

Cardiovascular Center

(Seoul National University Hospital)

The professors and doctors of the Cardiovascular Center at Seoul National University Hospital are committed to providing the highest level of care for patients with cardiovascular disease. We are continuously in search of new methods to better prevent, diagnose and treat various cardiovascular diseases through cutting edge basic and translational research.

SNUH boasts one of the largest and most diverse cardiovascular practices in the world. The physicians in the Division of Cardiology of the Department of Internal Medicine treat over 120,000 outpatients and care for 4000 inpatients annually. New diagnostic techniques, drugs and interventions are continuously being introduced into cardiology and vascular medicine. The expertise of the physicians in SNUH's many specialized areas enables the Cardiovascular Center to stay at the leading edge of change in cardiology and vascular medicine. The full time faculty members at SNUH Cardiovascular Center are very active in research from not only from the clinical side but also from basic research. We have a world class basic cardiovascular laboratory including but not limited to the cardiovascular stem cell laboratory and the cell signaling and vascular biology lab. In addition, clinical research is active in the fields of interventional cardiology, echocardiography and cardiovascular imaging and the electrophysiology laboratory.

SNUH Cardiovascular Center: Interventional Cardiology

Interventional cardiology at Seoul National University Hospital (SNUH) Cardiovascular Center is well known for its high patient volume as well as outstanding clinical research. It is one of the biggest cardiac catheterization laboratories in South Korea performing annually more than 3,000 cases of diagnostic angiography and 1000 cases of coronary intervention.

SNUH cardiovascular center is a global leader in "bench-to-bedside" research. Through strong cooperation with our basic research laboratory, our achievements in translational science have been remarkable. The basic study which showed that celecoxib retarded neointimal hyperplasia (Yang HM et al., *Circulation*, 2004) developed into a randomized controlled trial demonstrating the beneficial effect of celecoxib on restenosis after PCI with a Taxus stent (COREA-TAXUS trial, Koo BK et al., *Lancet*, 2007). With science and knowledge about EPCs (endothelial progenitor cells) we discovered (Hur J et al., *ATVB*, 2004, Yoon CH et al., *Circulation*, 2005), we recently developed a VE-cadherin antibody-coated EPC (endothelial progenitor cell)-capture stent (Lim WH et al., *ATVB*, 2011), and hopefully start a clinical trial soon.

Another field we have a strong advantage over any other in translational science is stem cell research. Based on the solid background of basic research on stem cells (Oh IY et al., *Blood*, 2007, Han JK et al., *Circulation*, 2008, Kim MS et al., *Circulation*, 2009), we are running MAGIC cell programs which utilize bone marrow-derived mononuclear cells for myocardial regeneration. These clinical trials have been published in top class-journals (Kang HJ et al., *Lancet*, 2004, Kang HJ et al., *Circulation*, 2006, Kang HJ et al., *EHJ*, 2012), and MAGIC cells are under development for the clinical application.

We are a leading group in cardiovascular clinical science as well. We have been playing a proactive role for several multicenter randomized controlled trials and registries such as HOST-ASSURE (2X2 factorial design, EES vs. ZES, DDAT vs. TAT) and EXCELLENT (2X2 factorial design, EES vs. SES, 6 month vs. 12 month DAT) trials. Further, we have a great interest in anti-platelet regimen and genetic determinants of clopidogrel responsiveness. These efforts have brought outstanding accomplishments in stent-related research (Park KW et al., *JACC*, 2011, Park JB et al., *EHJ*, 2012) and anti-platelets study (CILON-T trial, Suh JW et al., *JACC*, 2011, Gwon HC et al., *Circulation*, 2012).

Moreover, this is a world-class facility for the field of coronary imaging and physiology in terms of both research and clinical practice. Imaging and physiologic evaluation for the coronary artery disease has been adopted into our daily practice for more than 10 years. This activity has led to an important contribution to the field of coronary imaging and physiology (Koo BK et al., *JACC*, 2005, Koo BK et al., *EHJ*, 2008, Koo BK et al., *JACC Cardiovasc Interv.*, 2011). In addition to an academic achievement, our center has been acknowledged as the best Asian center for coronary physiology training.

