世界华人生物医学工程协会
World Association for Chinese Biomedical Engineers
# Newsletter

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MAK, Arthur FT (2009-2011)
SHUNG, K. Kirk (2011-2013)

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*The WACBE Newsletter welcomes letters to the Editor (info@wacbe.org). All material submitted for consideration is subject to editing and condensation. Advertising rates for display ads are available from the WACBE office and by visiting www.wacbe.org.*

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## MESSAGE FROM THE PRESIDENT

***Zong-Ming LI***

It is a pleasure to present to you, my fellow WACBE members, this issue of our Newsletter, thanks to the work of our Newsletter Editor, Dr. Siew-Lok Toh, and many contributors. As you read through this newsletter, I trust you will be pleased with the progress that our organization has made in many areas.

One of our highlights is the 6th WACBE World Congress on Bioengineering, which took place during the summer of 2013 in Beijing. Our local congress organizers, Professors Yubo Fan, Deyu Li and Cheng-Kung Cheng, along with their team, did outstanding work putting together an enriching scientific program and culturally intimate socials. Those who were able to attend spent productive time learning and exchanging ideas at plenary lectures, keynote talks, podium presentations and poster sessions, which covered a broad spectrum of topics in biomedical engineering. We were all warmly welcomed by the host and the student volunteers, many of whom skipped their summer vacations to prepare for the event and make sure that all of details were taken care of for the congress to run smoothly. We applaud their commitment and work that helped make the congress a grand success. Those of you who attended the congress brought ideas, questions, greetings, handshakes, and late dinner discussions, contributing to our organization and field in special ways. I enjoyed interacting with many of you in person and wish I had the opportunity to speak with each of you. For our fellow members who could not travel to the congress, we have assembled the keynote abstracts in this newsletter to provide you with the opportunity to catch up on many hot topics in biomedical engineering. If you missed the opening ceremony, I invite you to read my speech (see pages 5-6). I want to share with all WACBE members the enthusiasm that our council and I have about keeping our momentum and continuing to move our association forward.

I am very proud to work with distinguished members of the new WACBE Council (2013-2015), who represent remarkable expertise in biomedical engineering from geographic regions of Hong Kong, Mainland China, Singapore, Taiwan, and the USA. Professor Kirk Shung has finished his two-year (2011-2013) term as the President, but will continue to serve as the Immediate Past-President for important functions including award and election processes. Professor Yubo Fan is our President-Elect who will work closely with me and then lead our organization in two years. Professor Ming Zhang continues to serve as the Secretary for his four-year term and will be succeeded by Professor Fong-Chin Su (Secretary-Elect) in 2015. Professor Guoan Li steps up as the Treasurer and Professor Feng-Huei lines up as the Treasurer-Elect. We also have six Councilors including three incumbents, Professors Helen Lu, Qiushi Ren, and Cheng Zhu and three newly elected, Professors Cheng-Kung Cheng, William Lu, and Yong-Ping Zheng. In addition, Professor James Goh serves as the Chair of the next WACBE Congress, which is much anticipated in 2015 in Southeast Asia. For our communications, Professor Siew-Lok Toh takes the responsibility as our new Newsletter Editor. Recently, we created a new position to represent the student members and Yan


**WACBE COUNCIL MEMBERS:**
**From Left: ZHANG Ming, ZHENG Yongping, SU Fong-Chin, GOH James, SHUNG Kirk, WOO Savio, LI Zong-Ming, LIANG Zhipei, LIN Feng-Huei, FAN Yubo**

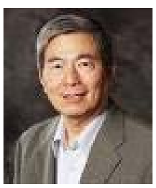
Wang was appointed as the first Student Representative. Finally, Professor Savio Woo is our founding president and is always with us to provide guidance.

To lead is to serve! On behalf of all of us in the WACBE Council, we want to listen to your suggestions and needs. During our recent council meeting, we discussed many ideas and initiatives including affiliated journals, societal awards, membership expansion, mentoring program, sponsorship, networking, and future congresses. WACBE has started working on societal journals to benefit our members to publish our best research work. Currently, we are discussing with the Executive Editor-in-Chief, Professor Jia-Jin Chen, about an affiliation with their well-established Journal of Medical and Biological Engineering. Professor Yubo Fan, with the China Biomedical Engineering Society, is also exploring a WACBE journal to accommodate the rapid increase of publications in Mainland China. To recognize individuals for their achievement and contribution to our society and field, we are establishing societal honors such as congress lecturers, fellowships, and student awards. To expand our membership, we want to reach out to worldwide Chinese biomedical engineers to join our association as members; we ask many of you as distinguished scientists to consider joining our association as Life Members, as way of giving back to our profession. Promoting the young generation of biomedical engineers is a high priority of WACBE, so we want to develop mentoring programs in our global community to help those up-and-coming bioengineers connect with senior and seasoned investigators for research ideas and career advice. The field of biomedical engineering is diverse and broad; we plan to facilitate the formation of WACBE Bioengineering Interest Groups (BIGs), which create opportunities for networking and leadership roles in many specialty areas. Your active participation is critical to the development of these initiatives and the growth of our association; please get involved!

