Graduate School

Department of Biotechnology

Tel : +82 31 201 2613 Fax : +82 31 203 8127 E-mail : gob@khu.ac.kr URL : http://web.khu.ac.kr/~bio21/

The Graduate School of Biotechnology was established for the purpose of creating a cultural world for the embodiment of humanitarian ideals through the systematic and professional education in order to nurture a sound and talented work force. We strive to acquire and research forefront intelligence and technologies for the academic development of biotechnology in order to contribute to the human welfare and regional development while keeping pace with the developing industrial and IT society.

The Graduate School of Biotechnology has been supported by the Ministry of Education as a recipient of the Brain Korea 21 program. It was first established in the Spring Semester of 2000 as an independent research institute, focusing primarily on plant, animal, and food biotechnology, to meet the growing demands of modern society and to be in the forefront of life science in the 21st century.

Currently, a team of 22 professors, about 100 graduate students and 10 post-doctoral research fellows in the fields of Biochemistry, Cell Biology, Functional Genomics, Microbiology, Molecular Biology, Immunology, Plant Molecular Biology, Natural Product Chemistry, Oriental Medicinal Chemistry and Food Biotechnology are involved in research.

Degree Requirements

- The minimum course credits for the doctoral program, excluding thesis guidance credits, are 36. For the master's degree, the minimum course credits are 24, excluding thesis guidance credits.
- In order to submit a graduate dissertation, the applicant must pass a foreign language test and a qualifying examination.

Courses

Advanced Biochemistry, Advanced Molecular Biology, Advanced Cytology, Advanced Molecular Cell Biology, Advanced Bioengineering, Advanced Immunology, Cell Genetics, Seminar, Advanced Genetic Engineering, Practical Genetic Engineering, Food Biotechnology, Oriental Medical Chemistry

Faculty

Tae-Ryong Hahn, Ph.D. Texas Tech University, 1983, Professor, Biochemistry, trhahn@khu.ac.kr
Ji-Young Kim, Ph.D. University of Chicago, 1981, Professor, Molecular Biology, jkim@khu.ac.kr
In-Sik Chung, Ph.D. Auburn University, 1986, Professor, Biotechnology, ischung@khu.ac.kr
Kwang-Hee Baek, Ph.D. University of Chicago, 1988, Professor, Molecular Biology, khbaek@khu.ac.kr
Jae-Seung Yoon, Ph.D. Purdue University, 1990, Professor, Cell Biology, jsyoon@khu.ac.kr
Dae-Kyun Chung, Ph.D. Cornell University, 1991, Professor, Microbial Genetics, dkchung@khu.ac.kr
Chang-Joong Kang, Ph.D. Texas A&M University, 1994, Professor, Immunology, cjkang@khu.ac.kr
Jong-Seong Jeon, Ph.D. Seoul National University, 1996, Professor, Plant Functional Genomics, jjeon@khu.ac.kr
Seong-Hee Bhoo, Ph.D. University of Nebraska-Lincoln, 1998, Associate Professor, Biochemistry, shbhoo@khu.ac.kr
Byung-Yong Kim, Ph.D. North Carolina State University, 1989, Professor, Bio-Rheology, bykim@khu.ac.kr
Seung-Kook Park, Ph.D. University of California, Davis, 1993, Professor, Food Chemistry, skpark@khu.ac.kr
Hae-Yeong Kim, Ph.D. Albert Einstein College of Medicine, 1994, Professor, Molecular Biology, hykim@khu.ac.kr

Cheon-Seok Park, Ph.D. University of California, Davis, 1997, Professor, Food Microbiology & Biotechnology, cspark@khu.ac.kr
Moo-Yeol Baik, Ph.D. University of Massachusetts, Amherst, 2000, Associate Professor, Food Processing, mooyeol@khu.ac.kr
Dae-Ok Kim, Ph.D. Cornell University, 2003, Associate Professor, Functional Foods, dokim05@khu.ac.kr
Nam-In Baek, Ph.D. Pharmaceutical Sciences, Osaka University, 1989, Professor, Natural Products Chemistry, nibaek@khu.ac.kr
Deok-Chun Yang, Ph.D. Kyung Hee University, 1990, Professor, Biotechnology, dcyang@khu.ac.kr
Tae-Hoo Yi, O.M.D., Ph.D. Kyung Hee University, 2005, Associate Professor, Oriental Medicine, drhoo@khu.ac.kr
Young-Sook Son, Ph.D. University of California, San Francisco, 1989, Professor, Tissue Engineering, ysson@khu.ac.kr
Young-Rok Kim, Ph.D. Cornell University, 2003, Assistant Professor, Food Nanotechnology, youngkim@khu.ac.kr
Yong-Su Jeong, Ph.D. Seoul National University, 1999, Assistant Professor, Developmental Genetics, yongsu@khu.ac.kr
Jae-Sung Hwang, Ph.D. Ajou University, 2003, Assistant Professor, Skin Biology, jshwang@khu.ac.kr