Finally, we are actively adopting the newly developed interventional technology. Both types of TAVI (transcatheter aortic valve implantation) technology (i.e. Medtronic CoreValve[®], Edwards SAPIEN Valve[®]) for inoperable severe aortic stenosis and Renal Denervation technology for refractory hypertension are being performed. OCT (optical coherence tomography) will be introduced soon, and LAA (Left Atrial Appendage) is under preparation.

We proudly introduce our international visiting scholar program. Every year, several doctors from all over the world have participated in our program. After visiting our

facility from several weeks to several months, the participants came back to their institutes with knowledge about not only basic principles and concepts, but also essential techniques and tools of coronary / endovascular interventions. We hope that this international visiting fellowship program will be an informative and educational experience to you as well.

International Visiting Fellowship Program

2 Weeks Program

Overview Suggested Level of Attendees: Beginner and above,

Coronary Intervention / Peripheral Intervention / Other Endovascular Intervention (e.g. TAVI, EVAR, ASD closing, Renal Denervation),

Research activity (IGR),

Scientific conference (ENCORE SEOUL, once a year)

Schedule Every weekday from 8A to 6P

Educational Contents

- ① Coronary Intervention: Every weekday from 8A to 6P
 - Interaction with experienced operators
 - Basic concepts / principles of coronary intervention as well as detailed practical techniques
 - CTO (chronic total occlusion) intervention: 1-2 cases / week (mainly on Monday, Wednesday)
 - Invasive diagnostic modalities:
 - FFR (fractional flow reserve): on-site teaching, from basic principles to clinical applications (mainly on Friday)
 - IVUS (intravascular ultrasound)
 - OCT (optical coherence tomography)

② Peripheral Intervention: Mainly on Tuesday or Friday

- Basic concepts / principles of peripheral intervention as well as detailed practical techniques
- Iliac, SFA (superficial femoral artery), BTK (below the knee) interventions

③ Other Endovascular Interventions: Mainly on Wednesday

- TAVI (Transcatheter Aortic Valve Implantation):
 - Performing both types of TAVIs: Medtronic CoreValve[®], Edwards SAPIEN Valve[®]
- EVAR (Endovascular Aneurysm Repair):
- Device closure: ASD (Atrial Septal Defect) and PDA closure
- Renal Denervation:
 - Medtronic Symplicity RDN system[®]

④ Interventional Grand Round (Interventional Research Meeting)

- Sunday, 9A30, room 9321 (Once a month)
- Randomized controlled trials, Multicenter registries
- Progress reports of the research projects by individual investigators
- Active discussion among participants

⑤ International Conference: ENCORE SEOUL

- Every year, hosted by a 4-hospital consortium in South Korea (**Seoul National University Hospital**, Samsung Medical Center, Severance Hospital, Gil Hospital)
- Live demonstrations for coronary intervention, endovascular intervention
- Didactic lectures and abstract presentations
 - ENCORE SEOUL 2013: August, 28th - 30th Venue: COEX, Seoul, South Korea

Faculty List



Hyo-Soo Kim, MD, PhD

Professor



Bon-Kwon Koo, MD, PhD

Associate Professor



Hyun-Jae Kang, MD, PhD

Associate Professor



Hae-Young Lee, MD, PhD

Associate Professor



Kyung-Woo Park, MD, PhD

Associate Professor



Han-Mo Yang, MD, PhD

Assistant Professor



Jung-Kyu Han, MD, PhD

Assistant Professor

Introduction of SNUH Cardiovascular Imaging Program

The SNUH Cardiovascular Imaging Program was formed to introduce echocardiography into clinical practice in 1978 and the scope and modalities have been expanding ever since its formation. The echocardiography laboratory now operates over 27 thousand high-quality echocardiography examinations annually in 2012. Although the Cardiovascular Imaging Program at SNUH roots from a firm base in echocardiography, we also perform thousands of magnetic resonance imaging (MRI) and cardiac computed tomography (CT), positron emission tomography (PET), and single photon emission tomography (SPECT). These imaging results are analyzed in collaboration with other departments, such as the Department of Radiology and the Department of Nuclear Medicine. Each case of our patient undergoes a comprehensive quantitative study through the most up-to-date scanners and is analyzed with the most appropriate software. A detailed report is generated and sent to each patient's referring physician. The SNUH Cardiovascular Imaging Center is well-equipped with the imaging technologies and experiences needed for leading-edge cardiovascular care. In addition to diagnostic services, cardiac ultrasound imaging is also used in guiding various interventional and surgical procedures, such as Transcatheter Aortic Valve Implantation (TAVI) for aortic stenosis and atrial septal defect (ASD) device closures. The laboratory has pioneered the development of many innovative ultrasound techniques and their clinical applications. The laboratory is also a well-recognized educational center.