In warm appreciation on behalf of the WACBE, we extend our best wishes to you and your families for a wonderful holiday season and a new year filled with joy and prosperity! 谨贺新年！

## MESSAGE FROM THE PAST PRESIDENT

***K. Kirk SHUNG***



It is a great pleasure for me as the immediate past president of the Society to write a welcome message for this issue of WACBE newsletter. WACBE is a young society initiated in 2002 following the first WACBE congress held in Taipei, Taiwan. Its purpose is to foster communications and interactions of Chinese biomedical engineers working around the world. Subsequently 5 more congresses were held respectively in Beijing, China, in 2004, Bangkok, Thailand in 2007, Hong Kong, in 2009, Tainan, Taiwan, in 2011 and most recently Beijing, China again in August, 2013. The attendance grew from one hundred to more than 400. In these meetings in addition to well-known Chinese scholars from around the world giving invited lectures, young investigators, and students are encouraged to present their work in the form of oral and poster papers. Starting from 2011, Dr. Savio Woo, University of Pittsburgh, the founding president has graciously provided travel support to allow several students to attend the meeting.

The governing body of the society is the WACBE council consisting of at present 16 members including the founding president, immediate past president, president, president-elect, secretary, secretary-elect, treasurer, treasurer-elect, newsletter editor, and 6 councilors. A council meeting is regularly held along with the WACBE congress. Informal council meetings are also held from time to time to discuss matters of relevance to the society and congress. Young blood is needed for these positions in generating new ideas and advancing society agenda. There are various categories of memberships, ranging from student member, regular member to life member. Only life members are paying members. There are currently approximately 60 life members in the society who pay a lump sum of US$500 when joining the society. Corporate sponsorship is also welcome. Company logo will be prominently displayed at the society website and in conference brochures. In case that you are interested joining the society, being considered for council membership or sponsoring WACBE, please contact Dr. Ming Zhang (ming.zhang@polyu.edu.hk), the secretary of WACBE. More information including the current roster of the governing body can be found at our website: WACBE.org.

One idea that is being currently pursued is to create a distinguished lectureship at the annual congress in honor of our founding president, Dr. Savio Woo. A prominent scientist will be invited to give this lecture following the opening ceremony. In addition to a token honorarium, the invitee's travel and lodging expenses will be covered by the conference. Any suggestions and comments in how to raise the funds to launch this initiative are welcome from the readers. Preferably an endowment can be garnered from corporate or individual donors.

The next congress to be held in 2015 will be chaired by Dr. James Goh at National University of Singapore. An exciting program is being organized. We are soliciting input on technical sessions and the venue. Interested parties should contact Dr. Goh at "biegohj@nus.edu.sg".

Finally I would like to say that WACBE is a totally voluntary organization. Grass root participation is extremely important to make it successful. I welcome you to join WACBE to become part of a vibrant society and better yet to attend our congress in 2015.

## REPORT FROM THE SECRETARY

***Ming ZHANG***

Our WACBE has been fast growing. The registered members are close to 600, including about 330 regular members, 180 student members, and 63 life members. The geographic distribution of members is comprised of China 320, Taiwan 80, Hong Kong 63, USA 72, Singapore 24, and others from UK, Canada, Australia and Japan.

If you wish to join WACBE, please download the application form from our website http://www.wacbe.org/ (tick JOIN at the top right hand corner). Also you may like to join as a life member. Life membership comes with benefits such as reduced congress registration fee, higher priority for Congress invited keynotes, eligibility for council member election and WACBE Fellows.

## REPORT FROM THE TREASURER

Guoan LI

As WACBE continues to grow, it becomes necessary to build various channels to secure sufficient funds to support various activities of the Society, such as bi-annual conference, student travel fellowship, and distinguished guest speakers. Since WACBE newsletters are distributed among thousands of WACBE members all over the world, we will publish biomedical related advertisements in WACBE newsletters with appropriate advertising rates. In addition, we will also accept corporate members with 3 different levels of membership. We hope WACBE will bridge the biomedical science research and the fast growing biomedical industries.

**WACBE Electronic Newsletter Advertising Rates (2014)**

The WACBE Newsletter is distributed among over 1000 members of the Society in December each year.

Rates for the upcoming year are shown in Table 1. Please supply artwork in electronic format to Toh Siew Lok (bietohsl@nus.edu.sg). Submissions could be in black and white or grayscale or in color. PDF is the preferred file format. Ads are billed upon publication. Contact us for information on 10% discounts for bulk advertisement purchases, including multiple ads in the same issue.

**WACBE Corporate Members**

**GOLD MEMBERS:**

- Yearly fee is $3,000.
- Identification on the WACBE Home Page as a Gold Member with a home page link.
- One time use of email membership list.
- One-page advertisements in the WACBE *Newsletter*.
- At the bi-yearly WACBE meeting: (1) 50% discount towards exhibition fee ($1000 max discount). (2) Two free registrations. (3) Lunch time 20 minute symposium; "How it works". (4) One free 1/2-page advertisement in the *Program* of the WACBE meeting. (5) First choice of exhibition locations.

