

# KIBAEK CHOE, Ph.D.

(Nov. 8, 2017)

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## EDUCATION

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M.S./Ph.D. (Advisor Prof. Pilhan Kim) Feb 2010 – Feb 2016

**Thesis: Intravital Imaging of Lymph Node and Small Intestine**

In Vivo Micro-Visualization Laboratory (<http://ivmvl.kaist.ac.kr/>)

Graduate School of Nanoscience and Technology

Korea Advanced Institute of Science and Technology (KAIST) Daejeon, Republic of Korea

B.S. Mar 2006 – Feb 2010

Department of Physics

Korea Advanced Institute of Science and Technology (KAIST)

## PROFESSIONAL POSITION

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**Post-doctoral Researcher** Mar 2016 – Present

In Vivo Micro-Visualization Laboratory

KAIST Natural Research Institute

Korea Advanced Institute of Science and Technology (KAIST)

## RESEARCH SKILL

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Development of Laser Scanning Confocal and Multiphoton Microscope System

GRIN-lens based Endo-microscopy

MATLAB, ImageJ, IMARIS, Photoshop & Excel for image processing and analysis

Mouse handling, Catheterization into tail vein and Micro-surgery of lymph node for intravital imaging

Immunohistochemistry, Cell culture, MACS, FACS, PCR, Antibody Labeling with Fluorophore

## AWARDS

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The International Conference of **the Korean Society for Molecular and Cellular Biology**, 2017  
Young Investigator Presentation Award

**Annual Biophotonics Conference 2016**, Young Investigator Award 2016

<b>Immunology 2016 (the American Association of Immunologists)</b> Trainee Poster Award	2016
<b>Annual Biophotonics Conference 2015</b> , Excellence Poster Award	2015
The meeting of <b>Vascular Science and Medicine Organization</b> , Excellence Poster Award	2015
The Fall Conference of the <b>Korean Association of Immunologists</b> , Best Presentation Award	2014
The Spring Conference of the <b>Korean Association of Immunologists</b> , Best Presentation award	2013
<b>Optical Society of Korea</b> Summer Meeting, Best Paper Award	2012

## **PUBLICATIONS**

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Google Scholar Page (<https://scholar.google.com/citations?hl=ko&user=oY4-wowAAAAJ>)

11. Intravital Longitudinal Wide-area Imaging of Dynamic Bone Marrow Engraftment and Multilineage Differentiation through Nuclear-Cytoplasmic Labeling  
Ahn S, Choe K, Lee S, Kim K, Song E, Seo H, Kim I, Kim P  
*Plos One*, 12(11), e0187660, 2017.
10. In Vivo Cellular-level Real-time Pharmacokinetic Imaging of Free-form and Liposomal Indocyanine Green in Liver  
Hwang Y, Yoon H, Choe K, Ahn J, Jung JH, Park JH, Kim P  
*Biomedical Optics Express*, 8(10), 4706-4716, 2017.
9. VEGFR2 but not VEGFR3 governs integrity and remodeling of thyroid angiofollicular unit in normal state and during goitrogenesis  
Jang JY, Choi SY, Park I, Park DY, Choe K, Kim P, Kim YK, Lee BJ, Hirashima M, Kubota Y, Park JW, Cheng SY, Nagy A, Park YJ, Alitalo K, Shong M, Koh GY  
*EMBO Molecular Medicine*, e201607341, 2017.
8. Polypeptide-based polyelectrolyte complexes overcoming the biological barriers of oral insulin delivery  
Jeong YJ, Lee D, Choe K, Ahn H, Kim P, Park JH, Kim YC  
*Journal of Industrial and Engineering Chemistry*, 48, 79-87, 2017
7. Holographic intravital microscopy for 2-D and 3-D imaging intact circulating blood cells in microcapillaries of live mice  
Kim K\*, Choe K\*, Park I, Kim P, Park Y (\* co-first authors).  
*Scientific Reports*, 6, 33084, 2016.
6. Intravital imaging of intestinal lacteals unveils lipid drainage through contractility  
Choe K\*, Jang JY\*, Park I\*, Kim Y, Ahn S, Park DY, Hong YK, Alitalo K, Koh GY, Kim P  
*The Journal of Clinical Investigation*, 125(11), 4042-4052, 2015. (\* co-first authors).
  - ✓ Paper: <http://www.jci.org/articles/view/76509>
  - ✓ Highlight in 'JCI This Month – Nov. 2015', p7: <http://www.jci.org/this-month/2015/11>