Laboratories

■ Biochemistry Laboratory

Director: Professor, Tae-Ryong Hahn (trhahn@khu.ac.kr)

Research Overview

Our research laboratory focuses on plant carbon metabolism to maximize crop productivity which is determined by the source (leaf) to sink (seed) interactions. Core regulation enzymes involved in carbon metabolism in chloroplasts and cytosol are overexpressed or knock-outed to investigate the role of those enzymes in sugar metabolism. Besides photosynthetic energy source, light acts as a signal for the development of higher plants. To elucidate light signal transduction mechanism, proteomics and molecular genetics approaches are employed. Novel light signal components are determined and the genes of the components are introduced into Arabidopsis with sense or antisense orientations. Transformants are investigated with various light and environmental conditions.

Ongoing Projects

- Carbon metabolism of photosynthesis using biochemical and transgenic plant systems
- Plant light signal transduction mechanism employing proteomics and molecular genetics approaches
- Sugar signal transduction in higher plants
- Pathways and enzymes involved in safflower pigments biosynthesis

■ Molecular Biology Laboratory

Director: Professor, Ji-Young Kim (jkim@khu.ac.kr)

Research Overview

Our research group is working on the regulation of chemokine genes in monocytic cell lines in response to various agonists in order to understand regulatory roles of chemokine during inflammation. We have been studying functional roles of chemokines in angiogenesis by analyzing endothelial cell migration and in vivo agiogenic activities. We are currently working on migration and invasion of hepatoma cells which are induced by CCR1 ligands. In addition, we are also interested in plant-derived natural products which could be utilized for prevention and treatment of inflammatory diseases and osteoporosis.

Ongoing Projects

- Function and signaling pathways of CC-chemokines in monocytes and endothelia cells
- Roles of chemokine, CCL23 (CK β 8) in CCR1-expressing hepatoma cells
- Functional analysis of Lactoferrin on cell growth and angiogenesis through receptor-mediated signaling
- Screening and analysis of plant-derived natural products for immuno-modulation and osteoporosis therapy

■ Biotechnology Laboratory

Director: Professor, In-Sik Chung (ischung@khu.ac.kr)

Research Overview

Our laboratory conducts research on medical biotechnology for the production of vaccines and therapeutic proteins. The research is also geared towards plant genetic engineering and biotechnology to introduce value-added traits into the plants.

Ongoing Projects

- Development and application of novel viral expression systems
- Medical biotechnology for the efficient production of therapeutic proteins
- Plant metabolic engineering-related research
- Plant genetic engineering for the production of edible vaccines and therapeutic proteins in transgenic plants

■ Laboratory for Molecular Genetics

Director: Professor, Kwang-Hee Baek (khbaek@khu.ac.kr)

Research Overview

Our research focuses on the development of protein expression in mammalian cell culture. For our research, we developed the unique expression vector containing MAR element in CHO cell, which can promote the easy selection of the protein-expressing cell line and increase the level of protein expression. We continue to characterize several MAR elements from various sources and analyze their functions in the promotion of protein expression. Using the expression vector, we are developing many cell lines expressing various proteins such as growth factors, cytokines, and GPCRs. On the other hand, we also focus on the research to identify the functional role of the DJ1, whose mutation can promote Parkinson's disease.

