika Mikelsaar

Dept. Microbiology, University of Tartu, Estonia,
marika.mikelsaar@ut.ee

This presentation introduces the research on improving some health biomarkers with specific probiotic lactobacilli relying on the role of microbial diversity of Lactobacillus sp. (LB) for host metabolism. In our previous studies the prevalence of LB species was related to geographical location, birth years and age (Sepp et al., 1998; Mikelsaar et al., 2004). Early shifts in composition of lactic acid bacteria predicted the development of allergy: in two-years-old allergic children the counts of lactic acid bacteria (enterococci) were lower at their newborn age (Björksten et al., 2003). At their age of 5 years, a less diverse composition of intestinal microbiota and a specifically higher prevalence of Bifidobacterium adolescentis compared to non-allergic children were shown (Stsepetova et al., 2007). Further we assessed that the health indices such as weight, white blood cell count, blood glucose and ox-LDL levels were differentially bound to the large biodiversity of counts and particular intestinal LB species in both Estonian adults and elderly (Mikelsaar et al., 2009; 2010; Stsepetova et al., 2011).

In late 90-ties, an antimicrobial and antioxidative probiotic L. fermentum ME-3 (DSM 14241) for reduction of oxidative stress and metabolic risk factors in atherosclerosis, food allergy and persistent intestinal infections was elaborated. In 2000-s the team developed two L. plantarum (DSM 21380 Tensia and DSM 21379 Inducia) strains and a multispecies combination of L. plantarum MCC1 & L. gasseri MCC2 for probiotic functional food which improves human metabolism by antihypertensive effects and reduces the risk of allergy due to immunological impact. The functional aspects of specific probiotics have been elaborated, comprising assessment of SCFA, glutathione redox system, NO, polyamines, antimicrobial and antihypertensive peptides using in vitro and animal models. The improvement of health biomarkers (BMI, blood pressure, inflammatory and metabolic cellular and blood biomarkers) was tested in healthy volunteer trials. The probiotic dairy products are naturally preserved against oxidation and contamination, granting their safety and use in Europe, Russia and Asia.

Keywords: Lactobacillus sp., metabolic properties, biodiversity, health biomarkers, probiotic development, functional dairy products

Probiotic lactobacilli improve health biomarkers

Marika Mikelsaar

University of Tartu

Bio-Competence Centre of Healthy Dairy Products LLC

University of Tartu:
Experience in
Improving some health biomarkers

with specific probiotic lactobacilli

relying on the role of microbial diversity of *Lactobacillus* sp. (LB)
for host metabolism:
glucose - adiposity
cholesterol , ox-Stress - CVD
blood pressure (BP)

Health **WHO:** A complete physical, mental and social well-being: quality of life

Biomarkers of health

EFSA Journal 2011;9(12):2474

• **Personal questioning** - Well being-quality of life Specific complaints • **Objective clinical indices** – BMI – Fat storage – Mucosal membranes state – EKG , MRI	• **BLOOD analyses** **Infammatory indices** us- CRP → WBC, formula **Insulin resistance +BP +BMI** **Blood sugar** → **Chol, LDI, HDL, Triglycerides** → **ox-LDL, isoprostanes** **URINE , Faeces**	Risk of **Infection** **Chronic inflammation** **MetSyndr** **CVD, ox-S**

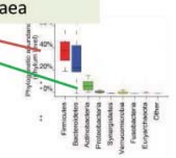
Do the microbiota shift these indices?

PROBLEMS

Microbiota
Allochthonous
Indigenous
- Beneficial bacteria
- Opportunistic pathogens
- Transitory microbes

Lactobacillus
Bifidobacteria

Metagenome = genome+microbiome
Superorganism 10% +90%
Viruses, eucarya, bacteria, archaea



Vrieze et al. Phylogenetic tree: diversity and abundance by 16S RNA sequencing. Diabetologia.2010 ,53(4): 606–613

In different diseases, the shifts in abundance of the predominant gut microbiota are accompanied with changes of host health biomarkers

OBESITY : contradictory results

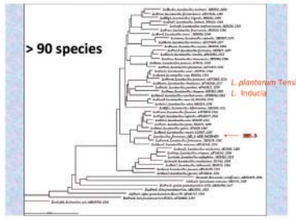
relative abundance of Firmicutes to Bacteroidetes?

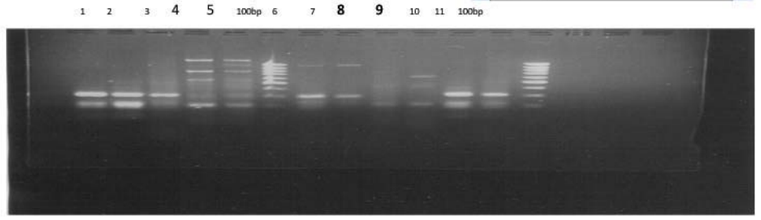
Ley 2005, 2006, Turnbaugh 2006, Nadal 2008, Xu 2012 vs. Schwiertz 2009, Duncan 2008

Do the microbiota shift these indices
differentially in various age groups ?

LACTOBACILLUS sp. genotypes:

16s RNA gene sequencing,
phylogenetic tree and
species specific PCR products





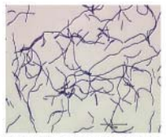
- ITS-PCR products of amplified 16S-23S rRNA gene spacer regions from Lactobacilli using primers16S-1500F and 23S-32R (DNA Technology AS).

1. ***L.casei* 8700:2**; 2. ***L.paracasei* ssp *paracasei*** *DSM20020;* 3. *L.paracasei* ssp *paracasei DSM 5622;*
4. ***L.plantarum* 299V**; 5. *L. plantarum* ATCC14917; 6. ***L.acidophilus* La5**; 7. *L.acidophilus* ATCC4356;
8. ***L.fermentum* ME-3;** 9. *L.fermentum* ATCC14931; 10. ***L.rhamnosus* GG**; 11. *L.rhamnosus* ATCC14931
100 bp DNA ladder

Genome sequencing, data NCBI genomes

Aging, intestinal microbiota and human biomarkers

Lactobacillus sp.



> anaerobic conditions

fermentative characteristicstics

Growth at **+15°C**

GAS from glucose

Obligately homofermentative lactobacilli (OHOL)	**Facultatively heterofermentative lactobacilli (FHEL)**	**Obligately heterofermentative lactobacilli (OHEL)**
Ferment **hexoses** to lactic acid.	Ferment **hexoses** to lactic acid + acetic acid, ethanol and formic acid (under glucose limitation), **pentoses** to lactic and acetic acids	Ferment **hexoses** to lactic acid, acetic acid, ethanol and CO_2, and **pentoses** to lactic acid and acetic acid.
L. acidophilus	***L. plantarum***	***L. fermentum***
L. delbrueckii	***L. casei***	***L. brevis***
L. gasseri	***L. paracasei***	***L. reuteri***
L. salivarius	***L. rhamnosus***	***L. buchneri***
L. johnsonii	***L. curvatus***	
L. helveticus		
L. ruminis		

Kandler ja Weiss, 1986

Healthy adults and elderly

Mikelsaar et al.,Anaerobe 2009

Stsepetova Brit. J. Nutr. 2011

- 24 healthy adults age: 27.0 (quartiles 23-31.5) years]
  37 healthy elderly age: 73.0 (quartiles 68-75.2) years]

Inclusion criteria:

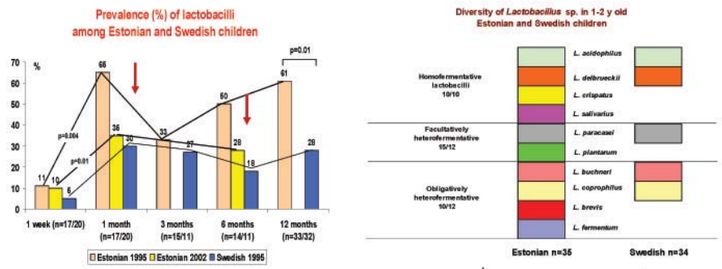
Considering themselves healthy, No gastrointestinal disorders,
No antibiotic treatment

Indices	Adults N=24 29.2±8.2	Elderly N=37 72.5±5.0	p-values	Reference Values
BiomassIndex BMI (kg/m^2)	24.5±4.1	27.2±4.2	P=0.01	Normal 18.5-24.9 Overweight >25 Obese >30
Fasting plasma glucose (mmol/L)	4.5±0.50	5.2±0.60	P<0.001	3.1-6.4 mmol/L

*** Altogether 42 clinical and laboratory indices were correlated with intestinal microbiota.**
*** In elderly the BMI was negatively correlated with counts of live Bacteroidetes .**Sepp et al, 2014, MEHD

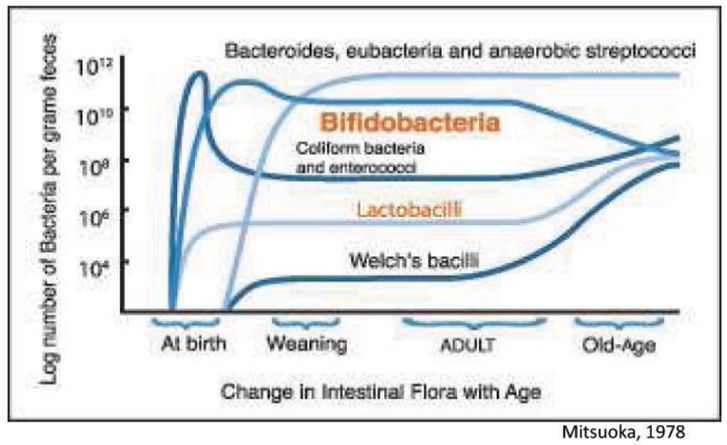
SHIFTS IN MICROBIOTA OF 1year old ESTONIAN CHILDREN during environmental changes in 90-ties

Sepp et al., 1987; 1998; 2000, 2006; Mikelsaar et al. 2002



10/6/2014 S-Korea, Seoul

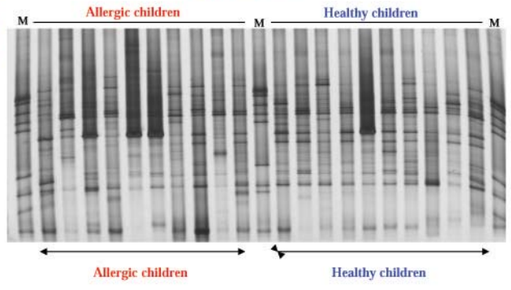
Changes in intestinal microbiota during life (bacteriological analysis)



Mitsuoka, 1978

Allergic vs. healthy children of 5 y have less biodiversity of microbiota

Amplified V6-V8 regions of the 16S rDNA gene in fecal samples detected by DGGE analysis



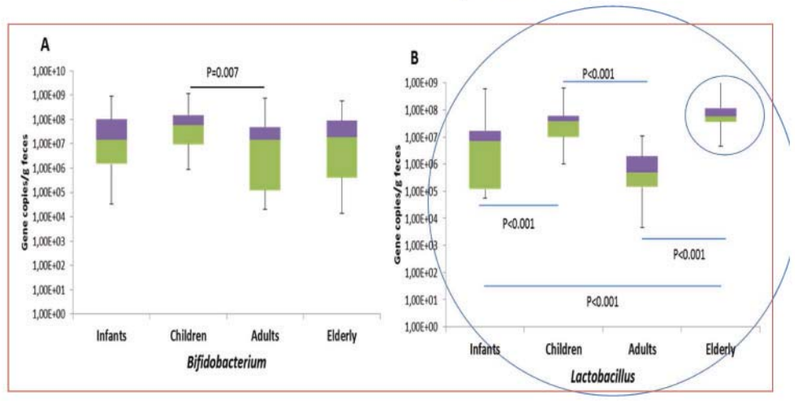
Bands: 15-24 (median 17.5) ⟷ P<0.001 17-36 (median 23.5)

Microbial deprivation – absence of tolerance induction, development of senzitisation and absence of allergy downregulating species

Stsepetova, Jet al. (2007). Molecularly assessed shifts of Bifidobacterium ssp. and less diverse microbial communities are characteristic of 5-year-old allergic children. FEMS Immunology and Medical Microbiology, 51(2), 260 - 269.

10/6/2014 S-Korea, Seoul

QUANTITATIVE CHANGES OF *LACTOBACILLUS* AND *BIFIDOBACTERIUM* SP. IN HUMAN INTESTINAL TRACT OF DIFFERENT AGE GROUPS (Real time-PCR)

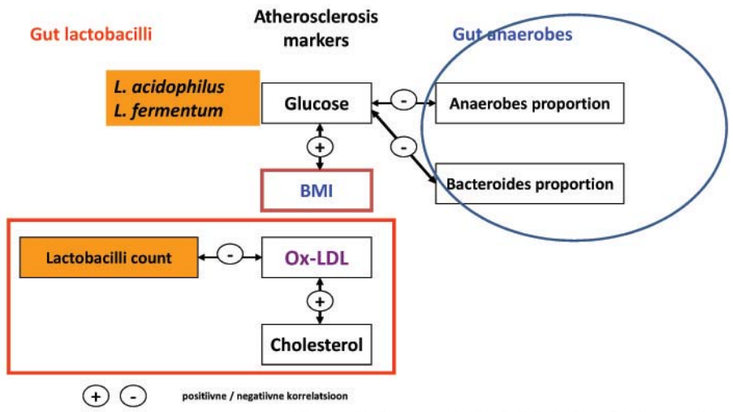


Štšepetova et al. ENGHIR Proceedings, 2014

10/6/2014 S-Korea, Seoul

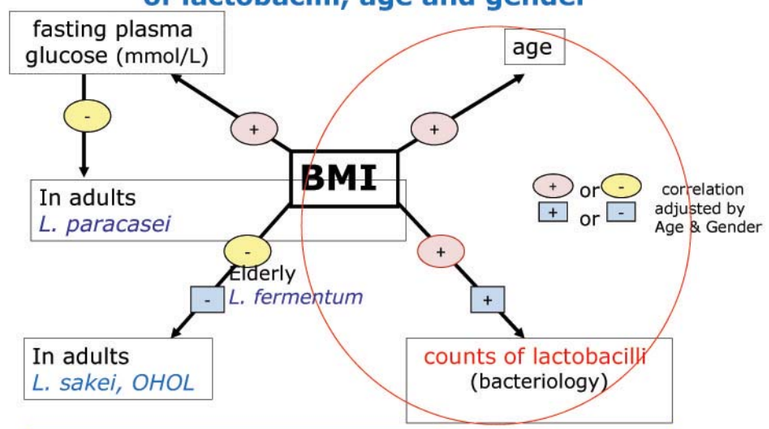
Multiple regression analysis

IMB of elderly and health



Mikelsaar, M.; Stsepetova, J.; Hütt, P.; Kolk, H.; Sepp, E.; Lõivukene, K.; Zilmer, K.; Zilmer, M. (2010). Intestinal Lactobacillus sp. is associated with some cellular and metabolic characteristics of blood in elderly people . Anaerobe, 16(3), 240 - 246.

Correlation between BMI and counts, species of lactobacilli, age and gender

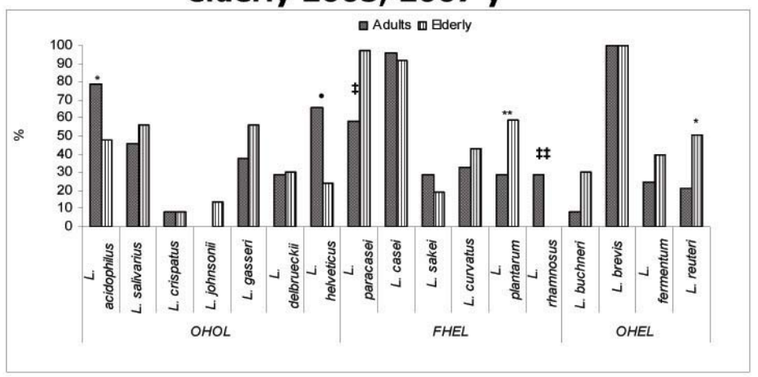


Specific Lactobacillus species affect different health biomarkers

Štšepetova, J. (2011). Diversity and metabolic impact of intestinal Lactobacillus sp. in healthy adults and the elderly. British Journal of Nutrition, 1 - 10.

Results 4

Lactobacillus sp. in healthy adults vs. elderly 2005, 2007 y



* p=0.031; • p=0.001; ‡ p=0.001; ** p=0.035; ‡‡ p=0.007

Each individual was colonized with **4 to 12 different species**
Adults, were often colonized with ***L. acidophilus*** **and** ***L. helveticus***.
in elderly, ***L. plantarum***, ***L. paracasei*** **and** ***L. reuteri*** prevailed.