- ✓ Highlight in JCI Posts: <http://www.jci.org/posts/339>

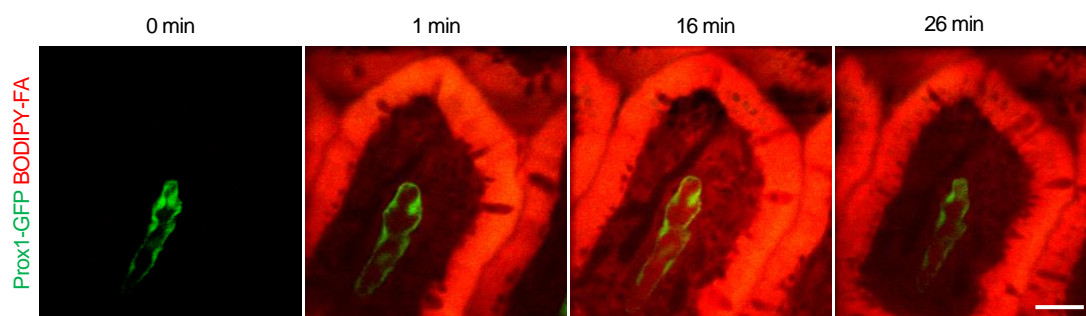
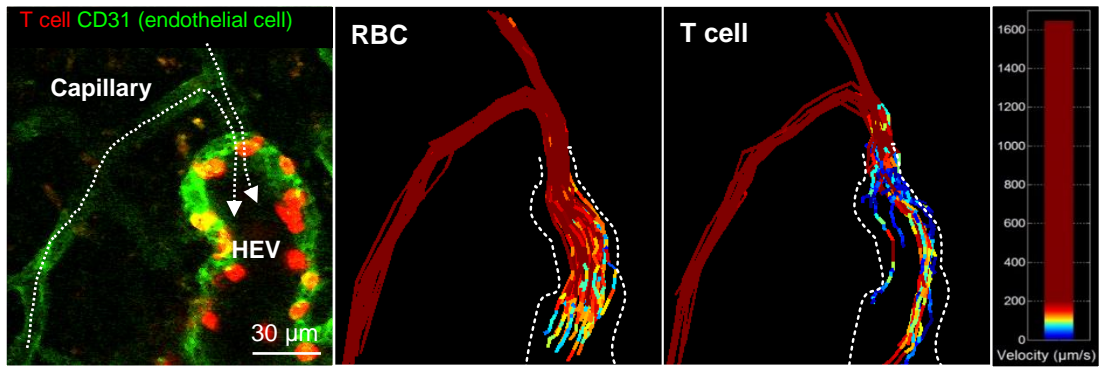


Figure shows dynamic absorption and drainage of BODIPY dye-conjugated fatty acid (BODIPY-FA) through a GFP+ lacteal (initial lymphatic vessel) in a single small intestinal villus. Scale bar, 30μm.

*In vivo* micro-visualization of the small intestinal villi is challenging because of continuous peristalsis of the small intestine. In this work, we successfully visualized the drainage pathways of lipids and various molecules through the intestinal villi *in vivo* by using our customized imaging chamber and video-rate confocal microscopy system. Surprisingly, we also discovered a contraction of the lacteals, and demonstrated its role in lipid absorption and neural control of the contraction.