**SILVER MEMBERS**

- Yearly fee is $2,000.
- Identification on the WACBE Home Page as a Silver Member with a home page link.
- One-page advertisement in the WACBE *Newsletter*.
- At the bi-yearly WACBE meeting: (1) 25% discount toward exhibition fee ($500 max discount). (2) One free registration. (3) One free 1/4-page advertisement in the *Program* of the WACBE meeting. (4) Second choice of exhibition locations.

**BRONZE MEMBERS**

- Yearly fee is $1,000.
- Identification on the WACBE Home Page as a Bronze Member with a home page link.
- One-page advertisement in the WACBE *Newsletter*.
- At the bi-yearly WACBE meeting: (1) Listed as a Bronze Member in the *Program* of the WACBE meeting. (2) Third choice of exhibition locations.

| **Ad Size** | **Ad Dimensions** (W x H in inches) | **Rate per Issue** |
|---|---|---|
| Quarter Page | 3 x 4 | $200 |
| Half Page | 7 x 4 | $300 |
| Full Page | 7 x 9 | $500 |

Table 1: Advertising Rates (2014)

## REPORT FROM STUDENT REPRESENTATIVE

**Yan WANG**, *The Hong Kong Polytechnic University*

Student representative is an appointed position by WACBE council. The main duties for this position are to link between WACBE Council and student members, including:

- To deliver information of WACBE society to student members.
- To collect suggestions or needs of students to council members.
- To provide student members with information for their professional and career development, including study/research position or opportunities application.
- To organize student activities.
- To collect and inform students other BME related conferences and workshops.

Communication platforms have been established as below.

- Members can log into WACBE account to update your profile and get newsletters of WACBE through the link: *http://www.wacbe.org/*
  - WACBE aim to promote new generation of BME. Students are welcome to connect with seasoned investigators for research ideas and communicate with senior professors for career advice.
  - Membership database is important resource for students. It can be accessed by ***advanced search*** function. Students can designate members by matching search criteria.
  - Keynote reports during WACBE congress will be available. Students can download if interested. Any specific questions, you can directly contact speakers by email.
- Students can apply to join the QQ Group Number: 331044664 for real-time group or individual chat with all the members in. Everyone can get and is welcome to offer information on research problems, travel information or any funny experiences.
- A new website *http://page.renren.com/601817517?id=601817517* was opened to deliver information of WACBE and BME-related events. All BME related information will be presented. Platforms are designated to serve for student nevertheless open to everyone who is interested in biomedical engineering. All are welcome to share research or travel exp*erience* on this platform.

There will be administrators, either volunteer or recommended, in each region. Regions are listed as below:

- Mainland China
- Hong Kong and Macau
- Taiwan
- United States of America
- Europe
- Others

If student members have any suggestions or enquiry on (no limited to) research, career or congress organization, please feel free to discuss on our platform or email to Yan WANG via 11901968r@connect.polyu.hk.


## REPORT ON THE 6TH WACBE WORLD CONGRESS ON BIOENGINEERING

The 6th WACBE World Congress on Bioengineering was successfully held in Beihang University, Beijing, China, on August 5-8, 2013. The congress covered a wide variety of areas in bioengineering including biomechanics, biomaterial, rehabilitation, tissue engineering, biomolecular engineering, biomedical image, biosensor, etc., and offered an interdisciplinary platform for bioengineers to share and exchange experiences, suggestions and opinions. Over 400 participants around the world gathered in Beihang University for 4 days of scientific communication.

We gratefully invited Prof. Shu Chien (University of California San Diego), Prof. Savio Woo (University of Pittsburgh), Prof. Chien Ho (Carnegie Mellon University), Prof. Kam Leong (Duke University), and Prof. Depei Liu (Chinese Academy of Medical Sciences) to give plenary speeches on the essential themes in Bioengineering. We also gratefully invited 38 experts to give 20 invited keynote and 18 session keynote speeches in the congress.

The congress totally received 327 abstract, and organized 18 oral sessions and 11 poster sessions. Two special forums were highlighted on the program, one on biomedical education and one on biomedical industry, where educational experts and directors from famous BME companies in China, respectively, were invited to share their valuable views and opinions with congress attendees. In the congress, three people won Savio & Pattie Woo Travelling Fellowship, and six people won Young Investigator's Awards.

We are thankful to the WACBE Council, who offers us the opportunity and guidance for organizing the congress. We are also thankful to the sponsors and exhibitors for their great support of the congress. Finally, we appreciate all participants for the wonderful presentation and sharing ideas and expertise.

**Yubo Fan, Ph.D**
**Congress Chairman, WACBE 2013**

## PRESIDENTIAL ADDRESS

ZONG-MING LI, PHD
CLEVELAND CLINIC, USA
WACBE PRESIDENT

AT THE OPENING CEREMONY OF
The 6th WACBE WORLD CONGRESS
ON BIOENGINEERING
AUGUST 6, 2013, BEIJING, CHINA

世界华人生物医学工程协会
第6次国际会议 开幕式
主席致辞
李 宗 明 博士
美国　克里夫兰医学中心
2013年8月6日
中国 北京

Distinguished Guests, Colleagues, Friends, Ladies and Gentlemen:

尊敬的各位嘉宾，各位同仁，朋友们，女士们，先生们：

On behalf of the World Association for Chinese Biomedical Engineers (WACBE), I am privileged to welcome you to our WACBE World Congress. As President, I extend my heartfelt appreciation to all of you for joining us from across the country and across the world. I am honored to have this opportunity to speak to you today.