Selection of Lactobacillus sp. Strains for Probiotics

Beneficial influence of *Bifidobacterium* and *Lactobacillus* sp. to human health

Functional properties:

- SCFA
- polyamines
- NO-, CO2
- biocides
- antioxidative capacity:

Mn- SOD, GSHPX, GSSGRX, scavenger of ROS

Anti-inflammatory cytokines

Health effects of probiotics:

- Prevention and reduction of diarrhea
- Lactose intolerance
- Antimutagenic and anticarcinogenic properties
- Host metabolism support
- Increasing mucosal immunity
- Contra oxidative stress
- Reducing serum cholesterol

TARTU Probiotics

***Origin of Lactobacillus fermentum* ME-3**

- 1995 from the GI tract of Estonian 1-year healthy child (Sepp *et al*., Acta Pediatr 1997, Mikelsaar et al. 2001)
- Inventors: Mikelsaar, Zilmer, Kullisaar, Songisepp, Annuk, 2001
- Deposited in April 2001 in Germany as DSM 14 241, Acronym ME-3
- Patent applications of Univ. of Tartu:
  - Priority application in Estonia 29.06.2001
  - International application PCT/EE02/00006 28.06.2002; EPO examination report 2003
  - Probiotik. RU 22 84354 27.09.2006
  - US patent, US 7,244,424 B2 Jul.17, 2007

EPO patent 2011

Antimicrobial activity enterobacteria
Antioxidative properties

L f ME-3
Vitamins
L-cysteine
Ubiquinol,
Monacolin

www.regactive.com/en/

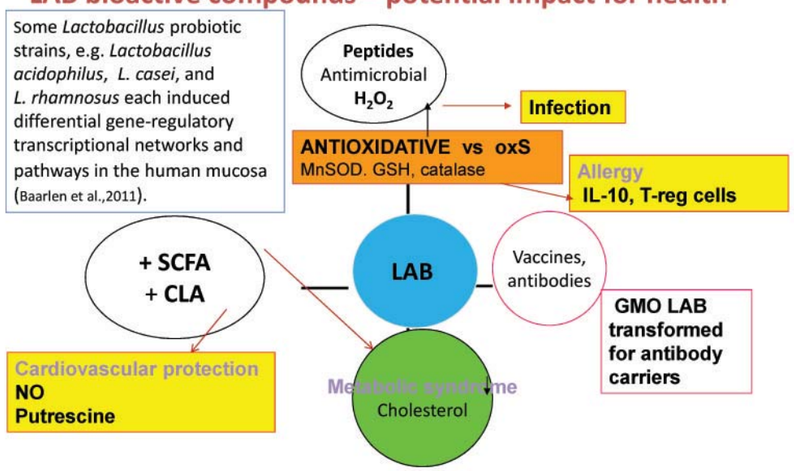
Origin: ***Lactobacillus plantarum*** **TENSIA** ™
1995. isolated from a healthy Estonian infant
Bio-Competence Center of Healthy Dairy Products LLC
Inventors: Songisepp, Mikelsaar, Rätsep, Zilmer M. Hütt, Zilmer K., Üksti, Kõljalg
Priority 2008
Russian patent 2013
EPO patent 2013

Antimicrobial activity e.g. listeria, salmonella, shigella
plantaricin, H_2O

- NO
- CLA
- peptides with ACE-inhibitory properties,
- metabolism of putrescine-spermidine

LAB bioactive compounds – potential impact for health

Some *Lactobacillus* probiotic strains, e.g. *Lactobacillus acidophilus*, *L. casei*, and *L. rhamnosus* each induced differential gene-regulatory transcriptional networks and pathways in the human mucosa (Baarlen et al.,2011).

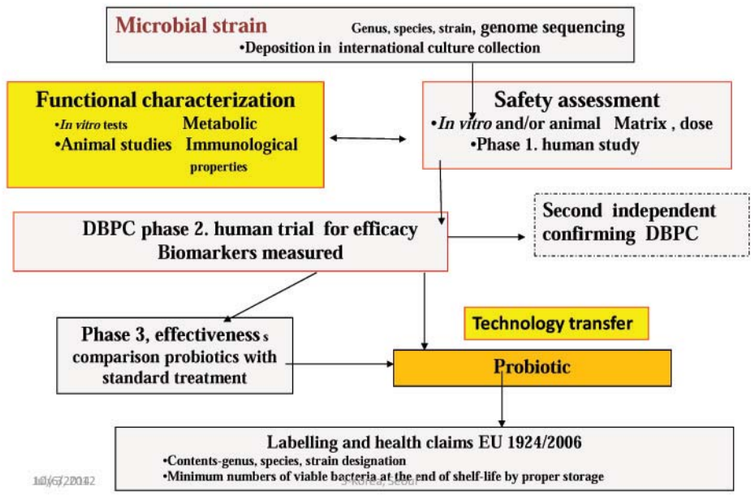


Annuk et al., 2003; Kullisaar et al., 2003; *Kõll et al. 2010*
Songisepp et al., 2012; Mikelsaar&Zilmer, 2009

How to perform clinical intervention trials with functional food ?

Regulations for application of PROBIOTIC BACTERIA in human food

Food and Agriculture Organisation of the United Nations (FAO) and WHO, May 2002
ILSI RECOMMENDATIONS 2008



Publications ME-3

- **Characterization of oral lactobacilli as potential probiotics for oral health**

Köll P, Mändar R, Marcotte H, Leibur E, Mikelsaar M, Hammarström L.

Oral Microbiology Immunology 2008: 23: 139–147

- **Two antioxidative lactobacilli strains as promising probiotics.**

Kullisaar T, Zilmer M, Mikelsaar M, Vihalemm T, Annuk H, Kairane C, Kilk A.

Int. J. Food Microbiol., 2002, 72, 215-224

- ***Lactobacillus fermentum* ME-3 - an antimicrobial and antioxidative probiotic**

Mikelsaar, M.; Zilmer, M

Microbial Ecology in Health and Disease, 2009. iOpen, 1 - 27.

- **Successful management of mild atopic dermatitis in adults with probiotics and emollients.**

Kaur S, Kullisaar T., Mikelsaar M, Eisen M, Rehema A, Vihalemm T, Zilmer K, Zilmer M.

Cent.Eur.J. Med., 2008, 3: 215-220.

- **Evaluation of the functional efficacy of an antioxidative probiotic in healthy volunteers.**

Songisepp, E.; Kals, J.; Kullisaar, T.; Mändar, R.; Hütt, P.; Zilmer, M.; Mikelsaar, M.

BMC Nutrition Journal, 2005, 4(22), 141 – 146.

Publications TENSIA

- **A new probiotic cheese with antioxidative and antimicrobial activity.**

Songisepp, E.; Kullisaar, T.; Hutt, P.; Elias, P.; Brilene, T.; Zilmer, M.; Mikelsaar, M. (2004).

J. Dairy Sci, 87(7), 2017 - 2023.

- **Safety of a probiotic cheese containing *Lactobacillus plantarum* Tensia....**

E. Songisepp , P. Hütt , M. Rätsep , E. Shkut , S. Kõljalg , K. Truusalu , J. Stsepetova , I. Smidt

J. Dairy Sci. 2012,95 :5495–5509

http://dx.doi.org/ 10.3168/jds.2011-4756

- **Probiotic Heart cheese "Harmony" comprising L. plantarum Tensia influences blood pressure and metabolic health indices**

Mikelsaar, M; Hütt, P; Stsepetova, J; Smidt, I; Shkut, E; Rätsep, M; Zilmer, M; Songisepp, E.

Voprossõ pitanija, 2012, 81(3), 74 - 81 (in Russian).

- **Hypocaloric diet supplemented with probiotic cheese improves body mass index and blood pressure indices of obese hypertensive patients - a randomized double-blind placebo-controlled pilot study.**

Sharafedtinov, Khaider; Plotnikova, Oksana; Alexeeva, Ravilay; Sentsova, Tatjana; Songisepp, Epp; Stsepetova, Jelena; Smidt, Imbi; Mikelsaar, Marika (2013).

BMC Nutrition Journal, 12, 138 - 159.

Clinical food trials in Tartu

Regulations for application of probiotic bacteria ... *FAO and WHO, May 2002, ILSI RECOMMENDATIONS 2008*

1. **SELECTION OF PROBIOTIC CANDIDATES**
   KÕLL et al. 2009
1. **Selection of human target group and biomarkers**
   EFSA Journal 2011, 9

4. ISCRNT43435738 and ISCRNT53154826 **registered trials**

3.ETHICS


Tartu Ülikooli inimuuringute eetika komitee
Research Ethics Committee of the University of Tartu (UT REC)

5.


EESTI AKREDITEERIMISKESKUS
ESTONIAN ACCREDITATION CENTRE
AKREDITEERIMISTUNNISTUS
ACCREDITATION CERTIFICATE

ME-3 : Reduction of the risk of atherosclerosis by
* antioxidative activity
* reduction of LDL cholesterol
- post-prandial triglycerides levels

Kephir – 200 ml /day
total 8×10^9 cfu/day

TENSIA : * Antimicrobial impact in dairy products
- Helps to control blood pressure
- Reduces the risk of metabolic syndrome

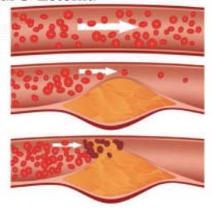
Probiotic cheese (50-100 g/d 3 weeks) helps to protect against CVD

L. fermentum ME-3 contra **ATHEROGENESIS by lipid metabolism regulation and CVD**

ISRCTN49744186

RDBC trial S-Estonia

ateromes

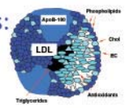


Inclusion criteria: desire to participate, appropriate age (35-65 years), **elevated blood lipids** >5.2 mmol/l for the total cholesterol, >3.4 mmol/l for LDL-C, >3.0 mmol/l for the LDL-C/HDL-C ratio and >1.7 mmol/l for the level of triglycerides),

New functional property
Bile salt hydrolysis activity
TDCA discs, precipitation zones 1.5 mm

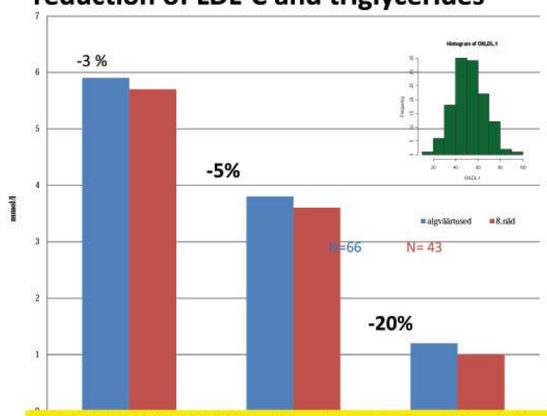
Outcome measures

* Primary markers:
LDL -cholesterol
Triglycerides



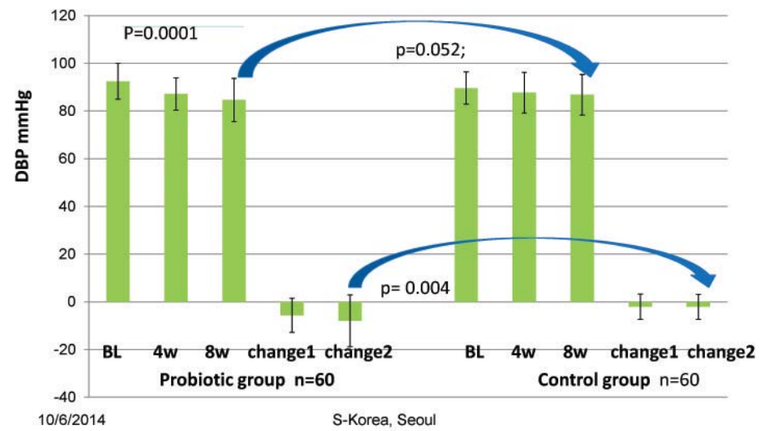
* Secondary markers:
LDL/ HDL-cholesterol
Ox-LDL
ApoA1/ApoB
HbA1c

Probiotic ME-3 kephir human trial in reduction of LDL-C and triglycerides



Probiotic ME-3 kephir (200 ml/d) **reduced the borderline indices of lipid metabolism in healthy persons after 8 w consumption**

Mikelsaar, M.E. et al., **Probiotic Heart cheese "Harmony" comprising L. plantarum Tensia influences blood pressure and metabolic health indices**
Voprossõ pitanija, 2012, 81(3), 74 - 81 (in Russian).



L. plantarum Tensia DSM 21378

- **NO**
- **CLA**
- **peptides with ACE-inhibitory properties**
- **metabolism of putrescine-spermidine**

STRAIN SPECIFICITY

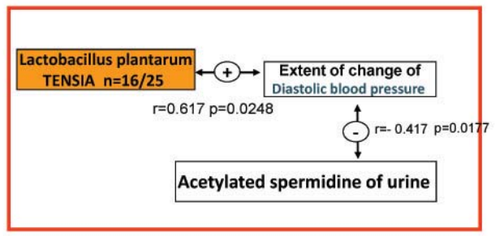
- **GENOME SEQUENCING IN CHINA,**
- **Bioinformatic analysis in Univ of Tartu, Inst. of Molecular and Cell Biology**

ca 100 genes specific for the Tensia strain which are absent in 6 open NCBI genomes of *L.plantarum*

Sharafedtinov et al., ***BMC J. Nutrition*** *2013, 12: 138*
Hypocaloric diet supplemented with probiotic cheese improves body mass index and blood pressure indices of obese hypertensive patients - a randomized double-blind placebo-controlled pilot study n=40 (25 vs15)
Institute of Nutrition, Russia, Moscow ; University of Tartu, Estonia

Multiple regression analysis

After adjustment for BMI, age, and sex, a positive association was observed between **TENSIA colonization** and the **extent of change of DBP at morning**



The probiotic *L. plantarum* TENSIA was present in variable amounts (529.6 ± 232.5 gene copies) in **16/25 (64%)** study subjects.

BMI, kg/m²	37.7 ± 4.3	35.7 ± 3.8	<0.001	36.3 ± 4.3	34.7 ± 4.2	<0.001	0.031

Body mass index **(BMI) was significantly reduced** (p = 0.031) in the probiotic cheese group versus the control cheese group. The changes in BMI were closely associated with the water content of the body (r = 0.570, p = 0.0007) when adjusted for sex and age.

Higher values of intestinal lactobacilli after probiotic cheese consumption were associated with higher BMI and urinary **putrescine** content

In patients simultaneously treated with BP-lowering drugs, similar reductions of BP were observed in both groups.

A positive association was detected between TENSIA colonization and the extent of change of morning diastolic BP and a trend toward lower values of morning systolic BP at the end of the study after adjusting for BMI, age, and sex.

Associated variables		Coefficient r	p
BMI	Water content**	0.570	0.0007
	Lactobacilli content *	**0.383**	**0.0305**
Lactobacilli content	Putrescine content*	0.475	**0.0060**
Colonization with TENSIA	Morning SBP*	–0.527	0.0640 A trend
	Morning DBP**	**0.617**	**0.0248**
Acetylated spermidine	Morning DBP**	**r = –0.417**	**p = 0.0177**

Thank you very much!

Dept. Medical Biochemistry
Mihkel Zilmer, Tiiu Kullisaar

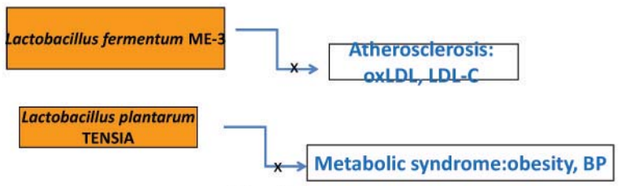
Dept. Microbiology
Jelena Stsepetova
Epp Sepp
Reet Mändar

SME
Epp Songisepp, Pirje Hütt

Colleagues

Conclusion

- **Specific species and STRAINS of *Lactobacillus* are bound to several health biomarkers:**
  BMI, Chol, LDL, ox-LDL, BP.
- **Probiotic products can**
  ***shift these biomarkers**
  ***reduce the risk** of some diseases as proved in clinical trials



Sang Woon CHOI, Ph.D.

Professor of Medicine and Nutrition, CHA University
sangwoon.choi@gmail.com or sang.choi@cha.ac.kr

Education

1992	Ph.D. in Medical Science, Seoul National University
1988	M.S. in Medical Science, Seoul National University
1988	Fellow of Gastroenterology, Seoul National University Hospital
1984	Intern & Resident of Internal Medicine, Seoul National University Hospital
1980	M.D., Seoul National University College of Medicine

Major Activities

2013 - Present	Director, Clinical Genomic Center at the Chaum Life Center
2013 - Present	Professor of Medicine and Nutrition, CHA University
2013 - Present	Adjunct Professor, University of Massachusetts, School of Public Health and Health Science
2013 - Present	Adjunct Professor, Friedman School of Nutrition Science and Policy Tufts University
2013 - Present	Adjunct Scientist, Jean Mayer USDA Human Nutrition Research Center at Tufts University
2002 - 2013	Assistant and Associate Professor, Friedman School of Nutrition Science and Policy Tufts University
1999 - 2013	Scientist I, II & III, Jean Mayer USDA Human Nutrition Research Center at Tufts University
1993 - 1999	Visiting Scientist, Jean Mayer USDA Human Nutrition Research Center at Tufts University
1990 - 1994	Clinical Instructor and Assistant Professor, Seoul National University College of Medicine, Seoul, Korea
1988 - 1993	Director of Internal Medicine, Boramae Medical Center affiliated to Seoul National University Hospital

Epigenetic Interactions between Aging and Nutrition

Sang Woon Choi
Professor of Medicine and Nutrition, CHA University
sang.choi@cha.ac.kr

Worldwide increase in longevity contradicts the hypothesis that aging is genetically programmed. Recent studies have led to a rethinking of the classical model of aging, shifting the emphasis from genetic factors to environmental influences. Nutrition may be one of the most important environmental determinants of aging because they have profound effects on the cellular repair and regeneration as well as the genetic and epigenetic phenomena. Epigenetics, which can be defined as a reversible but inheritable phenomenon that affects gene expression without altering base sequence, has been considered as a mechanism by which our environment determines our phenotypes. In fact, nutrition has the potential to modulate the interactions between genes, aging and disease susceptibility through epigenetic mechanisms. While DNA sequences cannot be changed and aging cannot be avoided, individuals have the ability to change their diet to achieve healthy aging.

Among several epigenetic marks DNA methylation has been most extensively studied. DNA methylation is the addition of a methyl group to the cytosine residue of CpG dinucleotides and has been implicated in many physiologic and pathologic processes. We have investigated how DNA methylation patterns change with nutrients and diets, especially folate, a western style diet and a calorie restriction diet. Through our studies we anticipate to find an ideal epigenetic pattern of healthy aging and a way how to achieve it through nutrition.

Keywords: Aging, Epigenetics, Diet, Nutrition, DNA methylation

Epigenetic Interactions between Aging and Nutrition

2014 KAST's 20th Anniversary International Symposium

"Food, Health and the Future"

Seoul Korea
Oct 24, 2014

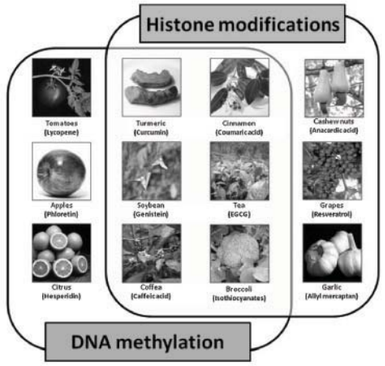
The latest science on how to live longer, healthier and happier

Some Asians seem to have discovered the fountain of youth.