Ongoing Projects

- Development of GPCR-expressing CHO cell lines and screening of effective molecules from natural resources to promote the signal transduction through the GPCRs
- Study on the cloning and functional identification of eye-specific genes in Drosophila
- Development of cell lines expressing growth factors
- Characterization of DJ1 function in vivo

■ Cell Biology Laboratory

Director: Professor, Jae-Seung Yoon (jsyoon@khu.ac.kr)

Research Overview

Many human diseases of the nervous system are caused by degeneration of nerve cells due to mutational changes in the proteins underlying their functions. We use the fruit fly Drosophila to investigate how the retinal neurons are excited by light, a process called phototransduction. Drosophila allows us to systematically generate mutants that are defective in the process and utilize these mutants to identify the molecules involved in it. We introduced this approach to the field of visual functions, and it has led to the identification of many of the molecules required in phototransduction. We also investigate the possibilities for enhancing the protein expression in mammalian cells. We continuously improve the expression vectors which can be used for CHO cells that are widely used as host for biopharmaceutical production.

Ongoing Projects

- Regulation of TRP channels
- Mechanism of retinal degeneration
- Development of the 3rd generation HBV vaccine
- Improved expression systems for CHO cells

■ Functional Biomaterial Engineering Laboratory

Director: Professor, Dae-Kyun Chung (dkchung@khu.ac.kr)

Research Overview

Our research focuses on the production of functional biomaterial with biotechnology. We have several screening techniques using recombinant DNA technology for the isolation of new functional biomaterial. There are many ongoing research projects such as development of new material for atopic dermatitis, whitening and wrinkle free skin, and osteoporosis. In addition, for the basic research, we have studied the relationship between microorganism and the innate immunity, especially the mechanism of toll-like receptors.

Ongoing Projects

- Research about human immune response, especially innate immunity including toll-like receptor
- Development of new functional biomaterial for atopic dermatitis from microorganisms
- Development of new functional biomaterial for osteoporosis from natural sources
- Development of new functional biomaterial for whitening and wrinkle free skin from natural sources
- Development of cell line producing peptides having anti-cancer, anti-hypertension and anti-thrombosis activity

■ Immunology Laboratory

Director: Professor, Chang-Joong Kang (cjkang@khu.ac.kr)

Research Overview

Our immunology lab is working to elucidate the regulation of gene expression during B cell development. As a model system, IgJ chain gene and its neighboring Crlz1 gene are our immediate targets for the study. IgJ chain gene is only expressed after a primary immune response. Crlz1 gene is almost unknown in terms of gene expression regulation and its function. We are currently studying the Crlz1 gene. The starting point of the research is the enhancer element positioned between the two neighboring genes.

Ongoing Projects

- Study on the chromatin structure of immunoglobulin J chain gene locus
- Identification and its functional analysis of transcriptional regulatory proteins binding to the STAT5-overlapping site of the J chain gene enhancer in the antibody-secreting plasma cells
- Study on the regulation of Crlz1 gene expression and its function

■ Plant Functional Genomics Laboratory

Director: Professor, Jong-Seong Jeon (jjeon@khu.ac.kr)

Research Overview

Our research at the Plant Functional Genomics Laboratory focuses on both signal transduction of rice blast resistance and regulation of rice carbon metabolism that facilitates the improvement of rice disease resistance and rice carbon metabolism.

Ongoing Projects

- Characterization of transcription factors regulating rice blast resistance
- Regulatory mechanism of rice blast resistance
- Enhancing sink strength
- Development of a novel rice variety with enhanced nutritional value

■ Plant Biochemistry Laboratory

Director: Professor, Seong-Hee Bhoo (shbhoo@khu.ac.kr)

Research Overview

Our laboratory focuses on the carbon metabolism and light signal transduction in plant Arabidopsis. Several enzymes involved in the plant carbon metabolism are regulated up or down to see changes in carbon metabolism and ultimately plant growth and productivity. Plant light signal transduction is being investigated. Red light specific Phytochrome A degradation is a sub research topic. Determination of Phytochrome A degradation domain and ubiquitination site is another research interest. Our laboratory also focuses on the determination of blue light signal intermediates using several mutants responding to specific blue light. Proteomics and molecular genetics are being employed to screen light signal components and genes involved in many different stimuli in Arabidopsis.