The SNUH Cardiovascular Imaging Program is also famous for high-quality clinical research. Since its publication of the monumental paper on diastolic function by Dr. Dae-Won Sohn (Sohn DW et al. Assessment of mitral annulus velocity by Doppler tissue

imaging in the evaluation of left ventricular diastolic function. *J Am Coll Cardiol* 1997;30(2):474-80), the laboratory has published over 100 papers in high-quality SCI journals, including *Circulation*, *Journal of the American College of Cardiology* and *European Heart Journal*. The scope of the papers range from basic hemodynamics to outcome studies in various heart diseases, providing major advances into the echocardiographic and Doppler assessment of myocardial, valvular, congenital, and ischemic heart disease. The laboratory has a long tradition of commitment to teaching in echocardiography, and members of the laboratory faculty are involved in educational seminars throughout the world. The lab provides expeditious scheduling for all state-of-the-art services, including transthoracic echocardiography, transesophageal echo, and exercise and pharmacologic stress echocardiography. The laboratory has led the way in providing a unique array of advanced services, including three-dimensional cardiac imaging for special evaluation of cardiac function, valvular, and congenital heart disease; stress echocardiography for evaluation of ischemia, and cardiac hemodynamics; myocardial contrast imaging for evaluation of ischemic heart disease and cardiac function; and assessment of cardiac dyssynchrony in patients who are being evaluated for cardiac resynchronization therapy.

The animal laboratory in the SNUH Cardiovascular Imaging Program goes side by side with the clinical problems encountered in daily clinical services. A problem that should be looked into mechanistically or a problem that needs new treatment plans are also verified by using various imaging techniques in the animal laboratory. A specialized echocardiography machine is located at the animal laboratory together with a miniaturized cardiac catheterization device for small animals, such as rats or mice. The

animal laboratory is continuously expanding and also integrates various imaging modalities, such as high-resolution cardiac MR (9.4T) and novel target tracers developed for PET and SPECT together with the Department of Nuclear Medicine.

Education

- Multimodality basic and advanced imaging programs
- On-site and distance learning tools
- In and out-patients care
- Basic hemodynamic research

The SNUH cardiovascular imaging program considers education to be critical in improving the practice of medicine and, therefore, patient care. All faculty members are actively involved in both formal and informal educational programs.

Routine time tables

Mon	Tue	Wed	Thu	Fri
9am Echo-room	9am Echo-room	9am Outpatient clinic	9am Cath-room or outpatient clinic or ER echo-room	9am Inpatient clinic Consultation services
principles of TTE & TEE	principle of Doppler echoCG with auscultation practice		EchoCG In interventions, joint education . or If no schedule. outpatient clinic or ER echoCG	Animal lab

Our Faculty Physician Leaders



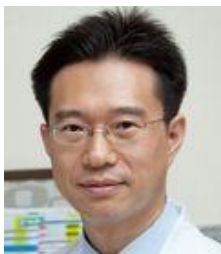
Dr. Dae-Won Sohn is a Professor at Seoul National University Hospital and is also serving as the director of the Cardiovascular Imaging Program of the same institution. Dr. Sohn obtained his medical degree from Seoul National University, College of Medicine in 1980 and received residency and fellowship training from Seoul National University Hospital. He has been appointed as a faculty since 1990 and has also served as the Director of the Cardiovascular Center during 2007 to 2012.

A member of the American Society of Echocardiography and the American College of Cardiology, he also served as the chairman of the Korean Society of Echocardiography. He has published and co-authored over 150 peer-reviewed publications, including the monumental paper on diastolic function (Sohn DW et al. Assessment of mitral annulus velocity by Doppler tissue imaging in the evaluation of left ventricular diastolic function. *J Am Coll Cardiol* 1997;30(2):474-80), which has helped clinicians to assess diastolic function in many ways.