How can we extend human lifespan, health span and beauty span?




EPIGENETIC DIET



- Epigenetic diet is a kind of functional diet that contain bioactive compounds with capacity to modulate DNA methylation, histone modifications or miRNA expression.

Medicinal Chemistry of the Epigenetic Diet and Caloric Restriction

S.L. Martin[1], T.M. Hardy[1], and T.O. Tollefsbol[1,2,3,4,5,*]

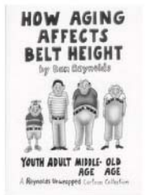
Epigenetic diet: impact on the epigenome and cancer

Tabitha M Hardy[1] and Trygve O Tollefsbol[1,2,3,4,5,†]

Curr Med Chem 2013;20:4050, Epigenomics 2011;3:503

Aging

- Worldwide increase in lifespan argues against the idea that humans are genetically programmed to die.
- Recent studies have led to a rethinking of the classical evolutionary models of aging, shifting the emphasis from genetic causative factors to environmental effects.



Can we prevent aging?

- Nutrition may be one of the most important environmental determinants of aging because they have profound effects on the genomic and cellular damage.
- While DNA sequences cannot be changed and aging cannot be avoided, individuals have the ability to change their diet.
- Nutrition has the potential to modulate the interactions between genes, aging and disease susceptibility through epigenetic mechanisms.

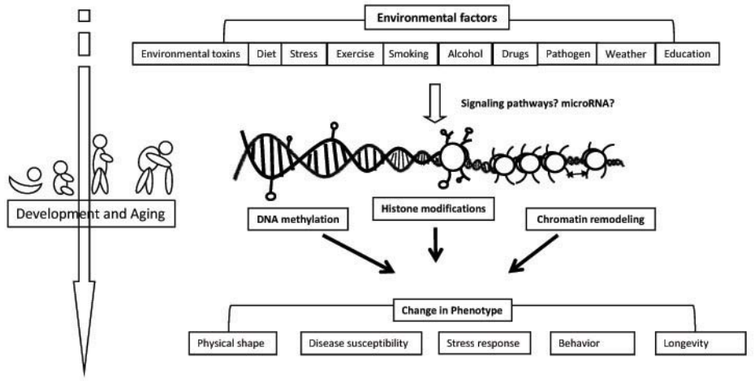
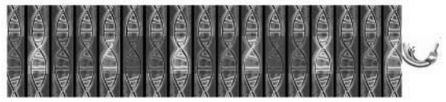


Figure 1. Epigenetic mechanisms provide the link between environmental factors and phenotypical changes during the whole lifetime.

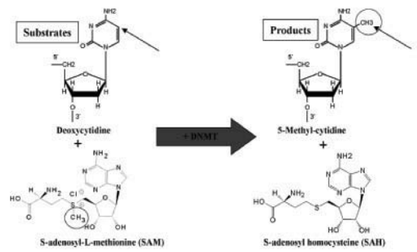


Epigenetics

- Epigenetics can be defined as an inheritable phenomenon that affects gene expression without altering the DNA sequence.
- Major epigenetic phenomena are DNA methylation, histone modifications, chromatin remodeling, and possibly microRNA.
- Epigenetic phenomena are critical for the embryonic development, aging, and the development of diseases including cancer, cardiovascular diseases, neurocognitive diseases, metabolic diseases and immune diseases.
- Epigenetic phenomena are reversible and can be modified by environmental factors, especially nutrition.

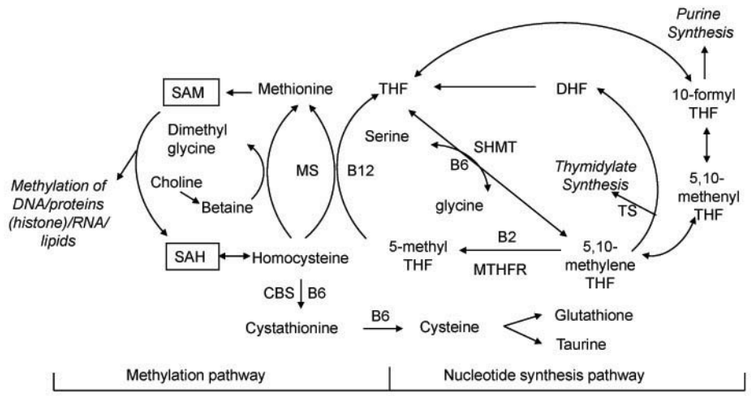
DNA methylation

- DNA methylation is a unique modification of DNA and the most common epigenetic phenomenon in eukaryotic cells.
- DNA methyltransferases catalyze the transfer of methyl group from S-adenosylmethionine (SAM) to the carbon-5′ position of cytosine in CpG dinucleotides.



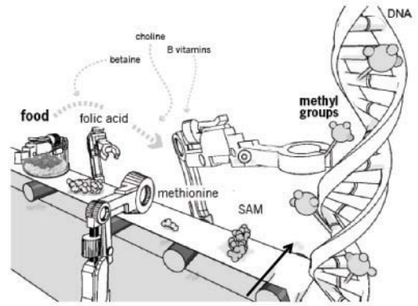
- ✓ DNA methylation regulates gene expression and integrity.
- ✓ Aberrations in DNA methylation play a mechanistic role in the development of diseases.

One-carbon metabolism



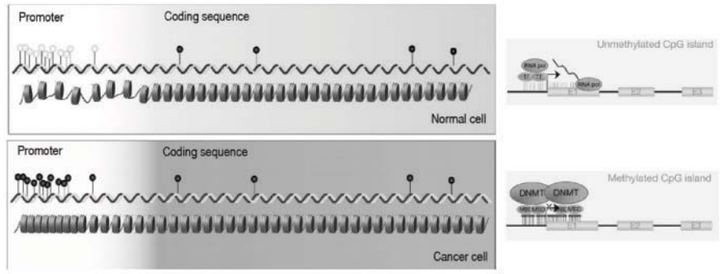
(J Nutr 2000;130:129)

Dietary methyl donor to DNA methylation



DNA methylation is an epigenetic mechanism involved in many physiologic and pathologic processes.

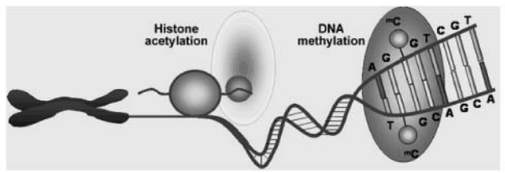
Promoter DNA methylation



Wong, J J L et al. Gut 2007;56:140-148

Aging epigenetics

- It is known that aging significantly alters epigenetic phenomena but it is not known yet if age-associated epigenetic changes are pre-programmed or random.
- Hypothesis:
  We may find a longevity epigenotype, an ideal epigenetic pattern of healthy aging, which can extend our lifespan and health span. Then, we may acquire this epigenotype through nutrition.

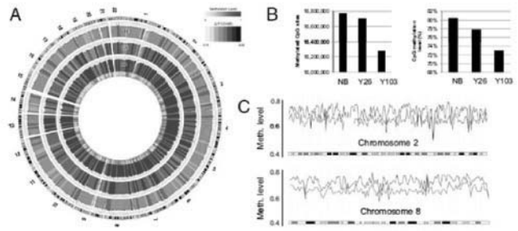


Distinct DNA methylomes of newborns and centenarians

Holger Heyn[a,1], Ning Li[b,c,1], Humberto J. Ferreira[a,d], Sebastian Moran[a], David G. Pisano[e], Antonio Gomez[a], Javier Diez[a], Jose V. Sanchez-Mut[a], Fernando Setien[a], F. Javier Carmona[a], Annibale A. Puca[f,g], Sergi Sayols[a], Miguel A. Pujana[h], Jordi Serra-Musach[h], Isabel Iglesias-Platas[i], Francesc Formiga[j], Agustin F. Fernandez[k], Mario F. Fraga[k,l], Simon C. Heath[m], Alfonso Valencia[e], Ivo G. Gut[m], Jun Wang[n,o,2], and Manel Esteller[a,p,q,2]

- Whole genome bisulfite sequencing of DNA from CD4+ T cells of a centenarian and a new born identified differentially methylated regions that were usually hypomethylated and less correlated with methylation of adjacent CpG dinuceotides in the centenarian.
- The more hypomethylated CpGs observed in the centenarian DNA compared with the neonate covered all genomic compartments.
- For regulatory regions, the most hypomethylated sequences in the centenarian DNA were present mainly at CpG-poor promoters and in tissue-specific genes, whereas a greater level of DNA methylation was observed in CpG island promoters.

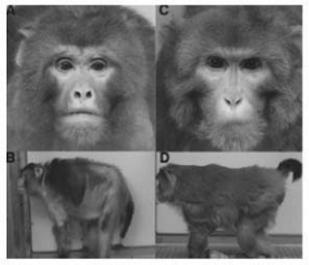
PNAS 2012;109:10522



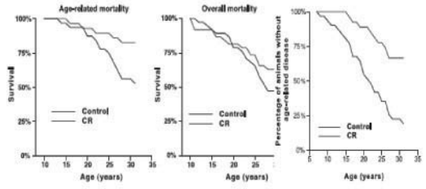
WGBS of a newborn (NB) and a centenarian (Y103) individual

(A) Circos representation of genome-wide DNA methylation levels in the NB, Y26, and Y103 individuals. Average levels for all of the CGs in 297 10-Mbp-wide windows. Inner track indicates the magnitude of the difference between the Y103 and the NB individual for each window (color scale and red line). Average methylation levels in all of the regions are expressed as β-values (0–1) and are colored blue.
(B) Total number of methylated CpG sites and the CpG methylation level (%) in the DNA from the newborn (NB), an intermediate 26-y-old sample (Y26), and the centenarian sample (Y103).
(C) Illustrative CpG methylation levels for Y103 (red line) and NB (blue line) in chromosomes 2 and 8.

Diets extends lifespan and healthspan



A and B: a control animal at 27.6 yr (ave life span)
C and D: an age-matched animal on CR



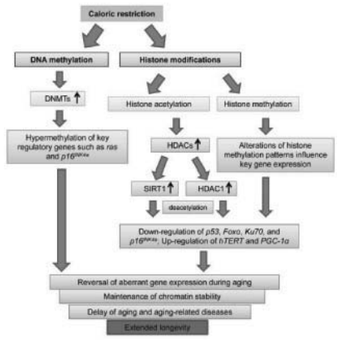
Eat less or eat selected food?

Calorie restriction diet

- In all species restricting caloric intake by 20–50%, while still providing adequate micronutrients, significantly extends mean and maximal lifespan, largely by retarding age-associated diseases such as cancer.

Science 2009;325:201,
Oncogene 2007;26:5505

Caloric restriction regulates epigenetic pathways.

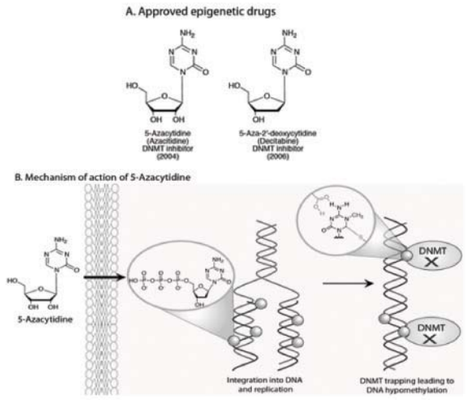


BMC Medicine 2011 **9**:98

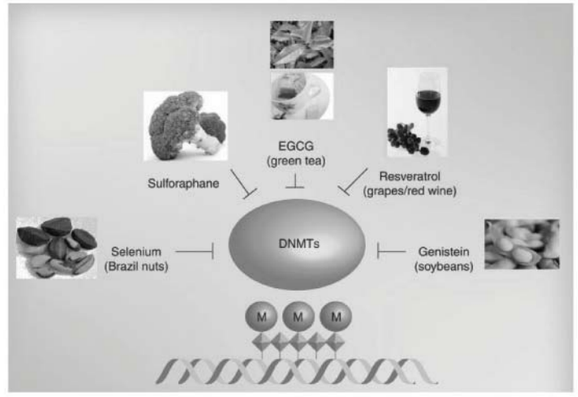
Nutrients that may affect DNA methylation and its mechanism

Category	Nutrient	Epigenetic mechanism
Methyl donor	Folate	Methyl acceptors and donors
	Vitamin B12	Coenzyme for MS
	Vitamin B6	Coenzyme for SHMT, CBS, and cystathionase
	Vitamin B2	Coenzyme for MTHFR
	Methionine	Precursor of SAM
	Choline	Homocysteine remethylation after converting to betaine
	Betaine	Homocysteine remethylation by BHMT
	Serine	Methyl donor to tetrahydrofolate by SHMT
micronutrient	Retinoic acid	Increases the activity of GNMT
	Zinc	Cofactor for DNA methyltransferase and BHMT
	Vitamin D	Passive demethylation
Bio-active food components	Genistein	Inhibition of DNA methyltransferases
	Tea polyphenol	Inhibition of DNA methyltransferases
	Raspberry	Inhibition of DNMT1, DNMT3B
	Sulforaphane	Inhibition of DNMT1, DNMT3B

Clinically approved DNA methyltransferase inhibitor to fight against cancer



Dietary inhibitors of DNA methyltransferases



Epigenomics. 2011 August 1; 3(4): 503–518.

Conclusions

- Even though aging exhibits substantial changes in DNA methylation, it is not yet known yet if aging is epigenetically programmed.
- DNA methylation patterns are significantly influenced by diet during the lifetime.
- Little is known about the ideal DNA methylation pattern for healthy aging. However, we might be able to achieve it through our diet, so that we can delay aging and possibly the development of age-related diseases

Conclusion-1

- Current literature strongly suggests that dietary components of fruits, vegetables, and various other plants may affect DNA methylation and other epigenetic phenomena.
- However, a large number of the currently reported natural product epigenetic modulators have a poorly characterized mechanism of action and likely have many off-target effects.
- Overall, there is little doubt that there is still huge scope for the development of epigenetic modulators to impact chemistry, biology and medicine, and it is likely that natural products will continue to play an exciting role in this field.

Future perspectives

- Dietary factors are likely to contribute to epigenetic alterations and in some cases may be able to reverse abnormal epigenetic states.
- While many of the aforementioned studies were conducted using a particular dietary factor, it is reasonable to believe that most may be consumed in combination and over a period of a lifetime.
- This may provide a rationale to propose an 'epigenetic diet' focused on consuming products that show the ability to stimulate beneficial epigenetic modifications, including increased consumption of fruit and vegetables.
- Future studies focusing on the clinical relevance and mechanism of epigenetic modification of bio-active dietary factors are needed to further assess the applicability of dietary factors.

Session 3

Health Food for the Future
(미래를 위한 건강 식품)

Chair: **Dong-Hwa Shin**
(Fellow Emeritus, KAST / Chonbuk National University)

Development Strategy and Trend of Functional Food in Korea
(한국의 건강기능성 식품 개발 전략과 동향)
Hyun Jin Park (Fellow, KAST / Korea University)

Food, Wellness and New Converging Industry
(식품과 웰니스 융합신산업)
Ki Won Lee (Associate Member, KAST / Seoul National University)

Food and Creating Shared Value
(식품과 공유 가치 창조)
Dae-Young Kwon (Fellow, KAST / Korea Food Research Institute)

KAST's 20th Anniversary International Symposium

Food, Health and the Future
(식품, 건강, 그리고 미래)

Dong-Hwa Shin, Ph.D.

Emeritus Professor
Chonbuk National University
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Education	1965	B.S., Food Science and Technology in Dongguk University, Korea
	1967	M. Sc., Food Science and Technology, Graduate School of Donggug University, Korea
	1981	Ph. D., Food Science and Technology, Graduate School of Donggug University, Korea
Major Activities	2009 - Present	President, the Korea Fermented Soybean Product Association
	2009 - Present	President, the Korea Food Safety Association
	2008 - Present	Director, Shindonghwa Food research Institute, Jeonju, Korea
	2004 - Present	Member, KAST
	2002. 1 - 2002.12	President Korean Society of Food Science and Technology
	2005. 1 - 2006.12	President, Korean Society of Food Hygiene and Safety
	1988. 4 - 2008. 8	Professor, Chonbuk National University, Jeonju, Korea
	1970. 3 - 1988. 4	Vice Director, Food Research Institute, AFDC
Honors and Awards	2003.06	Honorable Scientific Award. Korean Society of Food Science and Technology President,
	2005.11	Blue ribbon medal by president
Research Interests	Fermented Foods and Food Sanitation.	

Hyun Jin PARK, Ph.D.

Fellow, The Korean Academy of Science and Technology
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Education

1991	Ph. D., Food Engineering, The University of Georgia, U.S.A.
1987	M.S., Food Engineering, Korea University, Korea
1985	B.S., Food Technology in Korea University

Major Activities

2014	Vice President, Korean Society Food Science and Technology
2014 - Present	Adjunct Professor, Department of Food Science, Food Nutrition and Packaging Science, Clemson University, SC, USA
2013 - Present	Associate Editor, Food Bioscience, Elsevier
2013- Present	Head, Department of Food Science and Biotechnology, Korea Unviersity
2003 - Present	Director, The Functional Food Research Center, Korea University
1997 - Present	Professor, The Graduate School of Life Sci. & Biotechnology, Korea University
1993 - 2012	Adjunct Professor, Department of Packaging Science, Clemson University, SC, USA
1991 - 1993	Research Associate and Assistant Professor, Department of Agricultural and Biological Engineering, Clemson University, SC, USA
1985 - 1987	Researcher, Department of Food Engineering, Division of Bioengineering, The Korea Advanced Institute of Science and Technology, Korea

** Author of 165 SCI refereed journal articles with his role as first and/or corresponding author for 122 papers as well as 30 SCIE and others. In addition, his top ten journal articles have been cited over 1300 times

Development strategy and trend of functional food in Korea

Hyun Jin Park

Fellow, The Korean Academy of Science and Technology (KAST)

hjpark@korea.ac.krr

This presentation consists of 3 parts; 1. Functional food market in Korea, EU, and USA, 2. Government regulation and certifying process of the functional food in Korea, and 3. R & D trend of the functional food in the world. In the first part, definition, development strategy, and trend of present functional food in Korea and the world are introduced. Also some case studies are explained .