5. Optical clearing based cellular-level 3D visualization of intact lymph node cortex  
Song E, Seo H, Choe K, Hwang Y, Ahn J, Ahn S, Kim, P  
***Biomedical Optics Express***, 6(10), 4154, 2015.
4. *In vivo* longitudinal cellular imaging of small intestine by side-view endomicroscopy  
Ahn J, Choe K, Wang T, Hwang Y, Song E, Kim KH, Kim P  
***Biomedical Optics Express***, 6(10), 3963, 2015.
3. *In vivo* Quantitation of Circulating Tumor Cells from Great Saphenous Vein Based on Video-rate Confocal Microscopy  
Seo H, Hwang Y, Choe K, Kim P  
***Biomedical Optics Express***, 6(6), 2158-67, 2015.
2. Establishment of a controlled insulin delivery system using a glucose-responsive double-layered nanogel  
Lee D, Choe K, Jeong Y, Yoo J, Lee SM, Park JH, Kim P, Kim YC  
***RSC Adv.***, 5(19), 14482–14491. 2015.
1. *In vivo* high spatiotemporal resolution visualization of circulating T lymphocytes in high endothelial venules of lymph nodes  
Choe K, Hwang Y, Seo H, Kim P  
***Journal of Biomedical Optics***, 18(3):036005, Mar. 2013.  
(<http://biomedicaloptics.spiedigitallibrary.org/article.aspx?articleid=1661170>)



First figure shows post-capillary high endothelial venule (HEV) and adhered T cells. Arrows indicate tracks of flowing cells from capillaries to HEV. Second and third figures are velocity color-maps for RBC and T cell showing the changing velocity and spatial distribution of them simultaneously. Time resolution of the change of velocity is 30 Hz.

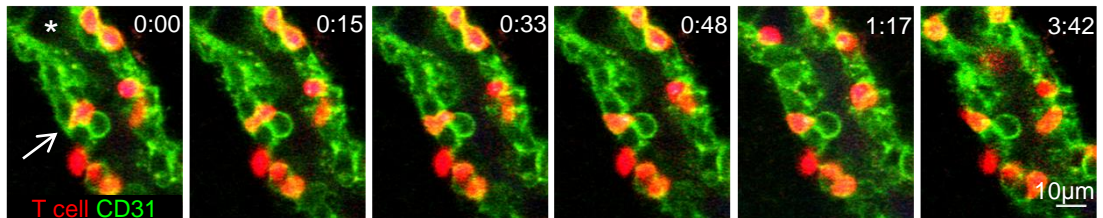


Figure clearly shows para-cellular trans-endothelial migration of T cell (arrow) in HEV of mice lymph node *in vivo* for the first time to our knowledge. Star indicates lumen of HEV. Time scale (min:sec).

## RESEARCH EXPERIENCE

### Development of optical microscope for intravital imaging of various murine organs

I designed and implemented a video-rate laser scanning confocal and multi-photon microscopy system in In Vivo Micro-Visualization Laboratory in KAIST, which was built on previously reported designs (1-2)