Dr. Yong-Jin Kim is an Associate Professor of Seoul National University Hospital and is also serving as the Associate Dean for Vision 2017 at Seoul National University College of Medicine. Dr. Kim obtained his medical degree from Seoul National University, College of Medicine in 1992 and received residency and fellowship training from Seoul National University Hospital. He has been appointed as a faculty since 2002 and currently serves as the Director of the Noninvasive Cardiovascular Testing Laboratory.

He is a member of and also is the chairman of the Board of General Affairs of the Korean Society of Echocardiography. He has published and co-authored over 100 peer-reviewed publications, including the highly-cited paper on tricuspid regurgitation (Kim HK & Kim YJ et al. Impact of the maze operation combined with left-sided valve surgery on the change in tricuspid regurgitation over time. *Circulation* 2005;112(9 Suppl):I14-9).



Dr. Hyung-Kwan Kim is the Assistant Professor of Seoul National University Hospital. Dr. Kim obtained his medical degree from Seoul National University, College of Medicine in 1998 and received residency and fellowship training from Seoul National University Hospital. He has been appointed as a faculty since 2008.

He is currently an editorial board of the American Society of Echocardiography since 2009 and also a full-time member of the Korean Society of Echocardiography. He has received several meritorious awards, such as the Young Investigator Award of the Korean Society of Cardiology. He has published and co-authored several peer-reviewed publications. The main topics of his research are speckle tracking imaging, hypertrophic cardiomyopathy, and pulmonary hypertension.



Dr. Seung-Pyo Lee is an Assistant Professor of Seoul National University Hospital. Dr. Lee obtained his medical degree from Seoul National University, College of Medicine in 2001 and received residency and

fellowship training from Seoul National University Hospital. He has been appointed as a faculty since 2011.

He is currently an editorial board of the Korean Society of Echocardiography. He has received several meritorious awards, such as the Clinical Award of the Korean Society of Cardiology. He has published and co-authored several peer-reviewed publications. He aims to dissect various cardiac diseases with multi-modality imaging approaches and is trying to integrate these information in understanding the process of ventricular remodeling.

1. Introduction of SNUH Cardiac Electrophysiology Laboratory

Cardiac Electrophysiology Laboratory at Seoul National University

After opening its doors in 1992, the Cardiac Electrophysiology (EP) Laboratory at Seoul National University Hospital (SNUH) has grown into one of the most experienced laboratories in the country. Our physicians provide advanced diagnosis and treatment methods utilizing the most advanced equipment and techniques. In addition to a strong clinical practice, we undergo various basic researches and publish numerous SCI papers, leading to scientific advancement in the field of electrophysiology.

Advanced capabilities of SNUH EP Laboratory include:

Clinical Work

Office consultation for evaluation and management of arrhythmias

Catheter ablation of tachyarrhythmia, such as PSVT, WPW syndrome, atrial tachycardia, atrial flutter, atrial fibrillation, ventricular tachyarrhythmia using 3-D electroanatomical mapping system

Diagnostic tests: Holter monitoring, Tilt table testing, Treadmill test

Device Therapy: cardiac pacemaker; cardiac resynchronization therapy (CRT); implantable cardioverter defibrillator (ICD), implantable loop recorder

Electrical cardioversion

Clinical meeting

EP research meeting

EGM conference

Basic Research Area

Autonomic nerve and arrhythmias

Mechanism of atrial fibrillation and development of novel therapeutic option

Arrhythmia model creation

Animal studies (arrhythmia canine model)

Clinical Research Area

Atrial fibrillation (AF): ablation, pharmacological study, stroke risk evaluation

Many phase III and IV clinical trials related to AF, i.e. ARTEMIS, PALLAS, GARFIELD, RHYTHM-AF, MK6621 (Vernakalant) etc..

2. Short-term visiting fellowship program

The visiting fellowship program is an integrated educational course which will provide trainees with a structured concept of cardiac arrhythmias, and experience in the diagnosis and management of arrhythmia patients within a few weeks. The trainees will be able to participate in clinical practice, conferences, and have opportunities to assist in cardiac interventions if competent.

The program consists of a 2 week course, which can be extended into 4 weeks at the trainee's wish. Trainees will participate in the following educational programs, which can be tailored to focus more on a specific specialty. Under the supervision of highly-experienced physicians, trainees will have opportunities to diagnose and manage various cardiac arrhythmias.