The second part introduced the government regulation as well as certifying process of the functional food in Korea and EU. Also the general type and specific product type of functional food in Korea will be introduced.

The third part suggests the R&D trend of the functional food in Korea, EU and USA. Also several strategies of commercialization of functional foods and case studies are discussed.

Keywords: Development strategy, Functional food, Government regulation

DEVELOPMENT STRATEGY AND TREND OF FUNCTIONAL FOOD IN KOREA

2014. 10. 24

Korea University Biopolymers Engineering Laboratory

Hyun Jin Park

CONTENTS

Definition of functional food & functional food market in the world

Part 1

Definition

USA — Food and Drug Administration (FDA)

Dietary supplements

- **A product intended to supplement the diet** and that contains one or more of the following dietary ingredients:

  Vitamin, mineral, herb or other botanical, amino acid, a dietary substance used to supplement the diet, a concentrate, metabolite, constituent, extract, and combination of any ingredient

- By Dietary Supplement Health and Education Act of 1994 **(DSHEA)**

Definition

EU — European Commision (EC)

Food supplements

- …**purpose of which is to supplement the normal diet** and which **are concentrated sources of nutrients** or **other substances** with a nutritional or physiological effect, alone or in combination
- By Food Supplement Directive 2002/46/EC

Definition

JAPAN — Ministry of Health, Labour and Welfare (MHLW)

Health Foods

- "Food" as used in this Law shall mean **all edible materials (food and drink) excluding drugs and quasi-drugs**
- By Food Safety Basic Law/ Food Sanitation Law/ Pharmaceutical Affairs Law

Definition

CHINA — China Food and Drug Administration (CFDA)

Health Foods

- …**food claiming to have a specific health function**…
- By Food Safety Law 2009

Definition

ASEAN

Definition

ASEAN

Food supplements

- …any product that is **used to supplement a diet and to maintain, enhance and improve the healthy function** of human body and contains one or more, or a combination of the following:

A) Vitamins, minerals, amino acids, fatty acids, enzymes, probiotics and other bioactive substances
B) Substances derived from natural sources, including animal, mineral and botanical materials in the forms of extracts, isolates, concentrates, metabolite

- By ASEAN TMHS PWG Harmonization

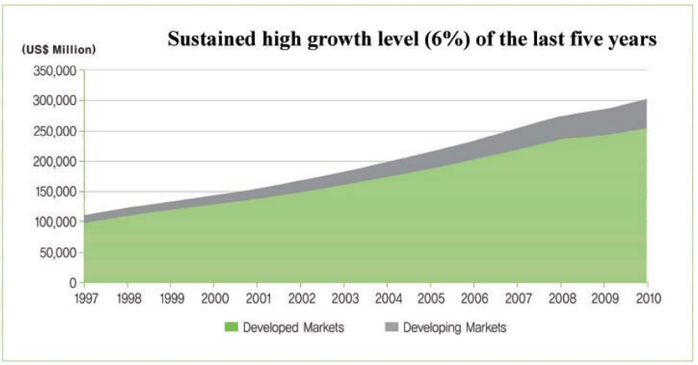
Definition

KOREA Ministry of Food and Drug Safety (MFDS)

Health Functional Foods (HFF)

- The term "**health functional food**" means food manufactured or processed in a form of tablet, capsule, powder, granule, liquid or pill, etc. with ingredients or components, that **possess the functionality useful for human body**.
- By Health Functional Food Code

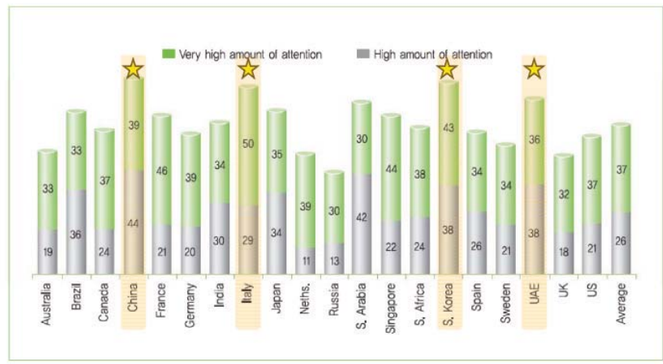
Market Size of Developed Markets and Developing Markets



The present state of a global market

Nutrition Business Journal estimates (mil., consumer sales).

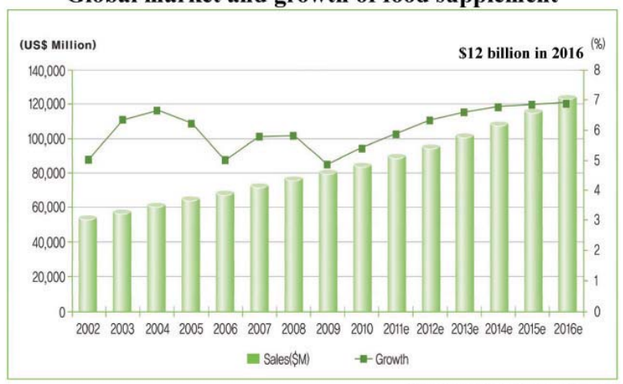
Interest of the consumer to the health



The present state of a global market

Datamonitor consumer survey, July/August 2010

Global market and growth of food supplement

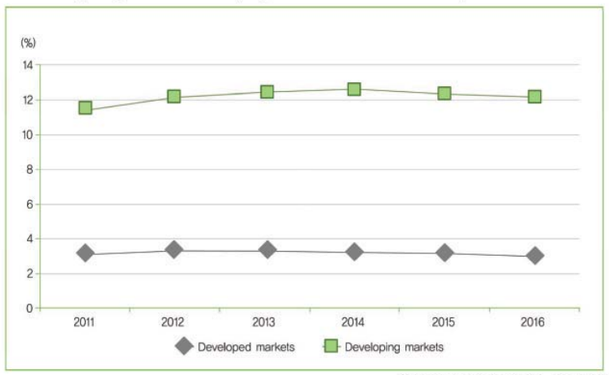


The present state of a global market

Nutrition Business Journal estimates(mil., consumer sales)

Growth of health functional food

Higher growth in developing markets rather than developed markets

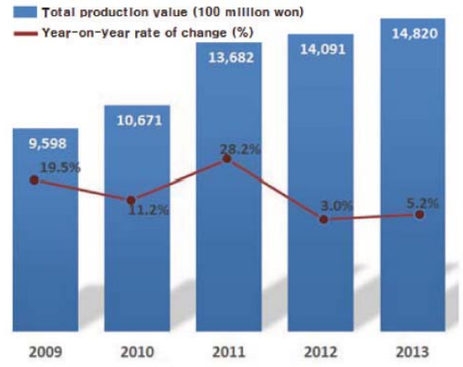


The present state of a global market

NBJ's Global Supplement & Nutrition Industry Report', Nutrition Business Journal (2012)

Korea

Health functional food production results for each year



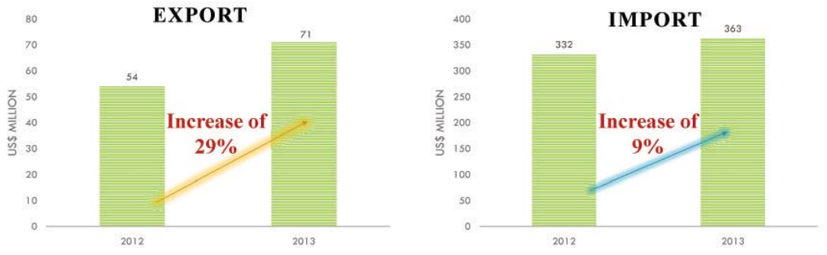
Results of the analysis of the health functional food production record in 2013, total production amounted to 1.5 trillion won (1.4 billion US dollar),

it was found that increased 5% compared to 1.4 trillion won (1.3 billion US dollar) in 2012.

13.12.31 MFDS

Korea

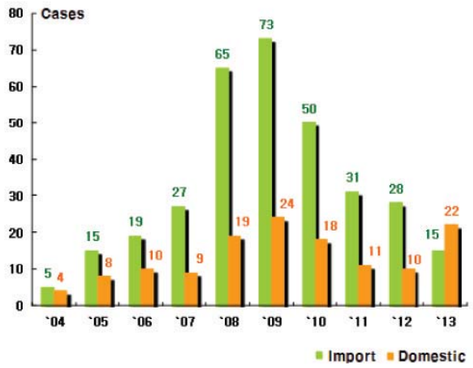
The present state of a health functional food market



14.2.28 MFDS

Korea

Approval status of functional ingredient



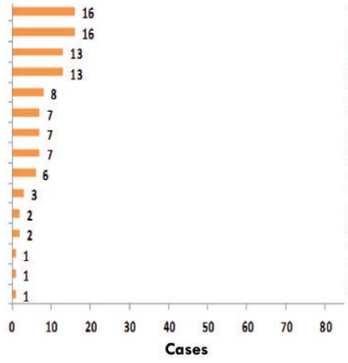
Total functional ingredient approving number was reduced since 2009.

The proportion of the domestic functional ingredient becomes higher in 2013.

14.2.28 MFDS

Korea

Approved functionality (2004-2013)



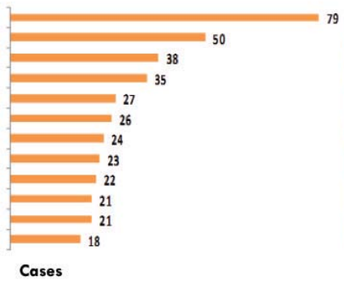
Fatigue improvement
Cholesterol improvement
Prostate health
Distress
Blood triglyceride improvement
Calcium absorption
Cognitive function
Menopausal women health
Exercise performance
Urinary tract health
Stomach hearth/ digestive function
Sensitive skin improvement
Tooth decay prevention
Urinary function
Menopausal men health

Rank order according to functionality

14.2.28 MFDS

Korea

Approved functionality (2004-2013)



Body fat reduction
Joint/bone health
Liver health
Blood glucose control
Eye health
Antioxidant
Memory improvement
Skin health
Blood circulation improvement
Blood pressure control
Immune function
Intestinal health

Quality of Life

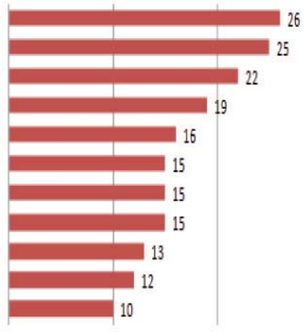
Anti-aging

Rank order according to functionality

14.2.28 MFDS

Korea

Approved ingredient (2004-2013)



Milk thistle extract
Garciniacambogia extract
Conjugated linoleic acid (FFA)
Coenzyme Q10
Saw palmetto seed extract
Rhodiola rosa extract
Ginko extract
Soy isoflavone
Lutein complex
Dimethylsulfone (MSM)
Green tea extract

Beauty - for Woman

Fatigue Recovery - for Man

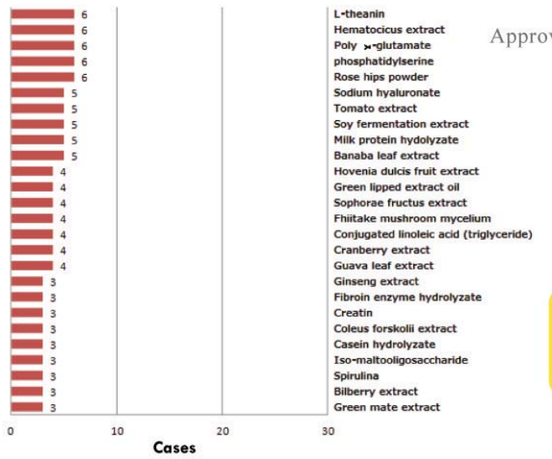
Anti-aging

Rank order according to functional ingredient

14.2.28 MFDS

Korea

Approved ingredient (2004-2013)

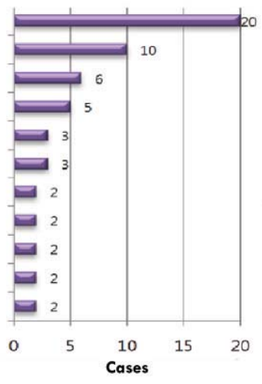


Rank order according to functional ingredient

14.2.28 MFDS

Korea

Popular item (Approved ingredient, 2009)

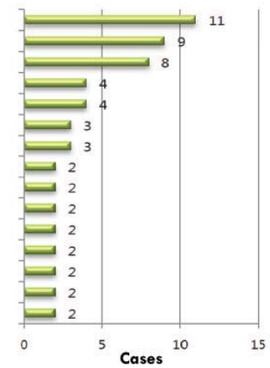


Body fat reduction

14.2.28 MFDS

Korea

Popular item (Approved ingredient, 2008)

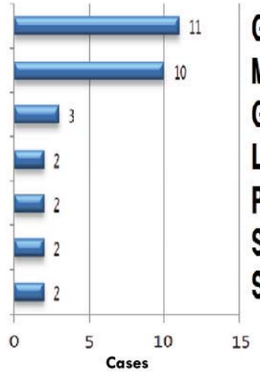


Antioxidant

14.2.28 MFDS

Korea

Popular item (Approved ingredient, 2010)

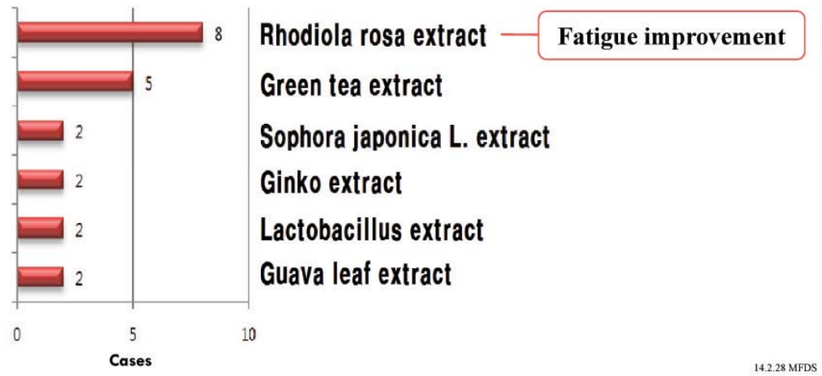


Blood circulation improvement

14.2.28 MFDS

Korea

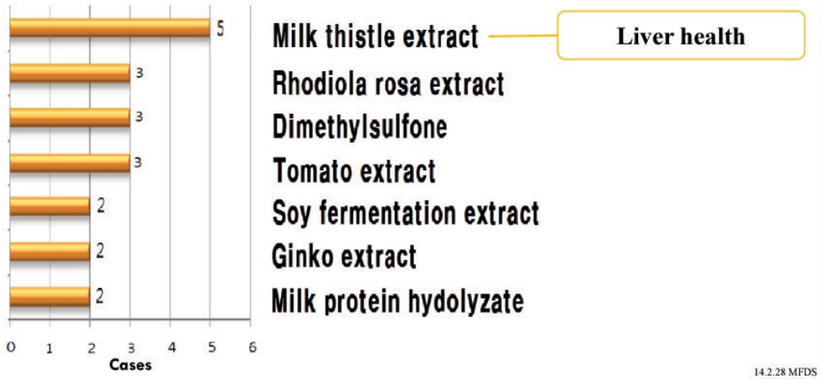
Popular item (Approved ingredient, 2011)



14.2.28 MFDS

Korea

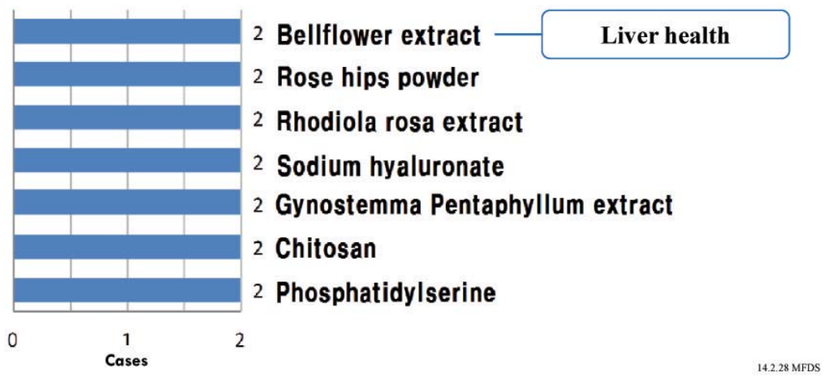
Popular item (Approved ingredient, 2012)



14.2.28 MFDS

Korea

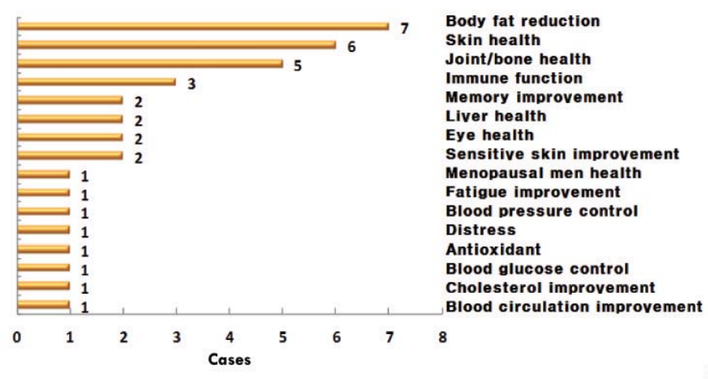
Popular item (Approved ingredient, 2013)