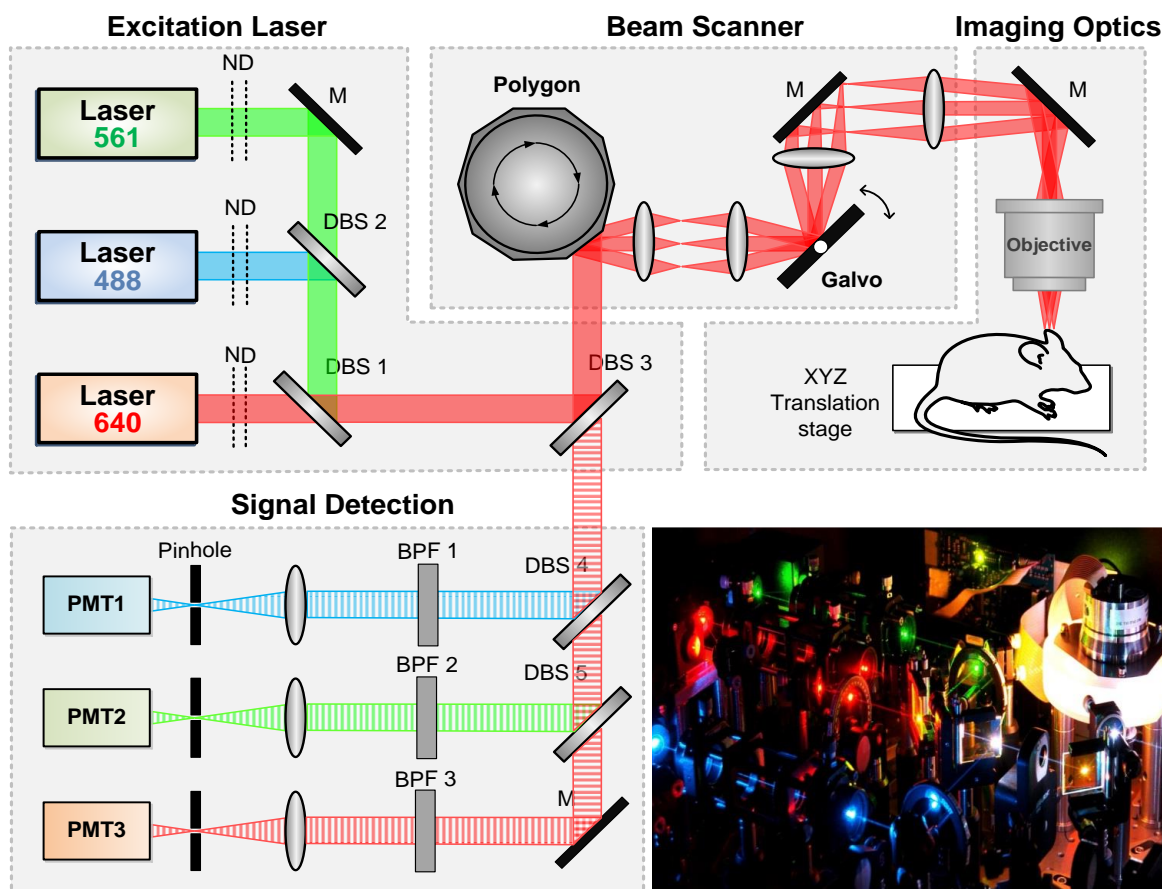
(1) Veilleux I et al., IEEE Journal of Selected Topics in Quantum Electronics 14(1), 10-18, 2008

(2) Kim P et al., Journal of biomedical optics 13(1), 010501, 2008

### Video-rate Laser Scanning Confocal microscope

- 30 frames (512x512 pixels) per second, 3-color fluorescence detection (GFP, RFP, NIR)
- Scanner consists of aluminum-coated polygonal mirror with 36 facets (X-axis fast scan) and silver-coated galvano mirror (Y-axis slow scan)
- Details of the system were described in following papers.

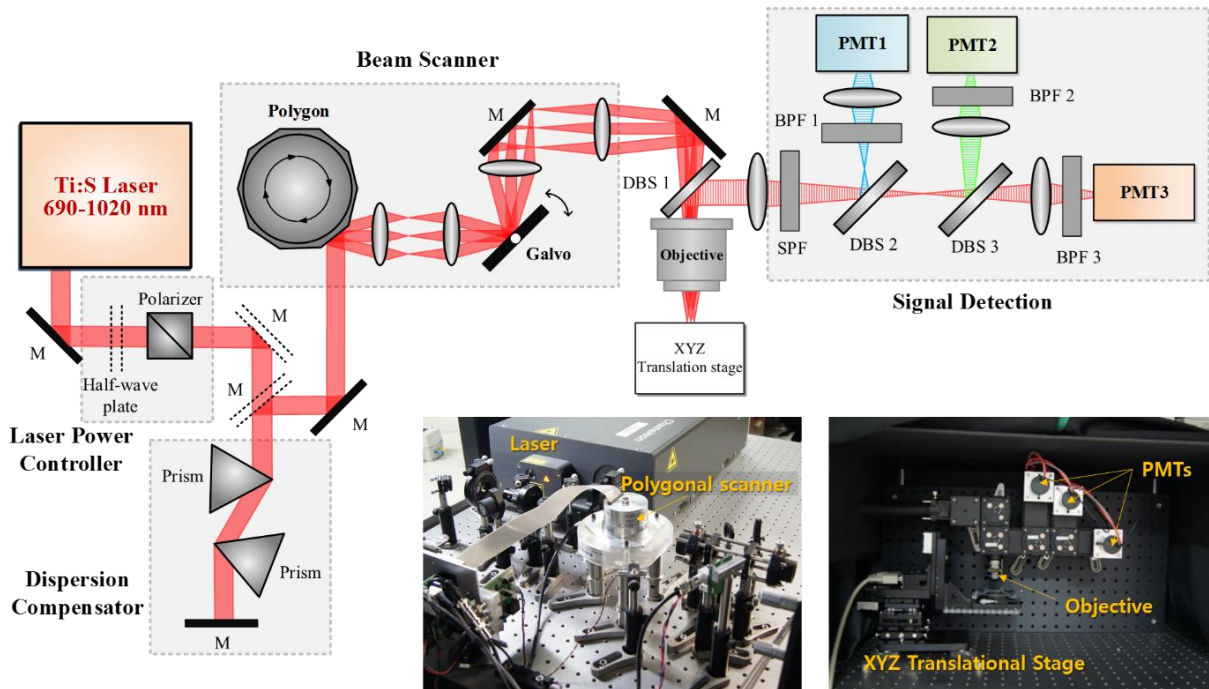
[\[Choe K et al., JBO 2013\]](#), [\[Choe K et al., JCI 2015\]](#)