① Electrophysiology study (EPS) and Radiofrequency catheter ablation (RFCA)

- Schedule: Mon (PM), Tue (AM,PM), Wed (AM,PM), Fri (AM,PM)
- Observation and participation of about 20 cases / 2 weeks
 - : RFCA ablation using 3D-mapping system
 - : PSVT (AVRT, AVNRT), AT, AF, VT etc.

② Device therapy

- Schedule: Mon (PM), Tue (AM,PM), Wed (AM,PM), Fri (AM,PM)
- Observation of about 10 cases / 2 weeks
 - : Pacemaker, ICD, CRT implantation/revision/removal
- Learning about device checking system

③ EGM conference

- Schedule: Friday 7A30~8A00
- Participating 2 times 2 weeks
 - : Discussion on selected cardiac arrhythmia cases and updated publications, decision making of difficult cases
 - : Presentation of trainee about what the trainee learns and feedback from the faculties at their second week.

④ Electrical cardioversion

- Schedule: Mon (AM), Tue (AM), Wed (AM), Fri (AM), Sat (AM)
- Observation of about 1-2 cases in first week, Participation of about 1-2 cases in second week

⑤ Other schedule

- Visit and observe the animal study
- Conversation with medical students
- Ward rounding
- Patients education

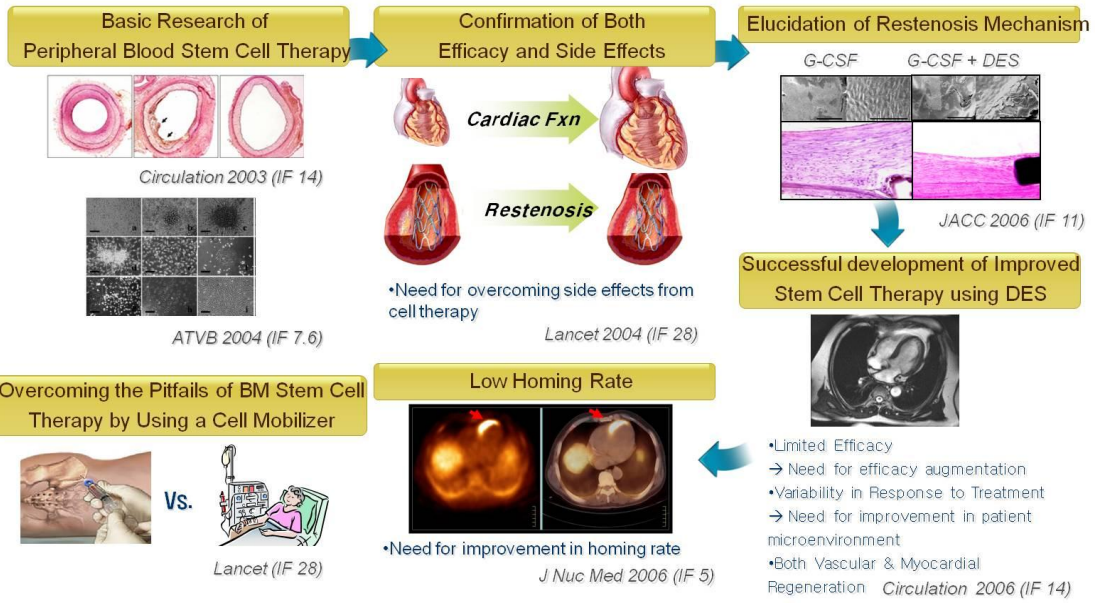
Training program time table

Mon	Tue	Wed	Thu	Fri	Sat
8A30 Introduction of EP lab.	9A Electrical cardioversion 8A30 EP&RFCA	8A30 EP&RFCA	9A Electrical cardioversion 10A Device therapy	7:30am EGM conference 8A30 Device therapy	9A Electrical cardioversion
1P Introduction of device therapy	1P EP&RFCA	1P Learning about device therapy	1P Animal study	1P Optional schedule	
Mon	Tue	Wed	Thu	Fri	Sat
8A30 EP&RFCA	9A Electrical cardioversion 8A30 EP&RFCA	8A30 EP&RFCA 10A Device therapy	9A Electrical cardioversion 10am Device therapy	7:30am EGM conference 8A30 Device therapy	
1P Introduction of 3-D mapping	1P EP&RFCA	1P Ward rounding Patients education	1P Animal study	1P Optional schedule	