14.2.28 MFDS

Korea

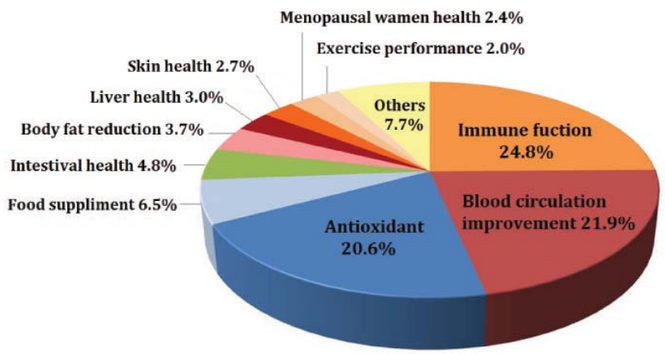
Rank order according to functionality for new approved ingredient (2013)



14.2.28 MFDS

Korea

Market share of functionality (2013)



14.2.28 MFDS

Korea

The prospect for future of HFF market

- It is expected that functional ingredient certification will become active to suit the diverse **needs of consumers to want to improve the quality of life.**
- It is expected that stable growth of health functional food to improve **aging continues.**

Government regulation of various countries about functional food

Part 2

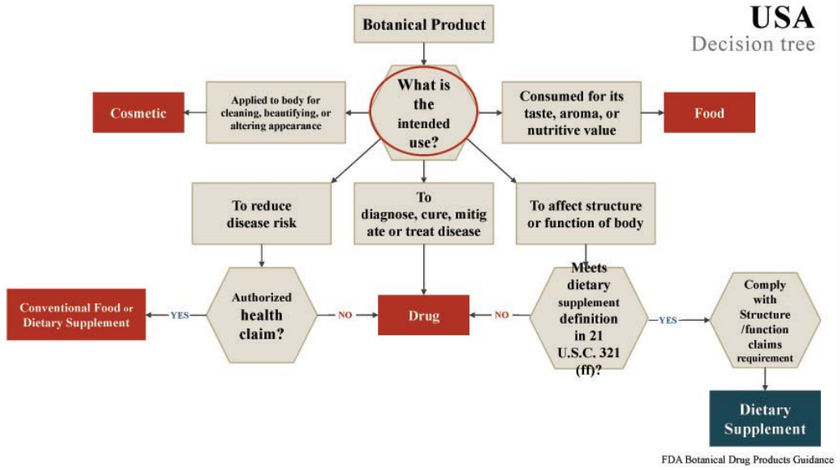
USA

Functional foods

Existing Ingredient	New Ingredient
◆ **"Old" or "Grandfathered" Dietary Ingredient** • Present in the food supply in the U.S. market before Oct. 15, 1994. • Manufacturers are responsible for ensuring safety for intended usage. • Can be used without further notification	◆ **New Dietary Ingredient (NDI)** • Dietary ingredient not marketed in the USA before Oct. 15, 1994. • Requires safety data (pre-market notification) ⇩ **NOT** required if NDI is present in the food supply (anywhere in the world) and has NOT been chemically altered.

USA

Decision tree

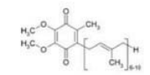


FDA Botanical Drug Products Guidance

EU

Bioactive substances in national legislation

Example: Co-enzyme Q10



No EU harmonization yet.

Positive lists
- Italy
- Denmark
- Slovenia
- Croatia

Negative lists
- Belgium
- Czech Rep.

Authorization
required for non- authorized substances
- Germany

Case by case
evaluation
- Poland
- Slovakia
- Cyprus

Safety
Self regulatory approach of manufacturers
- UK
- Netherlands

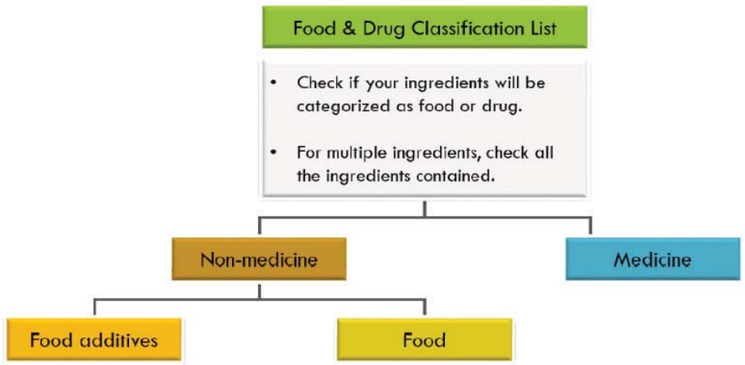
EU

Existing Ingredient	New Ingredient
◆ **Vitamins and Minerals** • Positive list of vitamins and minerals and permitted forms ◆ **Other Ingredients /botanicals** • Food Supplement Directive calls for establishment of approved lists for "other substances" including botanicals • No EU harmonization yet. • Currently allowed & regulated at National level.	◆ **Novel food & Food Ingredient** • Foods and food ingredients that have not been used for human consumption to a significant degree before May 15, 1997. • New or intentionally modified primary molecular structure. ✓ **Authorization**: Manufacturer to provide data for Safety Assessment or ✓ **Notification**: if "substantially equivalent" to existing foods or food ingredients

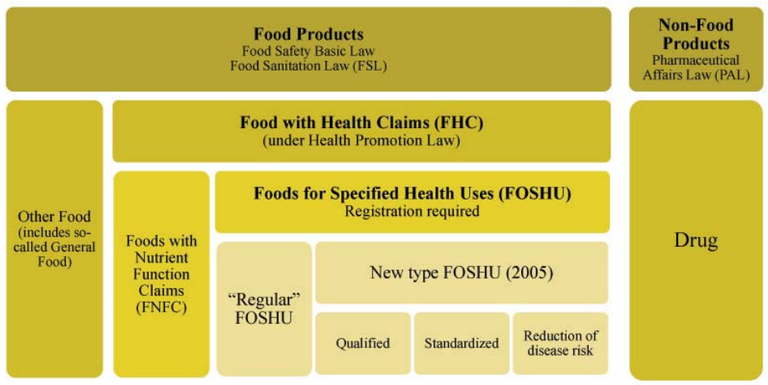
Japan

Existing Ingredient	New Ingredient
◆ **Foods with Nutrient Function Claims (FNFC)** • Standard criteria • Not required permission and notification ◆ **Foods for Specified Health Uses (FOSHU)** • Individual approval • Manufacturer to provide effectiveness and safety data for review by government	◆ **Classification as food (non-drug) or drug ingredient** • Self-assessment (or) Government review • Based upon safety • Factors that influence the classification ✓ Precedence for approval as drug domestic and abroad ✓ History/habit of eaten as food ✓ Presumed established safety

Japan
Ingredient classification



Japan
Ingredient classification



Korea

Health Functional Food (HFF)

Existing Ingredient	New Ingredient

◆ **Notified HFF Ingredient (HFF Code)**
• Safety evaluated at the efficacious dose listed in the HFF code
• Vitamin and mineral limits based on safety risk assessment
  ◦ 28 nutrients (13 vitamins, 11 minerals, dietary fiber, protein, and essential fatty acid)
  ◦ More than 55 other functional ingredients
	◆ **Approved HFF Ingredient** (Individually approved)
	• Manufacturers responsible to provide all evidences for safety, quality & efficacy
	• MFDS authorized to review and approve

• Safety Assurance: history of safety use	• Safety Assurance: adequate information to assure that an ingredient does not present a significant or unreasonable risk of illness or injury.

Korea
Regulation

Regulation on Standards and Specification of HFF (HFF Code)

Regulation on Approval of Functional ingredient & HFF

Korea
Functionality of HFF

Function	Concept
A. Disease Risk reduction function	• The link between a food ingredients and the **reduced** risk of developing a disease • Supported by totality of scientific evidence Example) "X may reduce the risk of CVD."
B. Nutrient function	• The link between a nutrient and function benefit Example) "Iron can help to make red blood cells."
C. Physiological active function	• The link between the food ingredients and structure/function benefit Example) "X may help relieve stress and frustration."

Korea
Classification of functionality

A. Disease Risk reduction function - Only 3 ingredients

Help to reduce the risk of osteoporosis

- Calcium (210~800mg/day)
- Vitamin D (1.5~10ug/day)

Help to reduce the risk of cavity

- Xylitol (Approved type)

B. Nutrient function
- Various vitamin, mineral, protein, dietary fiber and fatty acids

Korea
Classification of functionality

C. Physiological active function
- 31 functional fields

	Functional field		Functional field		Functional field		Functional field		Functional field
1	Memory improvement	7	Eye health	13	Cholesterol improvement	19	Digestive function	25	Urinary function improvement
2	Blood circulation improvement	8	Immune function	14	blood pressure control	20	Antioxidant	26	Sensitive skin improvement
3	Liver health	9	Joint/bone health	15	Destress	21	blood triglyceride improvement	27	Metapause men health
4	Reduction in fat	10	Prostate health	16	Intestinal health	22	Cognitive function	28	Improvement an uncomfortable condition before menstruation
5	menopause women health	11	Fatigue improvement	17	Calcium absorption	23	Exercise performance improvement /endurance enhancement	29	Sperm motility improvement
6	blood glucose control	12	Skin health	18	Urinary tract health	24	Tooth decay prevention	30	Vagina health with a increase of probiotics
								31	Children growth improvement

Korea
Approval levels of functionality

Function	Strength	Example
Disease risk reduction function	*SSA	Help to reduce the risk of disease
Physiological active function I	Convincing	Have a beneficial effect on
Physiological active function II	Probable	May improve~ May increase (decrease~)
Physiological active function III	Insufficient	May have possibility to improve But lack of evidence in human studies

*SSA: Significant Scientific Agreement

China

Existing Ingredient	New Ingredient
◆ **Vitamins and Minerals** • Positive list of permitted vitamins and minerals, sources and min/max levels ◆ **Other Ingredients** • Positive list for use in general foods, health foods and drugs (long history of safety use in China, i.e. *TCM ingredients) • Positive list for use in health foods based on safety (not approved for general foods) • Negative list of Prohibited substances for use in general foods and health foods	◆ **Novel Food Ingredient** ✓ Authorization: Manufacturer to provide data for review by Assessment Committee • Evaluation of quality and safety • Additional testing from government approved lab in China may be required. • NO formal process established, companies can present quality and safety data from China government approved lab during health food product approval process

*TCM: Traditional Chinese Medicine

ASEAN

Existing Ingredient	New Ingredient
◆ **Vitamins and Minerals** • General Principles for Establishing Maximum Levels of Vitamins & Minerals • Positive list of vitamins and minerals and limits ◆ **Banned Ingredients** • Guiding Principles to Inclusion from Negative List of Substances ◆ **Restricted Ingredients** • Guiding Principles for Inclusion of Active Substances into the Restricted List	◆ **Guidelines on Safety Data Requirements** • To provide information on the type of safety data required for submission to a regulatory authority for finished product • TBD whether notification or authorization process

Overview of Authorization Approaches

	Allowed "Existing" Ingredients	"New" Ingredients
USA	• Used before 1994 (DSHEA)	• New Dietary Ingredient (NDI) notification (exempt from notification if in food supply & not chemically altered)
EU	• Used before 1997 (FS Directive) • Vitamin & Mineral positive list • Other Ingredients regulated by MS	• Novel Ingredient authorization process
Japan	• Positive list for use in foods • List of not drug ingredient • Part of food supply	• Self or Government assessment if food or drug ingredient
Korea	• Generic HFF ingredients (HFF Code) • Part of food supply	• Individual HFF Ingredient authorization
China	• Positive list for use in foods & drugs • Positive list for use in health foods • Negative list for use in health foods • Part of food supply	• Novel foods/food ingredients authorization • No process for NEW health food ingredients
ASEAN	• Negative list • Restricted condition of use list	• Self assessment of safety and not meet established criteria for inclusion in Negative list or restricted list

Outstanding issues to resolve

Global standard

- There is no global standard regulation for functional foods

Labels with bioavailability

- Standard method for measurement of bioavailability

Trends of functional food in the world | Part 3

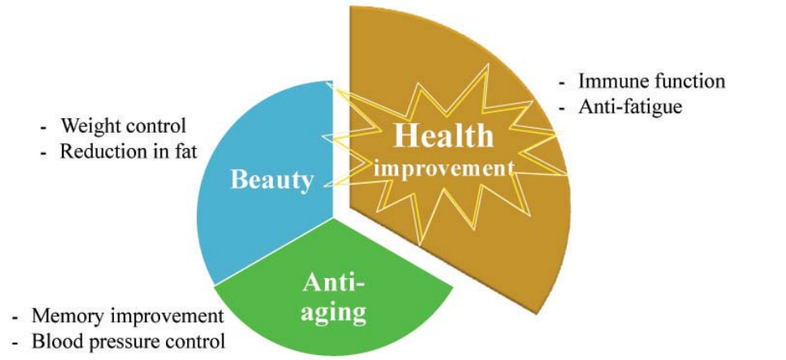
Trends of functional food in **USA**

Self-medication	• Vitalization of private health insurance • Nutrition therapy • Single products (Vitamin and mineral)
Eco-friendly organic food	• Intake of organic food since childhood
Aging care	• Arthritis, osteoporosis, and menopause • Calcium and glucosamine

2014 Market position of Health Functional Food and Functional Food Ingredient

Trends of functional food in **Korea**

Trends of functional food in **China**



2014 Market position of Health Functional Food and Functional Food Ingredient

Trends of functional food in **Japan**

Easy to remind the effect of functional food
- Green vegetable juice

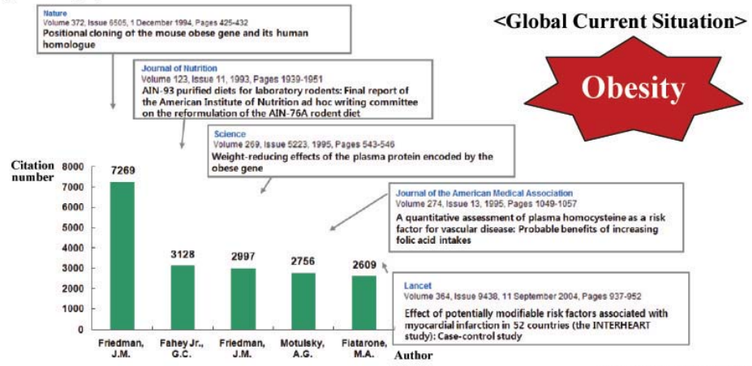
Beauty
- Placenta

Aging care
- Glucosamine
- Terrapin
- Placenta

2014 Market position of Health Functional Food and Functional Food Ingredient

Global R&D trend

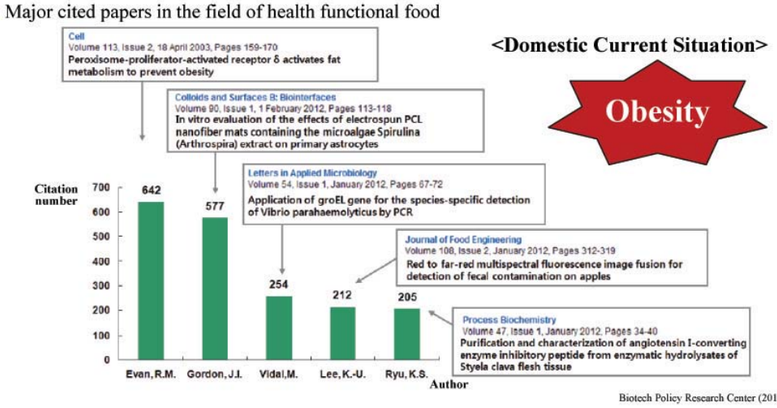
◆ Major cited papers in the field of health functional food



Biotech Policy Research Center (2012)

Korea R&D trend

◆ Major cited papers in the field of health functional food

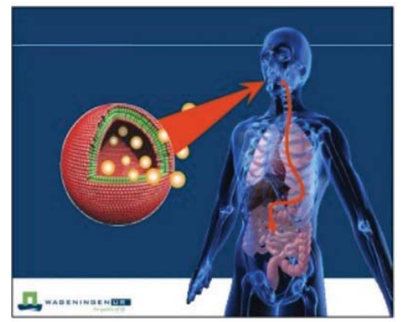


Biotech Policy Research Center (2012)

R&D trend

Improvement of bioavailability

Nanotechnology



2013 The International Harmonization for Nano-food on Processing, Application and Regulation

FFRC & CFFM

FFRC & CFFM

Functional Food Research Center (KU)
& Center for Functional Food Material
(Ministry of Health & Welfare)

Organization of Research Team in Center

Novel material Research & Develop	Novel material Functionality& Safety Evaluation	Novel material Standardization& commercialization
The Health functionality derived from a nature substance	The delivery of health functional materials in vivo	The standardization of health functional materials
The carbohydrate/peptide functional food material research and development	The safety evaluation of health functional materials	The commercialization of health functional materials
The functionality evaluation technology and development of biomarker by genome and protein	The living-body test of health functional materials by type	

Commission Task 1

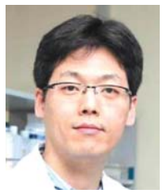
The development of biomarker for a rapid research and effect assessment of health functional materials with proteom technology

FFRC & CFFM

Functional Ingredient Authorization

Chlorella	Perilla frutescens extract	Maca gelatinization powder	Hyaluronan	Red wine polyphenol extract
No. 2010-52	No. 2010-48	No. 2011-7	No. 2012-11	No. 2014-30
Immune Function	Immune Function	Exercise Performance	Skin Health	Cholesterol Improvement

THANK YOU FOR LISTENING



Ki Won Lee, Ph.D.