今天，我很荣幸有这个机会在此发言。作为世界华人生物医学工程协会（WACBE）主席，我谨代表WACBE热烈欢迎从全国和世界各地远道而来的各位来宾，衷心感谢你们前来参加WACBE国际学术会议。

Let me say “thank you” to our founding president, Professor Savio Woo. It was your visionary idea that makes today possible. I also would like to thank you, the delegates from National Science Foundation, for joining us and supporting our congress, our organization, and our profession. Let me also thank you, Professor Yubo Fan and your team, for your dedicated work in putting together such a wonderful program. We all look forward to the excitement and joy in the next few days here at Beihang University.

首先我要感谢WACBE的创始人胡流源院士，因您的远见卓识，才让今天的一切成为可能。同时我也感谢来自中国国家自然科学基金委员会的代表们前来参会，感谢你们对WACBE和生物医学工程领域的大力支持。我还要感谢樊瑜波教授以及您的团队为此次会议筹备所付出的努力。我们期待未来几天在北京航空航天大学收获兴奋与喜悦。

Every two years, WACBE brings together Chinese biomedical engineers from across the world to network, to share, to learn, and to celebrate. Truly, each congress is a milestone for our organization. This is the second time that the WACBE congress is being held in Mainland China. In 2004, the congress also took place in Beijing at Jiuhua Villa. We are so delighted to be back. This time after only 9 years, we are back in Beijing to be amazed by the incredible advances in everything about China, and of course in biomedical engineering


每两年一届的WACBE学术会议让世界各地的华人生物医学工程学者齐聚一堂，大家共同分享、学习和庆祝。不容否认，每一届会议对WACBE来说都是一个里程碑。上次WACBE国际会议于2004年在北京的九华山庄举行，此次是WACBE第二次在中国大陆举办国际会议。九年后，我们非常高兴再次来到了北京。中国翻天覆地的变化令我们感到十分惊喜，生物医学工程领域的发展亦是如此。

In our culture, we like to talk about缘分. We gather here today – it is fortune, it is luck; and indeed it is 缘分. We are here because we cherish our friendships and our professional networks; we are here because we are passionate about sharing and passionate about learning; we are here because we are attracted by innovative minds and want to open minds for new possibilities; we are here because we are eager to inspire and to be inspired; we are here because we admire professional excellence and aspire to be world-class.

在中华民族传统文化中，我们讲究“缘分”。今天，我们相聚在一起，是幸运，更是缘分。我们之所以来到这里，是因为我们珍惜彼此间的友谊，是因为我们热爱这个科学领域并乐于分享，是因为我们想要汲取新的思想并进行创新，是因为我们希望激发彼此的思维和理念，也是因为我们追求卓越和世界一流。

As you know, WACBE is to unite us Chinese professionals world-wide for the advancement of basic and translational research; particularly, we want to make our advances with a global perspective. Although WACBE is a young organization, it has a proud history of 10 fruitful years. The past years have witnessed strong growth and development of our organization. It has attracted membership from all areas of biomedical engineering and from many regions in Asia, America, and Europe.

WACBE的宗旨是将全世界的华人学者聚集到一起以促进生物医学工程领域基础研究和转化医学的发展和进步。我们希望这种发展和进步能够吸引全世界同仁的关注。WACBE虽然还很年轻，但它已经历了十年的长足发展，期间取得了丰硕的成果，同时来自亚洲、美洲和欧洲的无数的优秀学者加入了我们的协会。

Dear colleagues, I am humbled to be your president. I am thankful to my predecessors – Professor Savio Woo, Professor Arthur Mak and Professor Kirk Shung – for building our foundation and taking many initiatives. I am excited about continuing the excellent tradition. I am committed to working with the council and providing leadership to move our mission forward and maintain our high professional standards.

各位同仁，作为WACBE主席，我深感荣幸。在此，我谨对我的前任主席胡流源院士、麦福达教授、熊克平教授表示感谢，感谢他们为协会的创立和发展做出的贡献。协会的优良传统得以延续，我感到非常兴奋。我将与理事会成员一道致力于推进协会的发展，努力将WACBE建设成为高标准的世界级协会。

It is well said – to lead is to serve. On behalf of all of us in the WACBE leadership, I assure you that we want to listen to your suggestions and respond to your needs. Yesterday, the council members met to discuss many initiatives, brainstorm new ideas, and develop strategies to implement them. During my term, I want to promote our young generation of biomedical engineers. I want to work on a mentoring program in our global community, so that you can connect with seasoned investigators for research ideas, and you can communicate with senior professors for career advice. In our council meeting yesterday, we have already appointed a student representative to our council, so your voice will be heard. We have a General Assembly for everyone today at noon. I personally invite you to join us to learn more about our organization, ask questions, contribute your ideas, and get involved. Your active participation is critical for our growth.