DBS (dichroic beam splitter), BPF (band pass filter), M (mirror), L (lens), ND (neutral density filter)

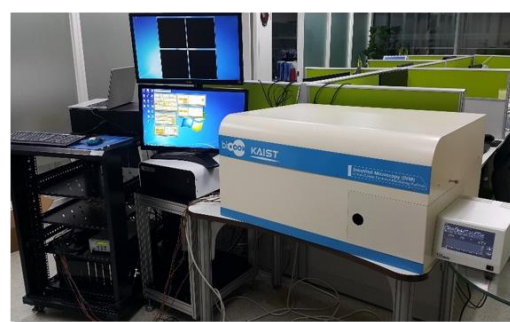
## Video-rate Laser Scanning Multi-photon microscope

- 30 frames (512 x 512 pixels) per second,
- 3 color-fluorescence (CFP, GFP/YFP, RFP) and SHG detection
- Scanner consists of an gold-coated polygonal mirror with 36 facets (X-axis fast scan) and a silver-coated galvano mirror (Y-axis slow scan)
- Laser power can be controlled by half-wave plate and polarizer
- A prism pair is adapted to the system for dispersion compensation



## Development of Prototypes of Intravital Microscopy System

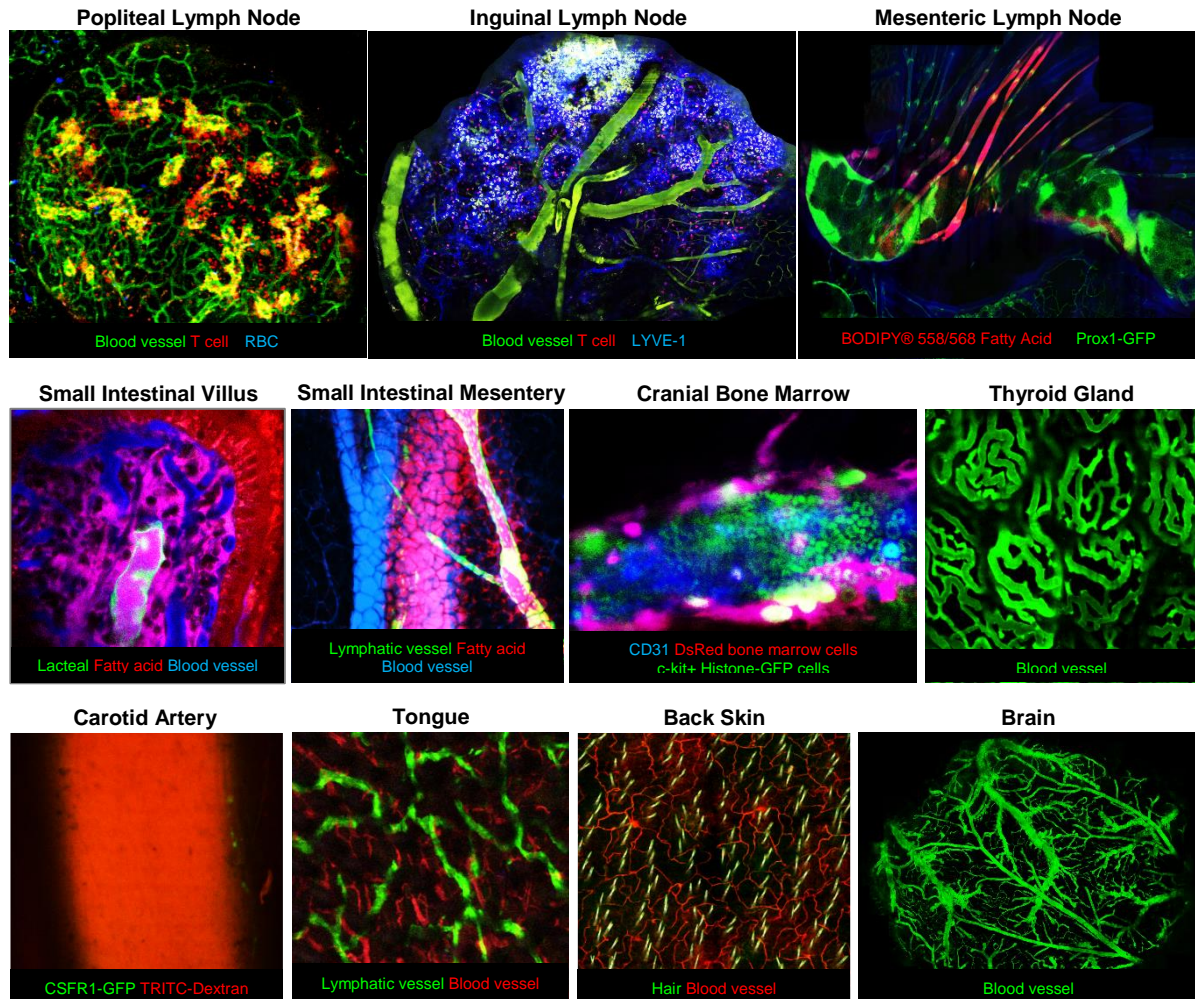
I designed and implemented the compact version of the video-rate laser scanning confocal microscope. The system consists of polygonal and galvo scanners, 4 color fiber lasers, motorized pinholes, XYZ-translational animal stage with body temperature controller and 4 color detectors. In addition, it is a combined design of optional two-photon microscope. Left and right figures show 1<sup>st</sup> and 2<sup>nd</sup> versions of the prototypes.