Associate Professor and Director, National Strategy Lab. of the Food-Medicine Genomics,
World Class University Biomodulation / Food Biotechnology Major, Department of Agricultural Biotechnology,
Emergence Center for Personalized Food-Medicine Therapy System, Advanced Institute of Convergence Technology,
Seoul National University, Republic of Korea / E-mail: kiwon@snu.ac.kr

Education

2004	Ph D., School of Agricultural Biotechnology, College of Agriculture and Life Science, Seoul National University, Seoul, Republic of Korea
2000	M.S., Department of Food Science and Technology, College of Agriculture and Life Science, Seoul National University, Seoul, Republic of Korea
1998	B.S., Department of Food Science and Technology, College of Agriculture and Life Science, Seoul National University, Seoul, Republic of Korea

Major Activities

2014 - Present	Director, 6+± Rural-Wellness Convergence Center
2011 - Present	Director, Emergence Center for Personalized Food-Medicine Therapy System in Advanced Institutes of Convergence Technology, Seoul National University, Republic of Korea
2011- Present	Assistant/Associate Professor,Major in WCU Biomodulation/ Food Biotechnology, College of Agriculture and Life Science, Seoul National University, Republic of Korea
2006 - 2011	Assistant/Associate Professor, Department of Bioscience and Biotechnology, Konkuk University, Republic of Korea
2005 - 2006	Postdoctoral Fellow, the Hormel Institute, Dept. of Biomedical Informatics andComputational Biology, University of Minnesota/Mayo Clinic, United States
2004 - 2005	Postdoctoral Fellow, Research Institute of Pharmaceutical Sciences, Seoul National, Univ. Republic of Korea, Seoul National University

Food, Wellness, and New Converging Industry

Ki Won Lee

Associate Professor and Director, National Strategy Lab, of the Food-Medicine Genomics,
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Modern society is now moving, beyond the age of longevity,toward the age of health and beauty, i.e.,the Wellness Age. The development of personalized products and services are important for the movement intothe Wellness Age. This requires discovering new biomarkersto identifythe characteristicsof individuals and utilizing this information to develop personalized products such as a diagnostic and prognostic prediction models and personalized food. It is also important to construct a platform for the integrative managementofthe personalized wellness services. It can be done through the convergence of various technologies, such as BT, ICT, IoT, and CT.

BT enablesus to provide a high quality contents based on the scientific evidences. Big data analysis plays an important role in providing personalized service contents and programsby enabling micro-targeting. In addition, by employing ICT,we can develop a management platform to overcome the limitations of time and space and systematically deliver personalized services to various public. While a variety of services are possible based on this platform, it is necessary to empathize on the personalized food research and develop a model because it plays an important role in thepersonalized disease prevention, prescription, and continuing management for personal wellness.

Once the integrated management platform is constructed, it can be applied to various fields. Potential applicable areas include adolescent obesity prevention, 6th industry expansion model for creative economy, and so on. Furthermore, if this platform is converged with the humanities and cultural elements, it can grow as a Korean wellness global model retaining our uniqueness.

Keywords: Wellness, Convergence Technology, Personalization, Big data, Integrated Management Platform

Food, Wellness, and New Converging Industry

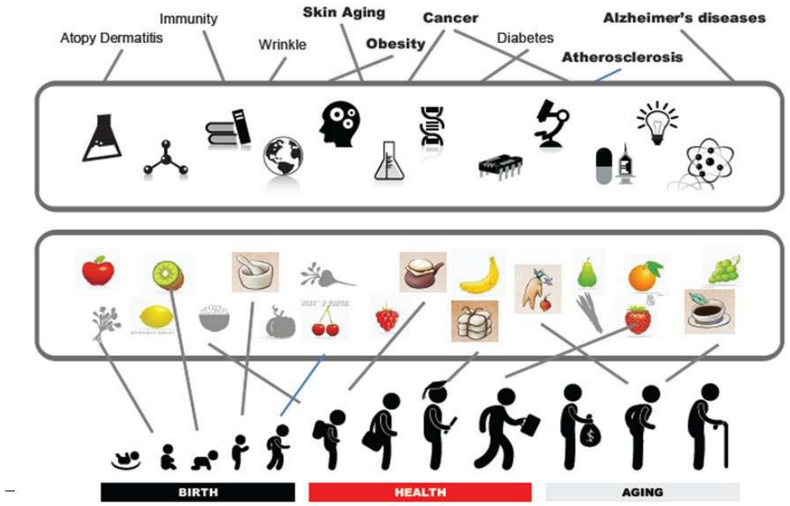
Ki Won Lee
Associate Member, KAST/ Seoul National University/
Advanced Institute of Convergence Technology

What is Wellness??

Wellness = well-being + happiness

Personalized food

Glocalized Health Care System



Convergence Technology

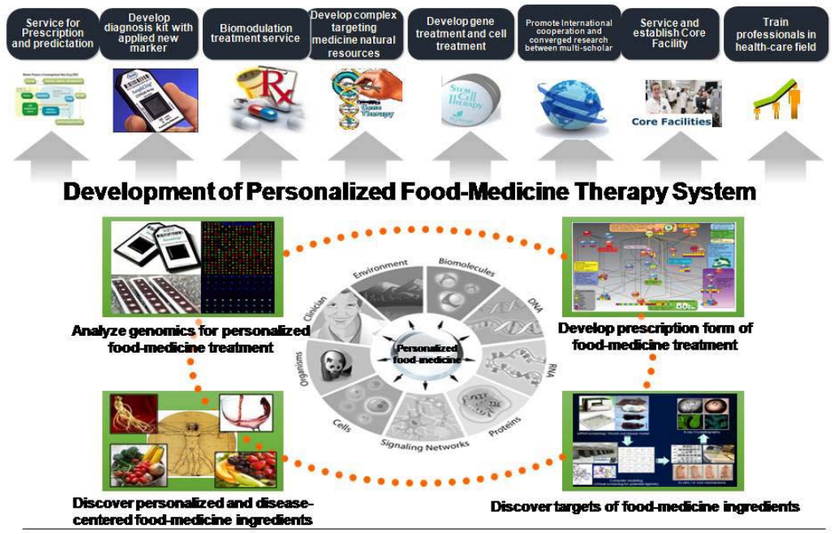
<Connect >

Network vs. Connect

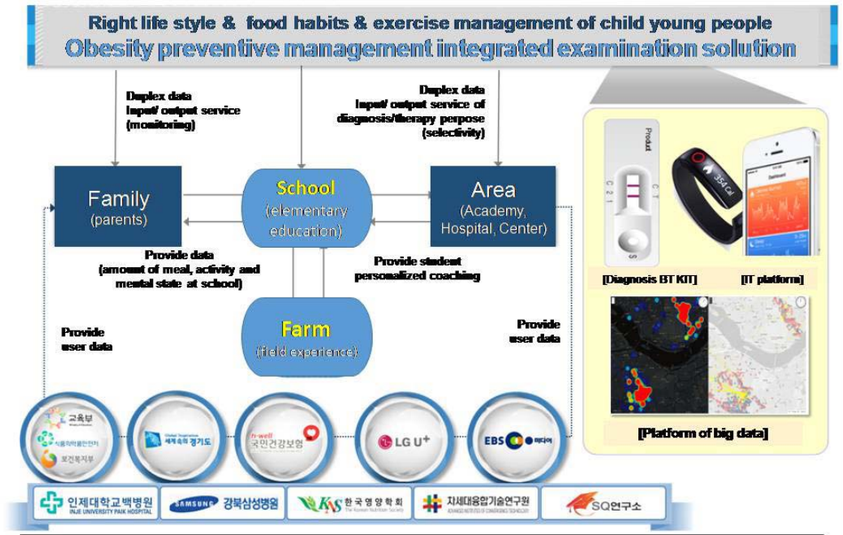
[Network]
Connect what agricultural management system with related-institutes or experts

[Connect]
Provide communication platform in order to draw conclusion from desired factors

Database for Innovation – BT



Database for Innovation – BT, IC Convergence



Database for Innovation– Big Data

Health Insurance Company, Well Point

- Efficient patients treatment applied with super computer

Instant Diagnosis

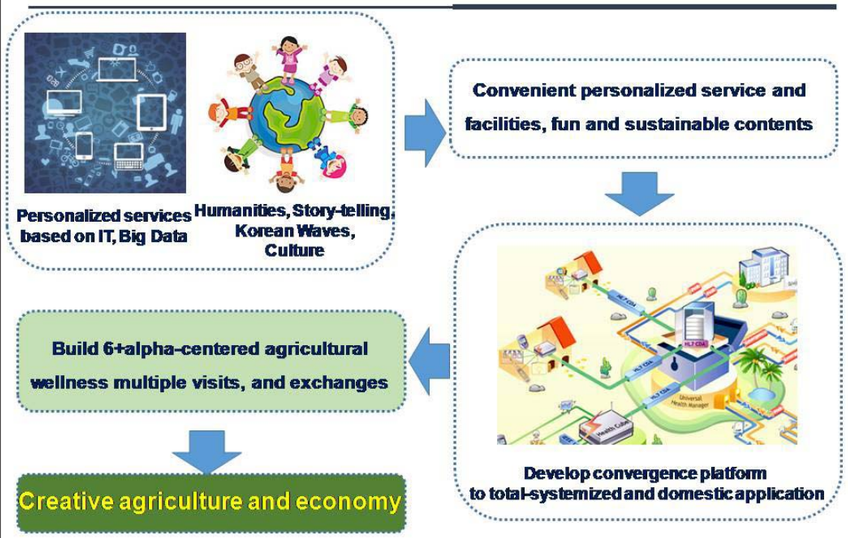
Introduction of IBM's Watson Solution, total analysis of patients information

- total analyzed 34 million patients
  → searched complicated medical treatment methods based on it
- Analyzed data that worth 2 billion pages within 3 sec.

Suggests the best personalized-treatment method

- Shares fast-moving prescription and treatment method
  → satisfaction of treatment increases
- reduce unnecessary treatment → Prevent unwanted medical fees
- Efficient management of elderly's chronic diseases
  → Treatment service for elders

Agricultural Wellness – BT, IT, Cultural Convergence



Service Model with New Convergence Technology

Virtual Reality
Vision, Memory, Sound

Personalized Processing
Diagnosis, Plant factory, Bio-Convergence

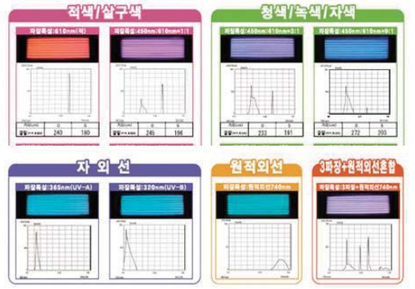
Total Service
Big data
Game, Robot, Education

Humanity
-Sensitivity recording trace
-Sharing

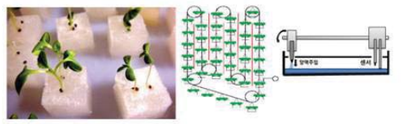
Technology of Enhanced Optional Nutrition Cultivation : Plant Factory

Seed

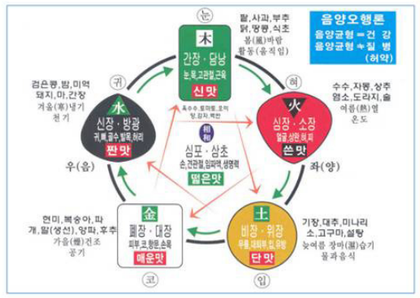
Light/LED



Culture medium

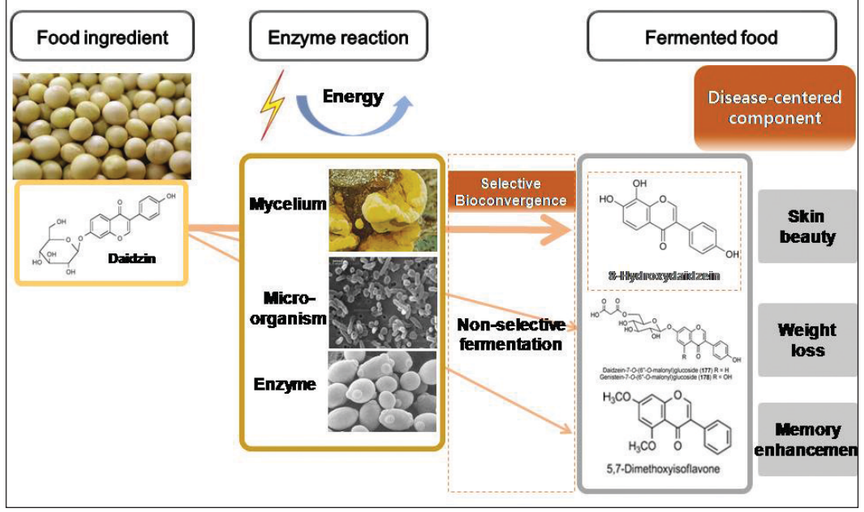


Personal constitution



Celebrity personalized diet

Selective Bioconvergence technology



Emotional Traceability

Famous consumer: Young Ae Lee
Recent buying: September. 9th, 2014

Producing site: Daegwallyeong pasture factory
HACCP (Hazard Analysis Critical Control Point) certification
Produced date: 2013.08.30

Producing center: Daekiri, Gangneung city
Strengths and weakness of product
Producer: Gil Dong Hong
Fowarding date: August. 26th, 2014

- ✓ Giving emotional information of food ingredients by storytelling
- ✓ Gaining reliability by product production and process visualization
- ✓ Arousing customers purchasing needs by giving information about local and global celebrity's product choice.

Humane Consumption: Sharing

Buy Tomato juice

(Sign-up)

Web or Appl

"very pleased that my purchase on tomato juice can provide the same to starving kids.."

Support starved children

Checking tree tomato
In farm cafe

Support tree tomato

Sustainable tomato chain (sustainable agriculture)

Visual Perception

Smart Table

Time

Food Intake

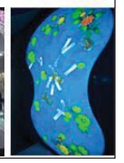
Perceptio n

Food behavior/ Nutritional detection/ Describing mind image

Visual perception system

Meal time, repast

High precision gage sensor



Memory

Conosci te stesso

Have you ever thought about sense of olfactory and taste effecting of our lives?

APP : X wave
Communicate with iPhone application
Starting signal through sensor
Measurement of various brainwave
Indirect diagnosis of current state

So che

Proust Effect
scent → Memory → recognition

ravioli
Thanksgiving day
home town

meatball
Mother

Food tasting about specific subject
Read his(her) thought in advance

WOW!
Get to know influence of food

Sound Integration of Food and Music ➔ Technology Inhancing Hapiness

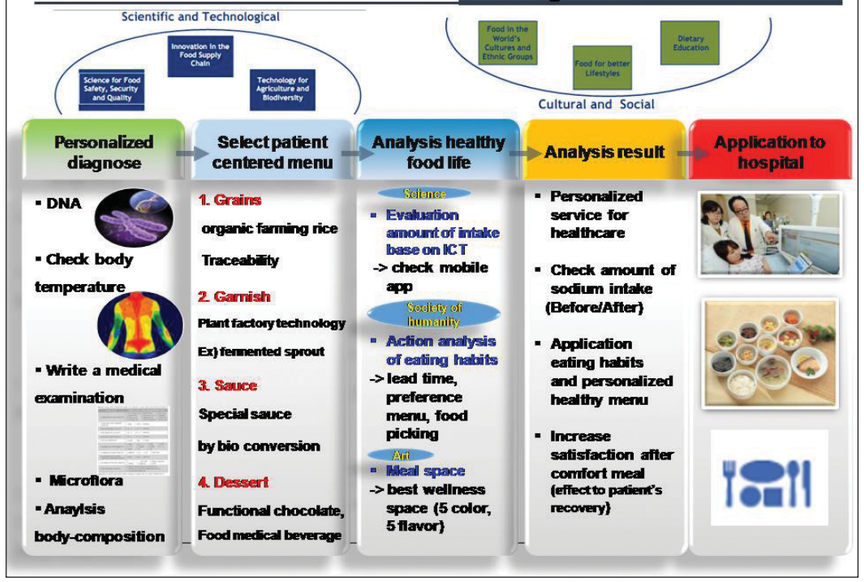
Same neurological response while eating delicious food and listening to music

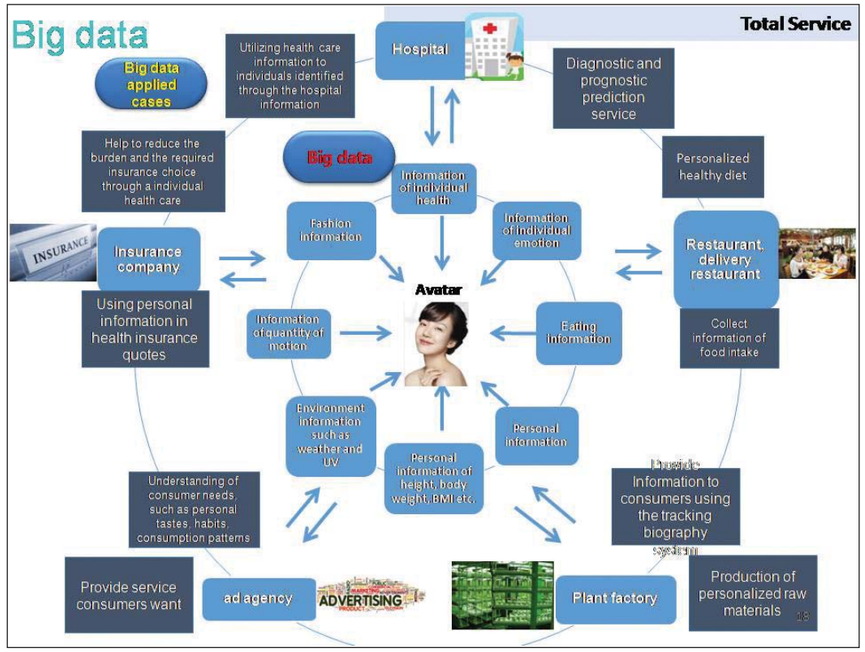
- Dopamine increased 6~9% more while listening to music
- 6% increase while eating delicious food