有句话讲得好，领导就是服务。我代表协会的理事会欢迎大家提出宝贵的建议让我们努力工作满足协会的需求。就在昨天，理事会成员一起商讨并制定了下一步发展策略和实施方案。在我任职期间，我将致力于支持和培养年轻一代的生物医学工程学者。我想在全球范围内建立一个指导网络，新一代的生物医学工程学者可以通过此网络与经验丰富的学者和资深教授交流，获得研究经验和职业生涯建议。在昨天的理事会会议上，我们也任命了一名学生代表进入理事会，我们想籍此听到你们的声音。今天中午我们将有一个会员大会，我邀请你们踊跃参加，借此机会更多地了解协会，提出问题，献计献策，参与其中。你们的积极参与对协会的发展至关重要。

Now, let’s take a look at biomedical engineering. We are biomedical engineers; we bridge engineering and biomedical disciplines to enhance human health. The convergence of engineering with biomedical sciences has opened up abundant opportunities, and continues to lead to exciting promises. We are proud of the countless discoveries and inventions in biomedical engineering, in many areas such as medical imaging, joint replacement, nanomedicine, medical devices, to name just a few. The medical advances we take for granted today come from research years ago. And future advances depend on our current endeavors in research and development. For me, every day is an exciting day when I get to work at the medical center. It is so meaningful to see so many patients benefit from clinical treatments – because of our contributions. Yet still, many are desperately awaiting cures.

在座的都是生物医学工程学者，我们的工作就是将工程学和生物医学的研究结合起来为提高人类健康服务。作为工程学和生物医学的交叉学科，生物医学工程为此提供了丰富的机会，前景光明。在医学图像、关节置换术、纳米医药和医疗器械等方面，我们已有无数令人骄傲的科研成果和发明创造。人类现在看起来想当然的医学成绩来自于前人数年的研究；未来医学的发展和进步要依赖于今天我们所有人的共同努力。对我来说，每一天去医学中心工作，都是值得期待的。许许多多的患者得益于临床治疗，这让我们的工作有了意义，因为我们贡献了自己的一份力量。然而，还有很多的患者迫切地等待治疗。

Challenges always remain! Today across the world, we are facing a new frontier in healthcare, calling for new strategies and innovations. As biomedical engineers, we are uniquely positioned to meet the challenges and answer the calls. Biomedical engineering is, essentially, rooted in many diverse fields. Fields collide, innovations spark!

挑战是永存的！当今世界正面临着新的医疗变革，这要求我们制定新策略并勇于创新。作为生物医学工程工作者，我们可以很好地面对挑战和解决难题为医疗服务。从学科的本质上来讲，生物医学工程置身于众多的研究领域。不同学科间的碰撞，会不断迸发出创新的火花！

We all know science and innovation are increasingly global and interdisciplinary. Modern communications have eliminated geographic barriers. Today, we must engage ourselves in basic science, translational research, innovative thinking, and collaborative spirit; and we do this with world-class on the world stage. The good news is that now we are at a good time. With as much talent and commitment that we put forth in our field, I have never been more optimistic about our future – a future that enjoys new advances in science, technology, and medicine; a future that embraces global co-operation and global prosperity.

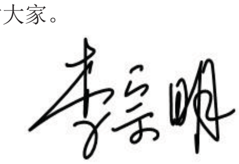
众所周知，科学和创新日益全球化和跨学科化，现代通讯交流手段让我们超越时空。我们应该在世界的舞台上积极从事基础科学和转化医学的研究，培养创新思维和倡导合作精神。幸运的是，我们生正逢时。全世界有如此多的优秀学者在生物医学工程领域做出了巨大努力，令我对未来充满莫大的憧憬。我们的未来将是科学、技术与医学长足进步的未来，我们的未来将是全世界共同合作、共同繁荣的未来。

Ladies and gentlemen, here we gather to celebrate our accomplishments; we look ahead at what the future holds for biomedical engineering; we take pride in our contribution to making the world a better place. Yes, WACBE! WACBE is in the right place, at the right time, for us as the right people to make a difference! We are the world; today is the future; this is our time!

女士们，先生们，今天我们相聚北京，一起庆祝我们取得的成就，一起展望生物医学工程学科的未来，一起为我们创造更美好的世界感到骄傲和自豪。是的，WACBE占据了天时地利人和，WACBE意义非凡。我们是世界的弄潮儿，今日铸就未来，这是我们的时代。

Thank you very much.

谢谢大家。



## Plenary Speeches on the Essential Themes in Bioengineering

### Mechanotransduction in Vascular Endothelial Cells

***Shu Chien, Ph.D***

*Department of Bioengineering and Medicine University of California, San Diego, USA*