## Intravital microscopy of various murine organs

Lymph nodes (popliteal, inguinal and mesenteric), small intestine villi and mesentery, cranial bone marrow, thyroid gland, carotid artery, skin (ear and back), tongue and brain



## PRESENTATIONS

Choe K, Lee SY, Moon J, Song E, Ahn S, Kim P, "Intravital imaging of T and B cell transmigration across high endothelial venules in lymph node", **2017 The International Conference of the Korean Society for Molecular and Cellular Biology**, Seoul, Korea, Sep. 2017. (Oral Presentation)

Choe K, Lee SY, Moon J, Song E, Ahn S, Kim P, "Intravital imaging of T and B cell migration in abluminal side of high endothelial venules in mice lymph node", **2016 Annual Biophotonics Conference (ABC)**, Daejeon, Korea, Nov. 2016. (Oral Presentation)

Choe K, Song E, Lee SY, Ahn S, Moon J, Kim P, "Intravital imaging of T and B cell migration across high endothelial venules in lymph node", **Immunology 2016**, P971, Seattle, USA, May. 2016. (Poster)

Choe K, Song E, Ahn S, Song S, Koh GY, Kim P, "Intravital imaging of T and B cell trafficking across high endothelial venules in mice lymph node", **2015 Annual Biophotonics Conference (ABC)**, P, Seoul, Korea, Oct. 2015. (Poster)