- Synergenic effect
- Service that can served together anytime , anywhere

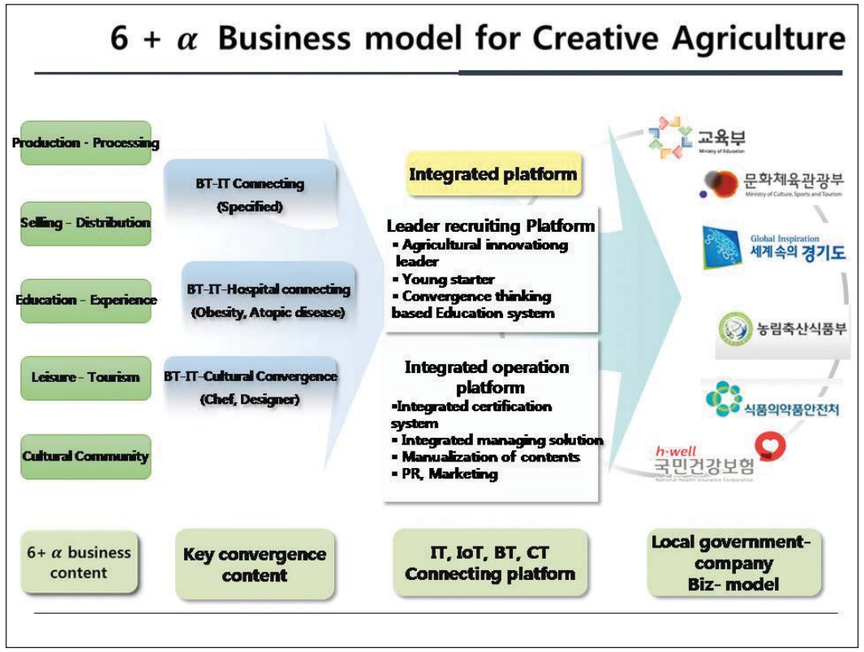
Program that stimulating not only vision, smell, taste but also auditory sense

Application convergence technique for Personalized integration service model

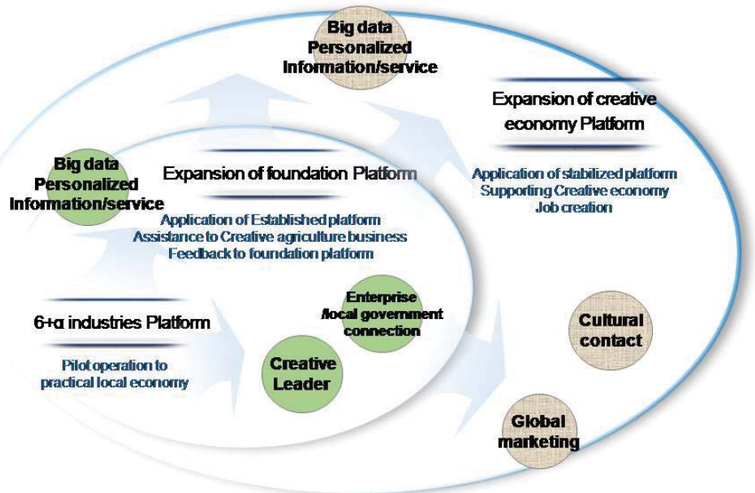




6 + α Business model for Creative Agriculture



Application of 6+α industries combined platform



Advanced Institutes of Convergence Technology

Thank you

Dae-Young Kwon, Ph.D.

Fellow, The Korean Academy of Science and Technology
President, Korea Food Research Institute
dykwon@kfri.re.kr

Education

Seoul National Univ (BS, 1981)
KAIST (Korea Advanced Institute of Science and Technology (MS 1983)
KAIST (Korea Advanced Institute of Science and Technology (Ph.D. 1986)
Post-doctoral Fellow: MIT, Whitehead Institute (1988-1989)

Positions

President, Korea Food Research Institute (2014-)
Acting President, Korea Food Research Institute (2013-2014)
Director of Planning and Strategic (2011-2012)
Director of Food Emerging Technology Division (2008-2011)
Director of Convergence Food Technology Division(2007-08)
Director of Functional Food Research Division(2002-2007)
Principal Researcher
Korea Food Research Institute (since 1988)
Adjunct Professor of Sookmyung University(1997-2001)
Professor of United University of Sci & Technol.(2002-)
Coordinator of National Project : Biofoods (2003-)
Food NCP Korea, EU FP6-7

Members

Member of Korea Academy of Science and Technology
Vice President of Korea Society of Metabolomics

About Dr. Dae Young Kwon

Dr. Kwon received his PhD in Biological Science and Biotechnology from the Korea Advanced Institute of Science and Technology in Seoul in 1986. After finishing his postdoctoral training at the Whitehead Institute, MIT, Cambridge, he has started his research as Research Scientist at Korea Food Research Institute. He worked at KFRI in the field of food biological chemistry. He worked as adjunct professor in Sookmyung University in 1997-2003. He is professor of United University of Science and Technology since 2004. He worked as a Director of Emerging Food Technology Division, Director of Food Convergence and etc in KFRI. He has studied the anti-metabolic syndrome, anti-aging food. He had experience to collaboration work with ifr, Norwich, UK. He has published more than 200 research papers in several renowned SCI international journals in the areas of ethnic foods and bioactive food components and those papers were cited about 1,000 times in SCI journals. He is a regular member of Korea Academy of Science and Technology.

S

A

Vladimir I. Radchenko

North Pacific Anadromous Fish Commission (NPAFC)

Food and Creating Shared Value

Korea Food Research Institute

Kwon Dae Young

kfri 한국식품연구원 Korea Food Research Institute

What are the key factors in food industry ?

Korea Food Research Institute

Recent Issues in Food Industry

1. Food supply?
2. Product?
3. Venture Company?
4. Production?
5. Market entry?
6. Technology?

Sustainability

What is food??

Korea Food Research Institute

韓非子(한, BC 200년경, 진시황때)
外儲設 左上篇

제나라 왕을 위해 그림을 나그네가 있었는 데

제왕이 묻기를 '무엇을 그리는 것이 가장 어려운가?'
犬馬最難,
왕이 다시묻기를 '무엇이 가장 쉬운가?'
鬼魅最易 夫犬馬 人所知也

The importance of story telling : Limits of products and technologies

Korea Food Research Institute

Changes in the global food market

Korea Food Research Institute

Products, Safety	Health
Selection by Taste & Sensory	Selection by Scientific Evidences
Mass production	Target oriented (Personalized foods
Provider oriented Products	Consumer oriented Products
(Farm to Table)	(Fork to Farm)

농림수산식품부 kfri 한국식품연구원

Changes in the food technology

Post-harvest processing → Products → Manufacture → Technology → Contents (Brand) → Glocali-zation

Before1970	1970	1980	1990	2000	After 2010
Under developed Countries	Developing Countries	Industrialization Phase Countries	Developing Countries	developed Countries	Global era:
Post-harvest processing of agricultural products, Exchange, Cooking	Food processing, Distribution, Packaging	Demand increase in mass production & production technology oriented processing foods	Pursuit of pleasure & taste from food, Demand increase in taste-related material & food safety, Expanding of the organic market	Health & longevity of body, Changes in food market regarding to disease prevention (LOHAS)	Demand increase in traditional health Food, Slow Food, Demand increase in organic food

Characteristic of food market: Low appropriability (전유성)

Korea Food Research Institute

Appropriability

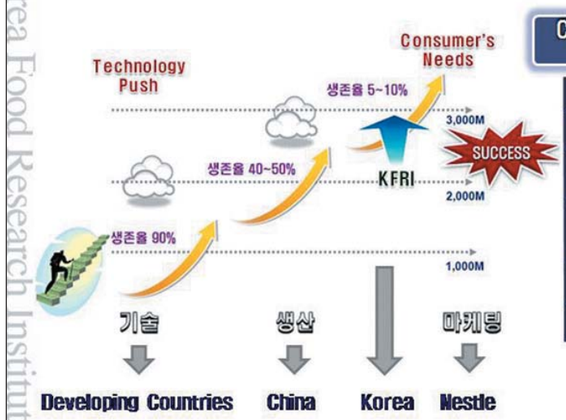
Technology

Exclusive benefits?: Shared values?

Korea Food Research Institute

Korea Food Research Institute

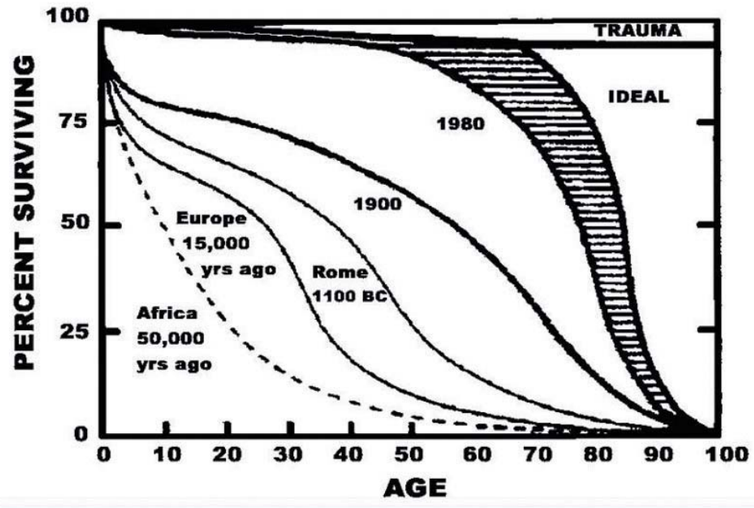
Food Industry TPM



Characteristic of Korean Food Industry

1. Connection of cultures & customs
2. Low technical protection
3. Known as functional foods: Health (Kimchi, Fermented soybean)
4. Safety, Function, Life, Health
5. Major Company in Korea → Small Businesses in the World
6. Lifestyle related diseases, Metabolic disorders, Related with longevity

Expanding of lifespan by Industrialization



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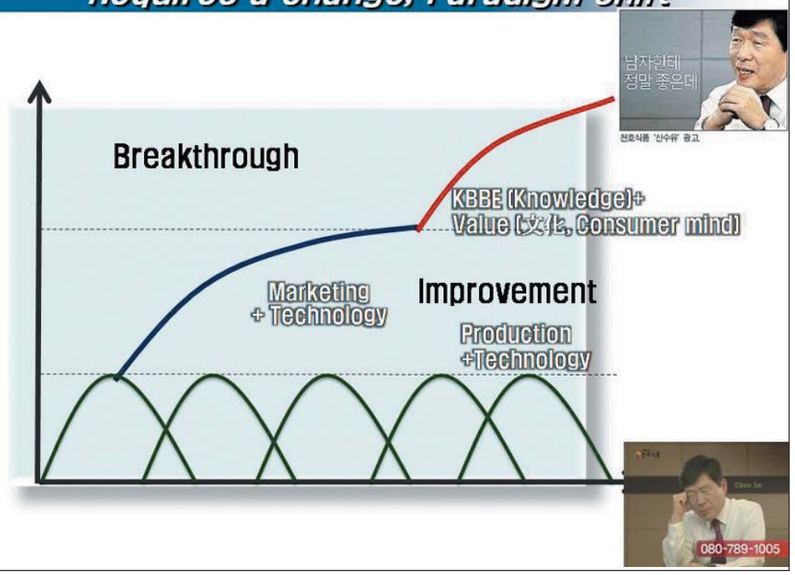
Limits of the materials: Requires a change, Paradigm shift



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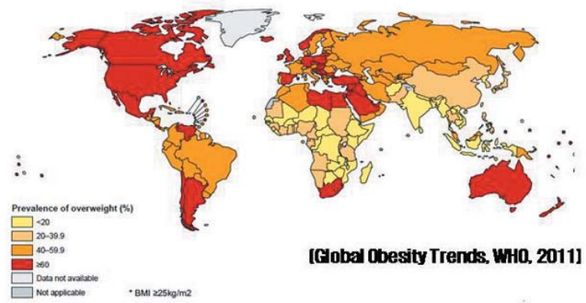
Value and disaster of the industrial era

$$\text{Efficiency (효율 = 효능과 능률)} = \frac{\text{Product or Calorie}}{\text{Input}}$$

How to increase the efficiency:

1] How to reduce input : Technology, Mass production, Standardization, cost-down

2] How to increase output : Output, outcome and value are more important than product



(Global Obesity Trends, WHO, 2011)

Korea Food Research Institute

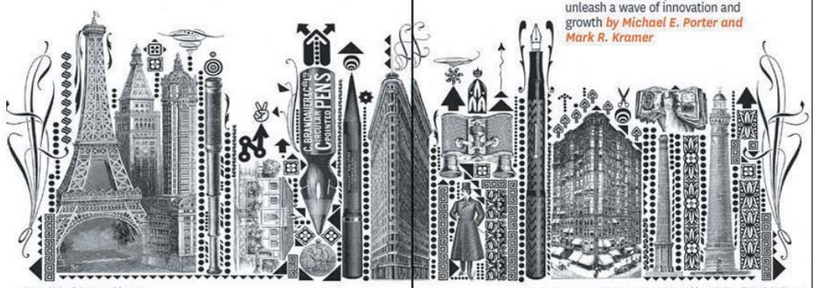
CSV (creating shared value)

The Big Idea

Capitalism is under siege.... Diminished trust in business is causing political leaders to set policies that sap economic growth.... **Business is caught in a vicious circle....** The purpose of the corporation must be redefined around

CREATING SHARED VALUE

How to reinvent capitalism—and unleash a wave of innovation and growth *by Michael E. Porter and Mark R. Kramer*



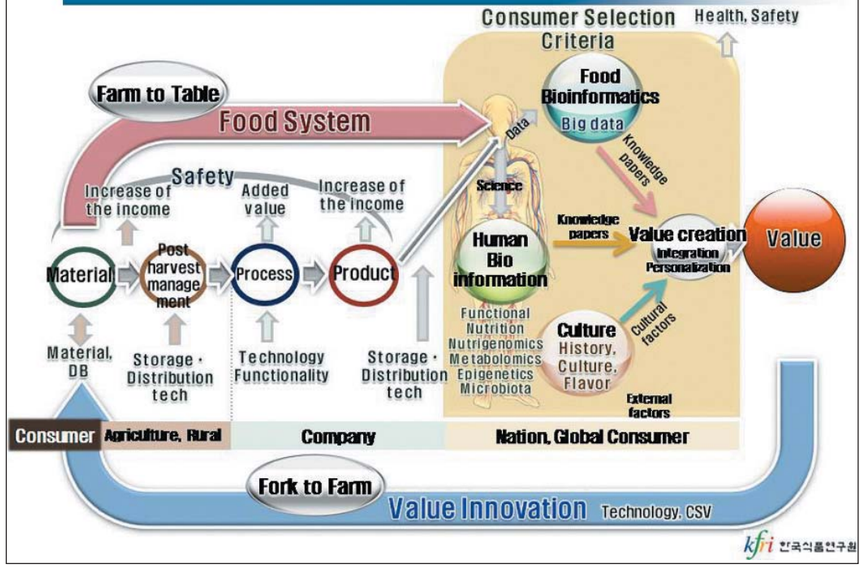
Harvard Business Review (2011)

Please enhance service R&D and system R&D

Consilience

The Geography of Thought, **Richard Nisbett**

Value chain of food research system



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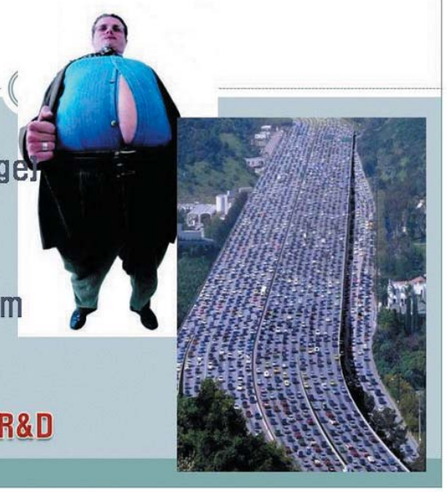
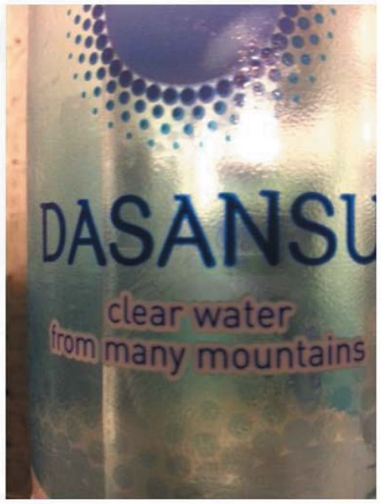
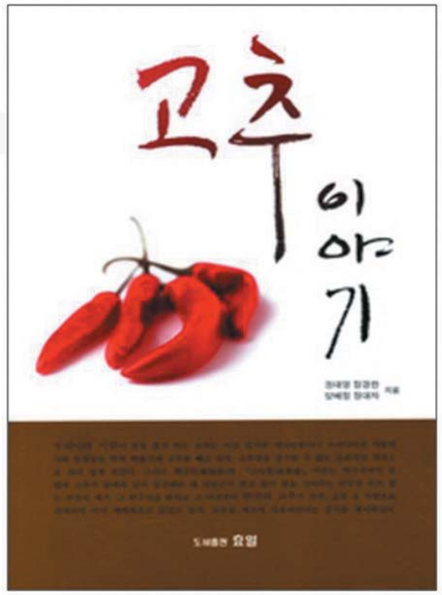
Information Obesity

1. Big data
2. Information obesity
3. Validation (Knowledge)
4. Value creation
5. Value Service system



CSV is the key in Service R&D



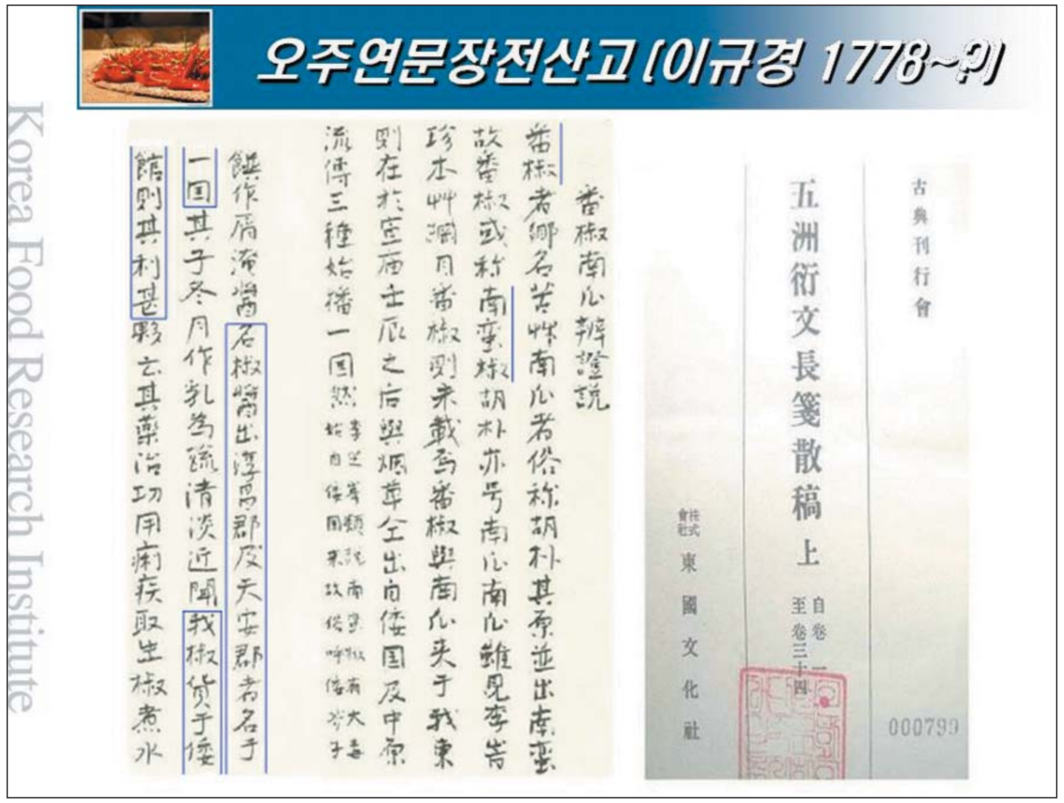


Seed dispersal

Directed deterrence by capsaicin in chillies

The primary function of ripe, fleshy fruit is to facilitate seed dispersal by attracting consumers[1,2], yet many fruits contain unpleasant-tasting chemicals that deter consumption by vertebrates[3]. Here we investigate this paradox in the chilli (*Capsicum*) and find that capsaicin, the chemical responsible for the fruit's peppery heat[4], selectively discourages vertebrate predators without deterring more effective seed dispersers.