Vascular endothelial cells (ECs) play significant roles in regulating circulatory functions. Shear stress with a clear direction (e.g., the pulsatile flow in the straight part of the arterial tree) cause only transient molecular signalling of pro-inflammatory and proliferative pathways, which become down-regulated when the directed mechanical force is sustained. In contrast, disturbed flow without a clear direction seen at branch points and curvature cause sustained molecular signalling of pro-inflammatory and proliferative pathways. The EC responses to directed mechanical stimuli involve the remodelling of EC structure to minimize alterations in intracellular stress/strain and elicit adaptive changes in EC signalling in the face of sustained stimuli. Using a 3D inter-/intra-cellular force microscopy technique to measure cell–cell junctional and intracellular tensions in sub-confluent and confluent EC monolayers, it is found that the z-direction cell–cell junctional tensions are higher in confluent EC monolayers than those in sub-confluent ECs. Under static conditions, sub-confluent cells are under spatially non-uniform tensions, whereas cells in confluent monolayers are under uniform tensions. The shear modulations of EC cytoskeletal remodelling, extracellular matrix (ECM) adhesions, and cell–cell junctions lead to significant changes in intracellular tensions. When a confluent monolayer is subjected to flow shear stresses with a high forward component comparable to that seen in the straight part of the arterial system, the intracellular and junction tensions preferentially increased along the flow direction over time. In contrast, the intracellular tensions do not show a preferential orientation under oscillatory flow with a very low mean shear. The differential responses of EC structure and function to various flow patterns involve interplays of signalling pathways and gene regulation, including the microRNAs, to modulate their homeostasis in health and disease.

### How Bioengineering Can Change Orthopaedic Sports Medicine in the Next 20 Years

***Savio L-Y. Woo, Ph.D***

*Musculoskeletal Research Center Department of Bioengineering University of Pittsburgh, USA*

Bioengineering has made significant contributions to the practice of orthopaedic sports medicine, particularly in the recovery of soft tissue injuries to improve joint function. In this lecture, we will first review how bioengineering research has improved clinical sports medicine in the last four decades and how it will continue to play a critical role in the next 20 years and beyond.

Beginning in the decade of the 1970's, laboratory studies found many deleterious effects of joint immobilization following ligament and tendon injuries that included contracture formation and joint stiffness, weakening of ligaments and ligament's bony attachments as well as cartilage degeneration. Additionally, bioengineering studies had found a highly nonlinear, stress and motion dependent homeostatic relationship for tendons and ligaments. As a result, there was a much better appreciation that ligaments are alive and the new concept of "controlled motion is good" was developed.

In the following decade, the focus was on the functional management of ligament injuries. In the laboratory, the medical collateral ligament (MCL) of the knee was shown to heal spontaneously. These healing tissues were better than those following surgical repair and immobilization. As a result, there has been a clinical paradigm shift from joint immobilization to functional managements of joints.

In the 1990's, there was a large increase in the number of anterior cruciate ligament (ACL) reconstructions with replacement graft. However, the surgical outcome varied. A novel robotic/universal force-moment sensor (UFS) testing system was developed in our research center to determine multiple degree-of-freedom (DOF) knee kinematics. This novel apparatus was then used to examine a number of surgical parameters, including graft choice, femoral tunnel placement, graft fixation and so on and the results on knee kinematics and *in-situ* forces were compared with those for the intact knee. By objectively evaluating ACL reconstruction procedures, bioengineering has helped to improve the outcome on a scientific basis.

Then, in the 2000's, functional tissue engineering (FTE) techniques became available and biological augmentation, such as the use of extracellular matrix (ECM) bioscaffolds was able to heal extra-articular tendons and ligaments faster and better. For the more challenging intra-articular ligaments, such as the ACL, a combined ECM bioscaffold and hydrogel has been used to significantly improve healing.

Looking into the future, the focus will be on how to better integrate bioengineering into biology and clinical medicine. For example, since the ACL healing process is rather slow, mechanical augmentation by sutures are needed to help maintain initial joint stability and aid ACL healing. Also, biodegradable metals are becoming available and they can be excellent scaffolds for mechanical augmentation. Thus, study on the synergy of biological and mechanical augmentation to further enhance ACL healing will be important. On the other hand, it is necessary to gain *in-vivo* data so that we can understand the function of ligaments and tendons on a quantitative basis. The availability of novel biplanar fluoroscopy systems has enabled us to measure joint kinematics *in-vivo* with sub-millimeter accuracy. In combination with computational modeling, valuable *in-vivo* data on ligament and tendon function could be obtained. This combined approach will permit us to learn more about mechanisms of ligament injury, to help develop improved treatment procedures, to design customized rehabilitation as well as injury prevention protocols. More excitingly, it can be applied to individual patients and move us closer to personalized medicine.

Still, we must recognize that the practice of sport medicine is extremely complex. Even with many advances in technology, the gaps between our ability to diagnose injuries and finding effective treatment will continue to grow. This will present challenges as well as opportunities for bioengineers on how to adopt better technologies, how to build appropriate analytical models and how to develop better experimental techniques to gain better understanding of ligaments and tendons at the molecular, cellular, tissue and organ levels. Then, working in concert with biologists, clinicians, and others, it will be possible to come up with more creative and scientifically based procedures to improve patient care.

## Cardiovascular Translational Medicine

***Depei Liu, Ph.D***
*Academy of Medical Science, President of Peking Union Medical College, Member of Chinese Academy of Engineering*

Translational medicine is patient-oriented research which connects basic medicine and clinical medicine. It is a 2 way model, which means more directly and quickly raising questions from clinical practice to basic research and translating findings in basic research into clinical practice. Cardiovascular disease (CVD) has become one of the top causes of death in China recently. To prevent and treat CVD more efficiently, the concept of "CVD translational medicine" is raised and getting popular. We will talk about some examples in CVD translational medicine.