Ongoing Projects

- Carbon metabolism research with up or down regulated transgenic Arabidopsis
- Determination of phytochrome A degradation domain and ubiquitination site
- Screening of light signal components using proteomics approaches
- Screening of phosphorylated and ubiquitinated proteins using proteomics approaches
- Determination of blue light signal components using molecular genetic approaches

■ Food Engineering Laboratory

Director: Professor, Byung-Yong Kim (bykim@khu.ac.kr)

Research Overview

Research interests include food rheology, food texture and optimization of the food formulation. Recent studies have involved fish protein gelation, and optimization of by-products for the food formulation. Methods of processing, storage, and packaging have received attention along with characterization of new products. Ideas for food equipment have been studied and laboratory prototypes developed.

Ongoing Projects

- Utilization of the enzyme hydrolysate for functional foods and optimization of formulation
- Data base of the amount of ethyl carbamate in traditional Korean liquors
- Quality mapping and searching the indicated proteins of optimized Chungkukjang production by using the proteomics

■ Food and Flavor Chemistry Laboratory

Director: Professor, Seung-Kook Park (skpark@khu.ac.kr)

Research Overview

Our research is focused on two major areas: the development and application of analytical chemistry techniques to study food chemistry, particularly in wine, coffee, tea, and beer and the elucidation of the chemical mechanisms for the formation of desirable and undesirable flavor compounds during processing.

Ongoing Projects

Our current research projects involve changes in volatile compounds of green tea during growing season, and off-flavor development from wine and beer fermentation.

■ Food Biochemistry Laboratory

Director: Professor, Hae-Yeong Kim (hykim@khu.ac.kr)

Research Overview

In the Food Biochemistry Lab, we carry out research on the identification and optimization of functional, nutritional, and health-related properties of foods using the recent recombinant technologies. Through our research, we identify the function and mechanism of food in human beings.

Ongoing Projects

- Microarray sensor for rapid detection of food-borne pathogens
- Isolation of iron and copper-storage elevated yeast and its characterization using proteomics
- Identification of allergy diagnostic markers by functional proteomics
- Safety assessment of genetically modified foods

■ Food Microbiology & Biotechnology (FMB) Laboratory

Director: Professor, Cheon-Seok Park (cspark@khu.ac.kr)

Research Overview

Our research laboratory mainly focuses on applied microbial engineering related to food microorganisms which produce many interesting functional biomaterials including industrial enzymes, functional secondary metabolites, and microorganism itself. There are three main topics being studied in our lab. First, bioconversions using microbial cells and/or enzymes in which we are making functional prebiotic carbohydrate materials including palatinose, maltooligosaccharides, and many transglycosylation products. Second, the production of functional secondary metabolites from useful fungal strains originated from traditional Korean food materials (Doenjang, Maeju, and Nuruk). We are interested in functional genomics of many metabolic pathway genes related with the anticholesterolemic, antimicrobial, and anticancer agents produced from many filamentous fungi. Third, we are trying to study the regulation of food pathogens via controlling various environmental factors based on the hurdle theory.

Ongoing Projects

- Functional genomic researches on food microorganisms originated from the Korean tradition fermented food
- Production of efficient bio-energy from fungal enzymes and cell wall-expanding protein
- Production of functional transglycosylated isoflavones using microbial transglycosylation enzymes
- Modification of Ginseng saponin using microbial transglycosylation enzymes

■ Food Processing Laboratory

Director: Professor, Moo-Yeol Baik (mooyeol@khu.ac.kr)

Research Overview

Our research goals are to develop the value-added technologies that are related to the modification of functional food ingredients such as carbohydrates, proteins and lipids, and their application in food and non-food products. Controlling water interaction and migration in various food systems is another area that we are interested in. Investigation of molecular dynamics, such as water and food biopolymer mobility/interaction is of great interest to us. The research field involving functional food ingredients and the interplay of water with food components will provide basic and applied knowledge. This is beneficial to the advancement of understanding of how food components interact with each other in various complex systems.

Ongoing Projects

- Physicochemical properties of cross-modified starches
- Non-thermal starch modification using ultra high hydrostatic pressure
- Development of value added Korean ginseng products using ultra high hydrostatic pressure and puffing

■ Functional Foods Laboratory

Director: Professor, Dae-Ok Kim (dokim05@khu.ac.kr)

Research Overview

Our laboratory has been working on various subjects on chemistry of fruits and vegetables related to nutritional, sensory, and nutraceutical qualities.

Identification and quantification of bio-functional phytochemicals, especially phenolics, is based on the instrumental analyses using spectrophotometer, HPLC, etc.