Choe K, Jang JY, Park I, Kim Y, Ahn S, Park DY, Hong YK, Koh GY, Kim P, "Intravital imaging of lipids drainage in small intestinal lacteal", **2015 Annual Meeting of Vascular Science & Medicine Organization (VSMO)**, P12, Busan, Korea, Oct. 2015. (Poster)

Choe K, Song E, Ahn S, Kim P, "In Vivo Imaging of T and B Cell Trafficking Across High Endothelial Venules in Mice Lymph Node", **Optical Society of Korea (OSK) Summer Meeting '2015**, M1B-VI4, Jeju, Korea, Aug. 2015. (Oral Presentation)

Choe K, Song E, Ahn S, Song S, Koh GY, Kim P, "Intravital imaging of T and B cell trafficking across high endothelial venules in mice lymph node", **The 2014 Fall Conference of the Korean Association of Immunologists**, OP-4 and P-219, Seoul, Korea, Nov. 2014. (Oral and Poster Presentation)

Choe K, Jang JY, Park I, Hong YK, Koh GY, Kim P, "Intravital imaging of lipid absorption in small intestine", **Optical Society of Korea (OSK) Summer Meeting '2014**, W1D-VI2, Jeju, Korea, Aug. 2014. (Oral Presentation)

Choe K, Jang JY, Park I, Hong YK, Koh GY, Kim P, "In vivo imaging of lipid absorption in an individual intestinal villus", **US-Korea Conference (UKC) '2014**, San Francisco, USA, Aug. 2014. (Poster)

Choe K, Hwang Y, Seo H, Ahn J, Song E, Kim P, "Direct in vivo visualization of dynamic interaction between EC and lymphocytes in HEV of lymph node", **International Vascular Biology Meeting (IVBM) '2014**, P-291, Kyoto, Japan, Apr. 2014. (Poster)

Choe K, Jang JY, Park I, Hong YK, Koh GY, Kim P, "Intravital visualization of absorption and transport of lipid transport via intestinal lacteals", **International Vascular Biology Meeting (IVBM) '2014**, P-290, Kyoto, Japan, Apr. 2014. (Poster)

Choe K, Hwang Y, Seo H, Song E, Kim P, "Real-time in vivo imaging of circulating lymphocytes in high endothelial venules of lymph node", **SPIE Photonics West '2014**, 8944-14, San Francisco, USA, Feb. 2014. (Oral Presentation)

Choe K, Kim K, Hwang Y, Ahn J, Kim I, Kim P, "Intravital Imaging of Hematopoietic Stem Cells Engraftment and Differentiation", **Optical Society of Korea (OSK) Summer Meeting '2013**, F1B-V4, Yeosu, Korea, July. 2013. (Oral Presentation)

Choe K, Hwang Y, Seo H, Song E, Ahn J, Kim P, "In Vivo Visualization of Immunological Tissue by Real-time Laser Scanning Confocal Microscopy", **Conference on Institute of Control, Robotics and Systems (ICROS) '2013**, TB05-5, Changwon, Korea, May 23, 2013. (Oral Presentation)

Choe K, Hwang Y, Seo H, Song E, Kim P, "In Vivo Visualization of Circulating Lymphocytes in High Endothelial Venules of Lymph Node", **Korean Association of Immunologists Spring Meeting '2013**, OP-1 and P116, Chuncheon, Korea, Apr. 2013. (Oral and Poster Presentation)

Choe K, Hwang Y, Seo H, Kim P, "In Vivo Real-time Imaging of Circulating T Lymphocytes in High Endothelial Venules of Lymph Node," **Korean Society of Molecular and Cellular Biology Annual Meeting '2012**, Q-18, Seoul, Korea, Oct. 2012. (Poster)

Choe K, Hwang Y, Seo H, Kim P, "High Spatiotemporal Resolution Imaging of T cells in High Endothelial Venules of Mice Lymph Node," **Optical Society of Korea (OSK) Summer Meeting '2012**, W1C-VI2, Jeju, Korea, Aug. 2012. (Oral Presentation)

Choe K, Hwang Y, Kim P, "Real-time in vivo Imaging of Popliteal Lymph Node," **Optical Society of Korea (OSK) Summer Meeting '2011**, TP-VI12, Busan, Korea, Jul. 2011. (Poster)