NATURE | VOL 412 | 26 JULY 2001 | www.nature.com



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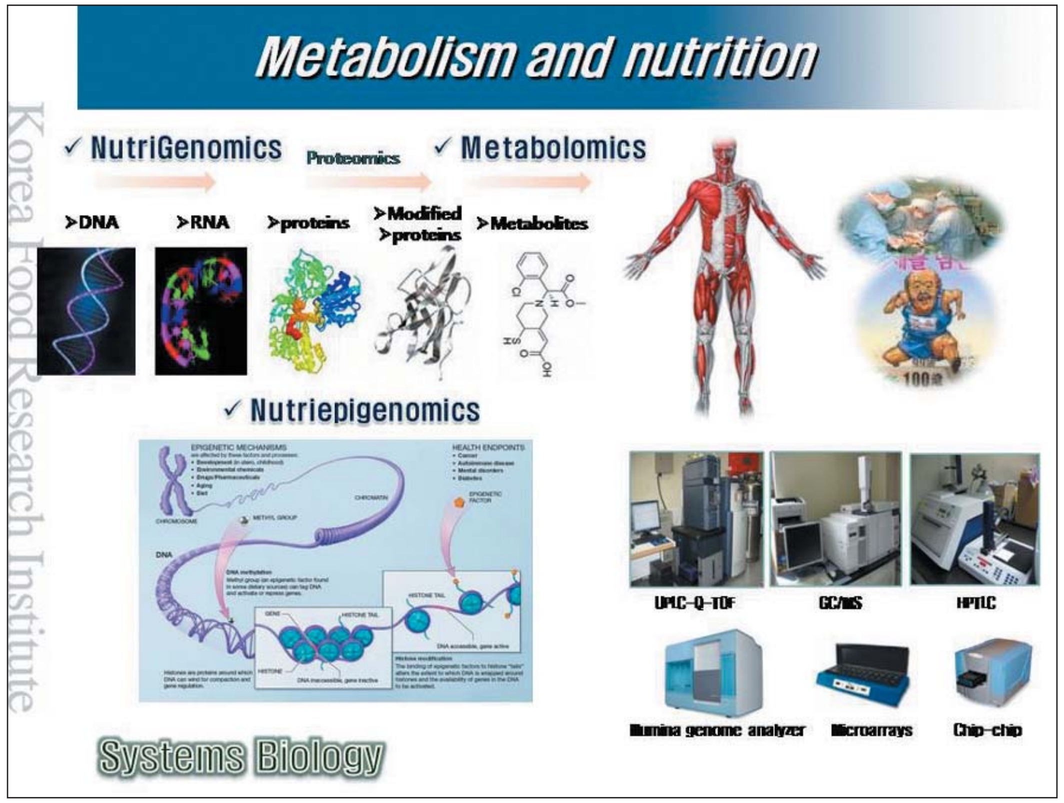
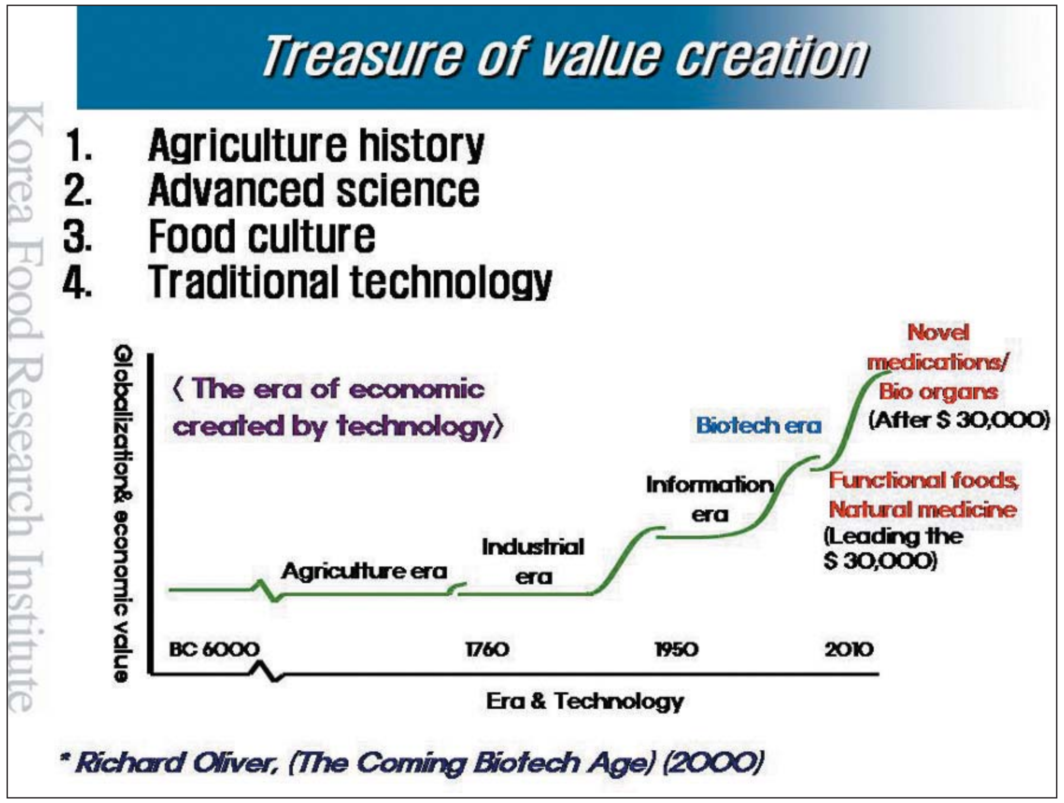
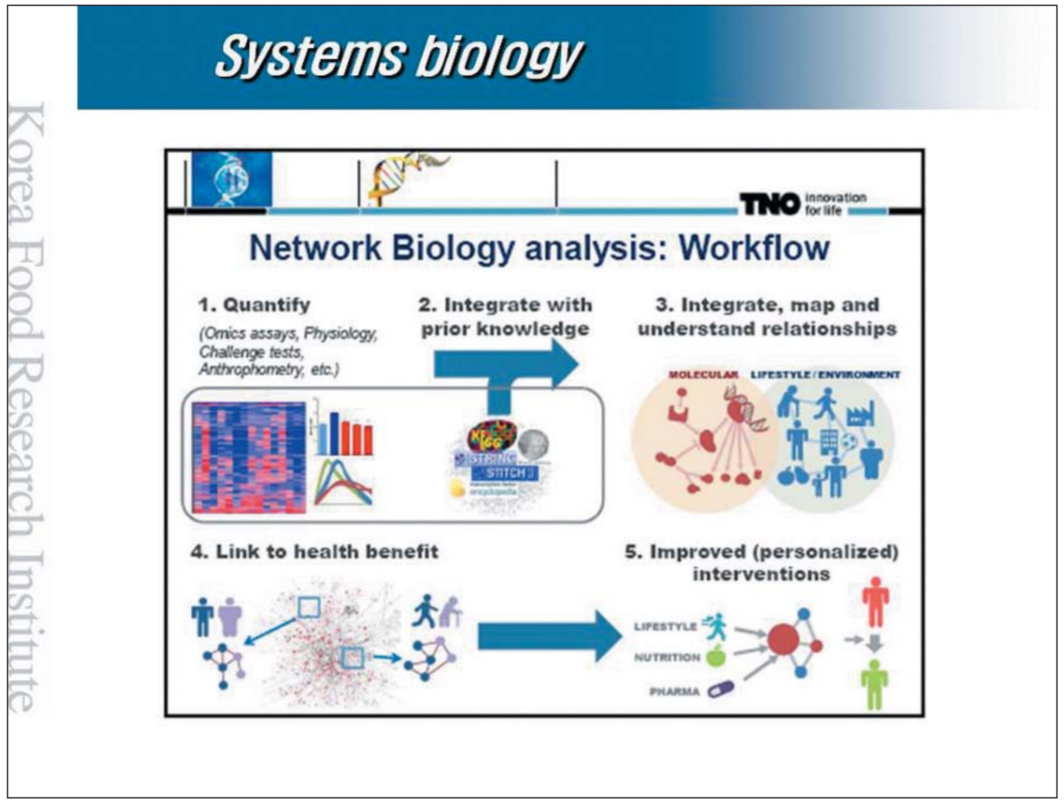
東國文化社
000790



Metabolism and nutrition
Korea Food Research Institute
✓ NutriGenomics
Proteomics
✓ Metabolomics
➤DNA
➤RNA
➤proteins
➤Modified ➤proteins
➤Metabolites
✓ Nutriepigenomics
UPLC-Q-TOF
GC/MS
HPTLC
Illumina genome analyzer
Microarrays
Chip-chip
Systems Biology



Treasure of value creation
Korea Food Research Institute
1. Agriculture history
2. Advanced science
3. Food culture
4. Traditional technology
Globalization& economic value
〈The era of economic created by technology〉
Agriculture era
Industrial era
Information era
Biotech era
Functional foods, Natural medicine (Leading the $ 30,000)
Novel medications/ Bio organs (After $ 30,000)
BC 6000
1760
1950
2010
Era & Technology
* Richard Oliver, (The Coming Biotech Age) (2000)



Systems biology
Korea Food Research Institute
TNO innovation for life
Network Biology analysis: Workflow
1. Quantify
(Omics assays, Physiology, Challenge tests, Anthrophometry, etc.)
2. Integrate with prior knowledge
3. Integrate, map and understand relationships
MOLECULAR
LIFESTYLE / ENVIRONMENT
4. Link to health benefit
5. Improved (personalized) interventions
LIFESTYLE
NUTRITION
PHARMA

음양오행설

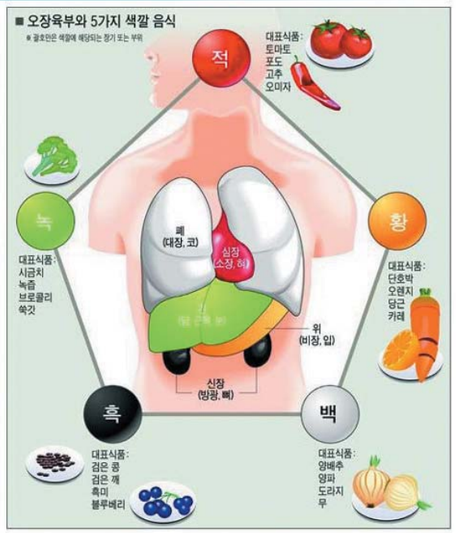
Korea Food Research Institute

음양오행설
【陰陽五行說】

음양 :일(日) 월(月)
오행: 화(火), 목(木),
수(水), 토(土), 금(金)

화 : 心(붉은색), 남
목 : 肝(녹색), 동
수 : 腎(검은색), 북
토 : 胃(황색), 중앙
금 : 肺(백색), 백

비빔밥



Consillience rather than Convergence

Korea Food Research Institute

Sci Transl Med . 2010

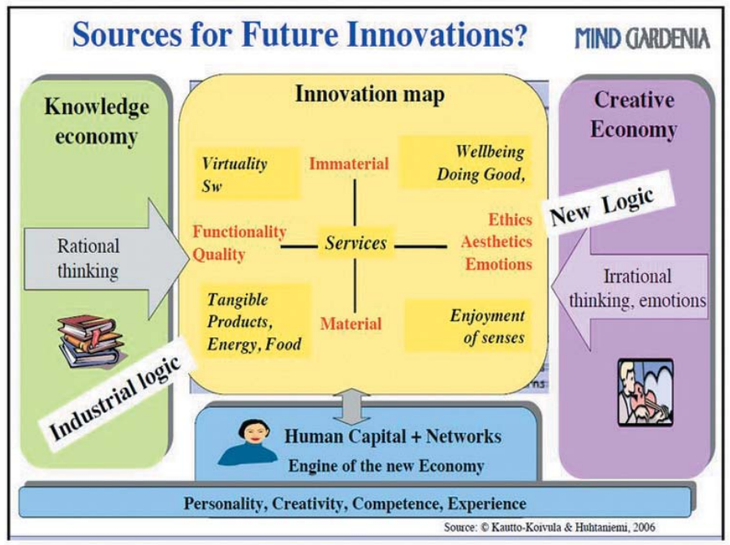
文化~ Living culture

Korea Food Research Institute

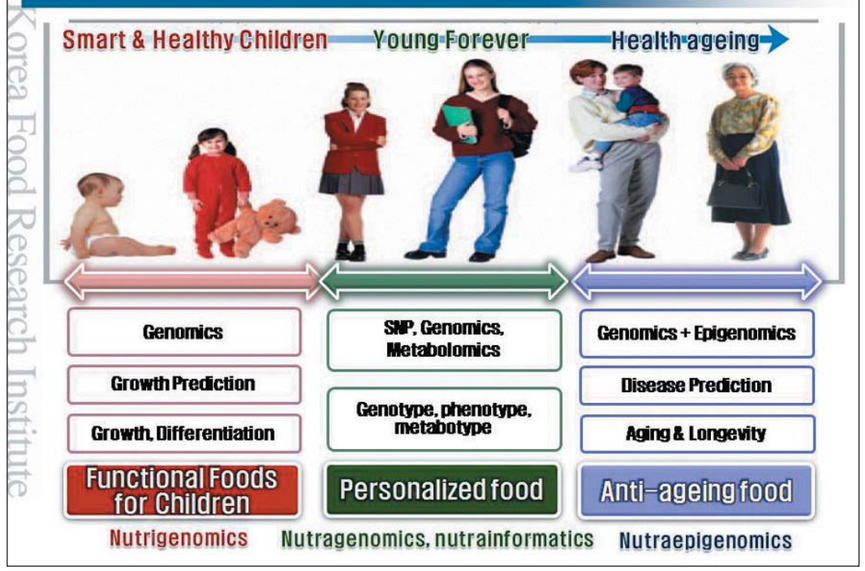
Shared value: A merger between Daum and Kakao

['Daum-KAKAO TkK Merger', 2014.05.26]

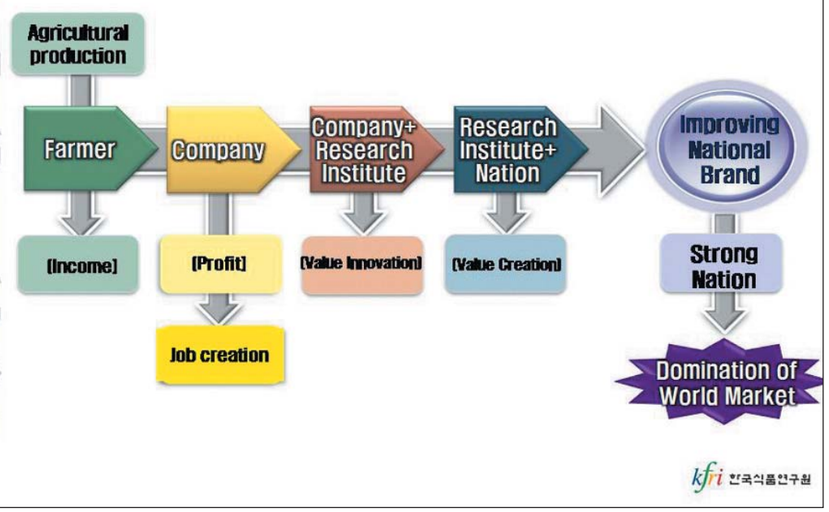
Creative Economy, Systems, Foods(Future Foods, 2009)



Market needs foods technology



Objective: National value creation



대장금(Daejangkum)

Thank You!