Introduction of SNUH Cardiovascular Stem Cell Laboratory

The Stem cell & Cardiovascular laboratory in Seoul National University Hospital is one of the leading academic research groups in Korea. The goal of the laboratory is to coordinate clinical and basic cardiovascular research: "from bench to bedside" or "from bedside to bench". We combine the expertise and experience of a leading clinical cardiovascular team with state of the art facilities and the capabilities of a highly academic and innovative research team.

Research in the laboratory is focused on three fields. One is the stem cell biology. We are performing various experiments to investigate the biology and to elucidate the exact characteristics of embryonic stem cells, induced pluripotent stem cells, mesenchymal stem cells and hematopoietic stem cells. The second field is translational research for clinical application of cell therapy and for development of new strategy to enhance the therapeutic efficacy of stem cells is also being performed. The third field is vascular biology and cell signaling. We are attempting to dissect the cell signals involved in angiogenesis and myocardial regeneration. In addition, the vascular pathophysiology of atherosclerosis and neointimal hyperplasia after coronary intervention is also of great interest. We are studying various target molecules and drugs that can reduce atherosclerosis and neointimal growth after vascular injury. Our another major field is clinical trials, which comprehensively bring together many of the valuable insights gathered from basic and pre-clinical research. One of the major achievements of our laboratory is the MAGIC Cell Trial, which was one of the pioneering clinical trials in cell therapy involving gathering of peripheral blood progenitor cells to be reintroduced via the coronary circulation.



Educational contents and Curriculum

1. Lab tour:



- Includes the introduction of diverse machines such as flowcytometry, FACS sorting machine, confocal microscopy, and real time-PCR.
- Visit our GMP facility for cell culture



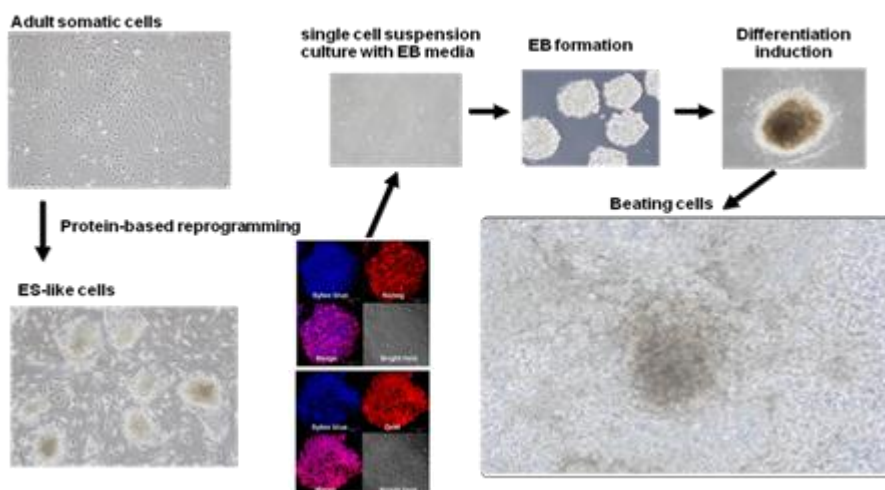
2. Research meeting

- Tuesday, 6PM~11PM
- Discussion of a variety of ongoing projects
- Study design, methods, and interpretation of results