Various chemical and enzymatic assays for antioxidant activity of phytochemicalsl from plants are currently used in our laboratory.

For the investigation of in vitro effects (anticarcinogenic or antineurodegenerative effect) of bio-functional phytochemicals, we have used various cell lines such as human cancer cell lines and PC 12 cells.

Fruit and vegetable processing has been also studied to evaluate its effects on the profile of phenolic phytochemicals and antioxidant activity.

Ongoing Projects

- Phenolics in lettuce and their protective effects on neuronal cells
- Characterization of flavan-3-ols in green teas organically grown in the Bosung area and their industrial applications to improve the quality of green tea products

■ Natural Products Chemistry Laboratory

Director: Professor, Nam-In Baek (nibaek@khu.ac.kr)

Research Overview

Our research at the Natural Products Chemistry Laboratory focuses of the study on isolation of secondary metabolites from natural sources including oriental medicinal materials, determination of the chemical structure, evaluation of the biological and pharmacological activity. Through our research, we develop novel and safe materials for drugs, cosmetics, functional foods and agrochemicals, which finally create the way for human well-being.

Ongoing Projects

- Development of pharmacological materials from oriental medicinal drugs
- Study on the biosynthetic pathway of guaianolide sesquiterpenes in compositae plants
- Development of anticancer materials from natural sources
- Study on the metabolomics of the secondary metabolites in the higher plants

■ Biotechnology Lab for Oriental Medicinal Materials (HanBangBio)

Director: Professor, Deok-Chun Yang (dcyang@khu.ac.kr)

Research Overview

Our research (HanBangBio) is being done on oriental medicinal plants including ginseng.

- More than 20,000 expressed sequence tags (ESTs) from ginseng, Codonopsis Ianceolata and other medicinal plants have been obtained. New genes from the EST sequences have been identified and characterized.
- Oriental medicinal plants including Codonopsis sp., Adenophora sp., etc. are re-identified by molecular taxonomic technique using ITS and ribosomal DNA sequences. After identification, molecular markers for discrimination of specific plants are developed.

- Promoter regions of medicinal plant genes responsive to environmental stresses are identified.
- Useful genes encoding biosynthetic enzymes for pharmaceutically active compounds in ginseng have been transformed to other plants and amplified for mass production.
- A new vector system without antibiotic resistance genes is being developed for plant transformation.
- Roots of medicinal plants (Sedium sp. and Rhodiola sp.) are regenerated in vitro.
- Major ginsenosides Rb, Rg are bio-transformed to pharmaceutically more active minor ginsenosides Rd, Rg3 and Rh2 by microbial enzymes. Many lactic acid bacteria and their enzymes were isolated and characterized.
- Pathogenic fungi on medicinal plants were isolated and their distribution in Korean field is analyzed using molecular technique.

Ongoing Projects

- Mass production of ginsenoside using rhizosphere microorganisms
- Development of ginseng culture technique for post-4 year culture
- Development of new pharmaceutical material by microbial fermentation in medicinal plants
- Development of genetic maker for Chun-Poong cultivar
- Development of new functional material using saponin-biosynthetic genes
- Analysis of Codonopsis lanceolata EST
- Characterization of stress-resistant genes and their transformation
- Re-evaluation of ginseng product containing red ginseng

■ Lab of Oriental Medicinal Product & Processing

Director: Professor, Tae-Hoo Yi (drhoo@khu.ac.kr)

Research Overview

Our research laboratory focuses on developing functional food and cosmetic materials using oriental medicinal plants and studying their mechanism. Until now we have focused on finding anti-alopecia agents from oriental medicinal plants and developing drugs and cosmetic products for alopecia. As most cases of hair loss seen in clinical practice mainly represent disturbances of the cycle of hair follicle that are based on a premature termination of anagen, we have been studying how herbal medicinal plants prevent anagen to telogen transformation and stimulate telogen to anagen transformation in C57BL/6 mouse resulting in both cellular proliferation and protein synthesis

Furthermore we focus on cell regeneration and mutual delivery mechanisms between the skin and drugs as well as a host of innovative products for aging prevention, whitening, hydration, etc, and study the delivery systems for effective oriental medicinal materials.