Translational medicine is a complex and big system. In future, translational medicine needs more close and tight cooperation among different fields and aims to realize "Translational Integration". Epidemiologic researches reveal disease occurance and morbidity; clinical researchers raise clinical questions to basic medicine; basic medicine researchers find out strategies and methods to prevent and treat diseases for patients and population; drug researchers found targets from basic medicine and carry out clinical trials in clinics; and biomedical engineering and emerging technology provide up-to-date instruments and methods for clinics and basic medicine researchers.

Recently, systems biomedicine is developed rapidly. This provides a good opportunity for translational research. Some papers describe how to get better understanding of pathogenesis of disease from the whole level and how to use system biomedicine to predict and diagnose disease. In the future, system biomedicine would help to discover the basic disease development mechanism and help to prevent and treat disease and, at last, to realize 9P medicine (Protecting health, Promoting health, Prolonging healthy life span; Predicting diseases, Pre-warning diseases, Preventing diseases; Population, Participation, Personalization).

## Imaging the Immune Response with Magnetic Nanoparticles

***Chien Ho, Ph.D***
*Department of Biological Sciences Carnegie Mellon University Pittsburgh, USA*

Iron-oxide nanoparticles have been used as magnetic resonance imaging (MRI) contrast agents for biomedical research and clinical diagnosis. Using these particles, we magnetically label cells to investigate the immune response following organ transplantation using a rat cardiac transplantation model. Heart transplantation is the preferred treatment for patients with end-stage heart failure, but organ rejection threatens long-term survival. The current "gold standard" for diagnosing cardiac rejection is endomyocardial biopsy, which is invasive and prone to sampling errors. Our laboratory has developed a non-invasive, two-pronged approach to monitor cardiac transplant rejection by simultaneously tracking immune cell infiltration and cardiac function with MRI.

A new class of iron-oxide nanoparticles (ITRI-IOP, coated with polyethylene glycol), exhibiting high transverse relaxivity, high biocompatibility, and low toxicity, has recently been developed. These particles can label macrophages, dendritic cells, as well as mesenchymal stem cells. The aminated ITRI-IOPC-NH2 particles can label non-phagocytic T-cells directly with high efficiency, without perturbing cell function. These particles are excellent candidates to facilitate clinical translation of MRI-based cell tracking for a large number of applications, including cell-based therapies.

Many studies have been reported that intravenously injected nanoparticles are rapidly cleared by the reticuloendothelial system (RES), in particular by Kupffer cells in the liver. To minimize clearance by the RES and improve targeting, we have developed a new methodology using a U.S. Food and Drug Administration (FDA) approved agent, Intralipid, to temporarily blunt the RES clearance. Pre-treatment with Intralipid can result a ~50% decrease in liver uptake and a ~3-fold increase in blood half-life for nano- and micron-sized magnetic particles, resulting in a 2- to 5-fold increase in the labelling efficiency of monocytes in the peripheral blood. Our Intralipid findings can have broad applications for molecular imaging and drug targeting with nanoparticles.

## Optimizing Nanotherapeutics with Engineering Strategies

***Kam W Leong, Ph.D***
*Departments of Biomedical Engineering, and Surgery Duke University, Durham, NC*

Advances in genomics and systems biology have identified many nucleic acid-based therapeutics such as DNA, siRNA, mRNA, miRNA and aptamers that can target diseases at the molecular level. The future of genetic medicine hinges on the successful intracellular delivery of these nucleic acid-based therapeutics. This presentation will focus on polymeric gene carriers, which enjoy the advantage of versatility and relative biocompatibility. I will review our studies on using chitosan as a carrier to deliver FVIII and FIX genes for hemophilia therapy via the oral route. This is complemented by studies to understand the rate barriers in nonviral gene transfer using quantum dot-FRET (QD-FRET) technology. Using a more rational gene carrier design, we apply bioreductive polycations to deliver transcription factors for direct cellular reprogramming. Finally, I will also cover our recent effort on applying microfluidics to improve the self-assembly of polycation-DNA nanocomplexes.

**Cell Traction, Motility and Directed Growth on Polymer Surfaces: Implications for Processing and Surface Modification of Micro- and Nano-fibrous Scaffolds**

***Richard A. Black***
*Department of Biomedical Engineering, University of Strathclyde*
*Glasgow, Scotland, United Kingdom*

The ability of a cell to exert traction forces to the surrounding matrix is central to numerous processes, including cellular migration and proliferation, tissue formation, wound healing and tumour metastasis. Studies of cell motility on different polymeric substrates have shown that the rate at which cells migrate across a given surface depends on the material surface properties and the abundance of adsorbed fibronectin. Likewise, collagen and fibronectin matrices are known to stimulate migration of microvascular endothelial cells, and the process of tubulogenesis, but the physical, chemical, and topographical cues for directed cell growth and vessel formation are not well understood. Hence the influence of surface and bulk properties on cell behaviour is of particular interest insofar is they may offer insights into how responses at the cellular and molecular levels may be controlled.
This presentation will present and discuss the implications of studies of cell motility, directed cell growth and tubule formation, with reference to the surface analysis techniques, including atomic force microscopy and nanoindention, that the members of our laboratory are using to characterise the surface properties of polymer scaffold materials processed by means of solvent casting and electrospinning fabrication techniques. Mechanical characterisation of each surface on different length scales has revealed surprising differences in surface properties, which depend on the conditions under which the each polymer is processed. Systematic studies of the parameters for directed growth of cells in two- and three-dimensional culture environments have been undertaken, and the ability of a given cell population to adhere to various polymer substrates quantified in relation to fibre diameter, density, orientation, and surface chemistry. Our results show that endothelial cell guidance is possible within nanofibre/collagen–gel constructs that mimic the native extracellular matrix in terms of the size and orientation of the fibrillar components.