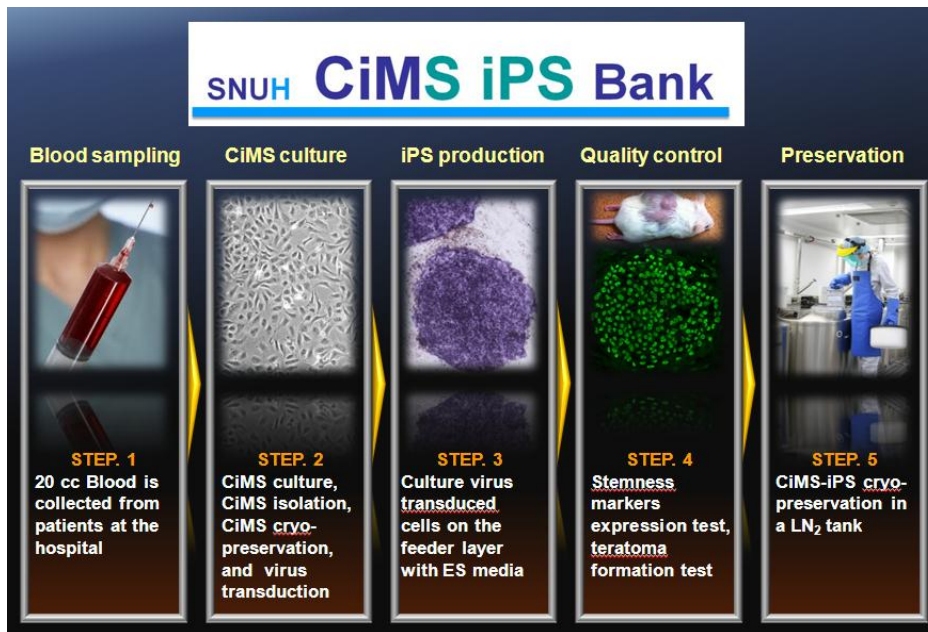
3. Orientation for Stem Cell Biology (Lecture)

- 1) Isolation and culture of adult stem cells from human peripheral blood
- 2) Characteristics and application of EPCs (endothelial progenitor cells)
- 3) Culture Techniques for ES cells
- 4) Generation of iPS cells (human and mice)
 - a. Lenti virus
 - b. Protein
 - c. Sendai virus
 - d. Modified RNA

Reprogramming/dedifferentiation at SNUH



- 5) Culture Techniques for iPS cells
- 6) Characterization of iPS cells (differentiation into three-germ layers, teratoma formation)
- 7) Application of iPS cell into clinical setting
 - introduction of SNUH iPS bank

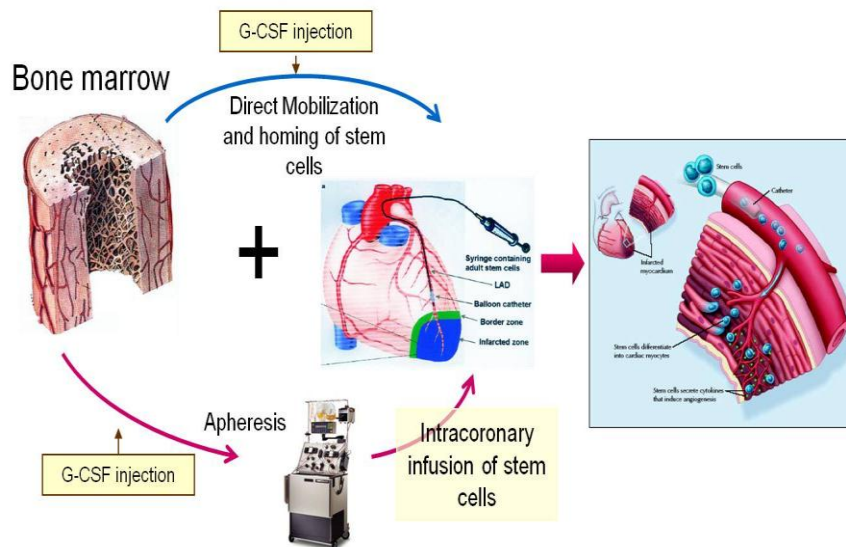


4. Orientation for cardiovascular stem cell therapy (Lecture)

- Introduction of MAGIC Cell program
- Results of MAGIC Cell trials
- Future trials

MAGIC Cell program

(Myocardial Regeneration in Acute and old myocardial infarction with G-CSF mobilization and Intra-Coronary Stem Cell Infusion)



5. Orientation for preclinical animal models in cardiovascular fields(Lecture)

1) Mice

- a. Myocardial infarction model
- b. Femoral artery injury model
- c. TAC model

2) Rat

- a. Carotid artery injury model
- b. Myocardial infarction model
- c. Hindlimb ischemia model

3) Rabbit

- a. Iliac artery stent implantation model
- b. Balloon injury model

4) Dog

- a. Arrhythmia study model