Ongoing Projects

- Development of hair follicle and hair cycle destruction/recovery mouse model for anti-alopecia agent evaluating system (APES)
- Oriental medicinal plants screening for having hair growth promoting effect by using keratinocyte and dermal papilla cells

■ Tissue Engineering Laboratory

Director: Professor, Young-Sook Son (ysson@khu.ac.kr)

Research Overview

Our research laboratory focuses on basic cell biology of tissue stem cells and their applications on regenerative medicine. More specifically, we are studying mechanism to regulate mesenchymal stem cell (MSC) pool and their mobilization especially in the bone marrow in the context of tissue injury. With use of MSC and/or dedifferentiated chondrocytes, we are developing technologies for tissue engineered cartilage and bone with the aim for future clinical application of osteoarthritis and bone fracture. We are also exploring several alternative accessible neural precursor cells from adipose stem cells and melanocytes and evaluate the possibility for neuronal cell therapy in the spinal cord injury animal model.

Ongoing Projects

Tissue-Engineered Biocartilage, MSC mobilization, Development of bone scaffold by Musculoskeletal Bioorgan Center Project. Induced-Schwann cells for the repair of spinal cord injury by Stem cell research center. Cell signaling from cyclic tension and their effect on cell survival. 3-D BioSkin for bioscreening of cosmetics and toxic materials.

■ Food Nanotechnology Laboratory

Director: Professor, Young-Rok Kim (youngkim@khu.ac.kr)

Research Overview

Our interests span a range of topics that are related with the Nanobiotechnology and its application to the Food Science and other biological research. It includes the development of nanomaterials for the advancement of food system and human health. We are working on a variety of problems related with the synthesis of biocompatible nanomaterials, integration of these materials with biological molecules, and confer them specific functions that can be deliverable to our body through food system. Upon scaling down the size of macroscopic materials into nano scale, the physical principles that determine the overall property of the system changes, and we are utilizing this phenomenon to develop an advanced food materials.

Ongoing Projects

- Development of smart nanoparticles for effective delivery of functional components in food
- Development of a fast label-free detection system using nanopore for the early diagnosis of infectious animal disease
- Development of high speed single nucleotide polymorphism detection using nanopore technology

■ Laboratory of Developmental Genetics

Principal Investigator: Professor, Yong-Su Jeong (yongsu@khu.ac.kr)

Research Overview

The secreted protein, Sonic hedgehog (Shh), plays essential roles in establishing the ventral patterning of the vertebrate central nervous system (CNS). In the absence of Shh function, the normal processes to form neural tube are impaired resulting in holoprosencephaly (HPE), a structural malformation of the brain, as well as neuronal patterning and path finding defects. It is integral to study how Shh transcription is regulated in the CNS for the understanding of ventral neural tube development. Research in my laboratory focuses on uncovering the cis and trans acting determinants of Shh expression in the mouse CNS through employing genetic, genomic and biochemical approaches. An understanding of how Shh expression is initiated in the ventral forebrain may provide insight into additional causes of holoprosencephaly.

Ongoing Projects

- Identify novel regulators of Shh transcription in the mouse central nervous system
- Screen for upstream activators of Six3-Shh pathway
- Determine the role for ZLI in the development of the thalamus and prethalmus
- The role for Shh in the development of ventral telencephalon

■ Skin Biology Laboratory

Director: Professor, Jae-Sung Hwang (jshwang@khu.ac.kr)

Research Overview

Our research laboratory focuses on skin pigmentation and atopic dermatitis. As hyperpigmentation induced by UV irradiation or unusual pigmentation caused by medical conditions such as melasma, post-inflammatory melanoderma and solar lentigo is undesirable, the development of effective skin-lightening agents is essential. We are trying to elucidate the cause of hyperpigmentation and develop materials to treat such conditions. Atopic dermatitis (AD) is an itchy inflammatory dermatitis with a chronic course with remissions and exacerbations. AD occurs primarily in children, but persisting cases in adulthood as well as adult late-onset AD occur. It is estimated that about 20% of the population of the industrialized countries has an atopic constitution. We are trying to restore the integrity of the skin barrier, in particular the composition of the stratum corneum which appears to be of great importance for the development and progression of skin lesions in patients with AD.

Ongoing Projects

- Pathways and enzymes involved in skin melanin biosynthesis
- Post translational modification of tyrosinase and related enzymes
- Skin lipids and compounds which strengthen skin barrier function