**Security of Orthopaedic Implant in Biomechanical Perspective**

***Cheng-Kung Cheng, PhD***
*Distinguished Professor, School of Biology and Medical Science, Beihang University, Beijing; Institute of Biomedical Engrg, National Yang-Ming University, Taipei*

Security should be the top priority in development of a medical device before its efficacy is concerned. Information of product security should be provided for registrations of general orthopaedic implants before marketing. The mechanical tests, referring to international standards such as ASTM and ISO, are executed for comparisons in security and functional performances with predicate devices. This essential procedure for evidences of product security is acknowledged and recommended by Food and Drug Administration in every country. However, according to previous clinical researches and retrieval analysis reports, unexpected reactions, adverse effects, and mechanical failures are still inevitable. These problems have revealed the possible insufficiency in determining security of orthopaedic implants by utilizing the conventional mechanical testing methods only. Due to the more complicated environmental parameters for the implanted orthopaedic devices in vivo, the more strict strategies for in vitro mechanical tests should be taken into consideration for better simulation / expectation of practical usages in biomechanical point of view. Why those conventional tests may not be capable to completely reconstruct the mechanical environment for orthopaedic implants in vivo will be discussed in detail, which would cause the underestimation of the possible potential risks of implant failures. Orthopaedic retrievals can also provide useful information that reflecting the flaws in either implant designs or biomechanical environments in vivo. Knowledge in biomechanics shall enhance and fulfill the integrity of the security inspection of orthopaedic implant, and shall also be strengthened and concerned before the registry is approved.

**Swirling Flow in the Arterial System and Its Potential Clinical Applications**

***Xiaoyan Deng***
*Key Laboratory for Biomechanics and Mechano-biology of the Ministry of Education, School of Biological Science and Medical Engrg, Beihang University, Beijing, China*

The human aortic arch possesses a 3-D spiral-shaped spatial geometry. This special geometry makes blood flow through the aortic arch with a corkscrew-like pattern. We believe that the aorta's spiral-shaped geometry and resulting swirling blood flow is a typical example of 'form follows function' in the circulatory system, which may play important physiological roles. To verify this hypothesis, we conducted numerical simulations of the blood flow and mass transport in aortic models constructed from magnetic resonance images of the human aorta. The results demonstrated that the swirling flow in the ascending aorta can effectively stabilize the blood flow in the aorta, compensating for the adverse effect of aortic curving on blood flow and, as a result, reduces/suppresses flow disturbance and flow separation. This, in turn, lessened the deposition/accumulation of atherogenic macromolecules such as low density lipoproteins (LDLs) on the arterial wall and enhanced the oxygen supply to the arterial wall. We then performed an ex vivo experimental study comparing the LDL accumulation in test rabbit aortic segments under normal flow and swirling flow conditions. The results showed significantly reduced LDL accumulation in the arterial wall of the swirling flow condition, further verifying our hypothesis. Inspired by the findings, we hypothesized that the mechanism of swirling flow might be clinically applicable to solving 1) the occlusion of small caliber (<5-6mm) arterial prostheses due to acute thrombus formation; 2) the re-stenosis of arterial bypasses due to intimal hyperplasia; 3) the re-stenosis of endovascular stents; and 4) the blockage of vena cava filters (VCF) by captured blood clots. To investigate these hypotheses, we carried out a series of preliminary studies to test each of the scenarios. The results indicated that incorporating a mechanism to create a swirling flow pattern into vascular interventional therapies and the design of vascular devices has the potential to improve clinical outcomes.

**Biomechanics and Mechanobiology of Medical Implants**

***Yubo Fan, PH.D***
*Changjiang Chair Professor Director, Key Laboratory for Biomechanics and Mechanobiology of the Ministry of Education; Dean, School of Biological Science and Medical Engineering, Beihang University, Beijing, China*

The mechanical stress/strain and its distribution around the implant or intervention body are very important factors which affect the growth or remodeling of the around tissue and cells. There are influences on cell proliferation, differentiation and apoptosis of mechanical loads, also on the tissue alteration and remodeling, and finally on the successful use or failure of the implants/intervention. It's important to study the biomechanics and mechanobiology between the implant/intervention-body and the host tissue. In order to understand the interaction between the biodegradable implants/interventions and the around tissue, the computational biomechanics or biomechanical modeling are very useful. The biomechanical and mechanobilogical study is important for optimal designing for medical implants and interventions. The following researches have been perused, (1) Biomechanical modeling and experimental study on the interaction between the implants/intervention and host tissue, including stent vs. blood flow, artificial joint (knee or hip) vs. bone/ligament/muscle, dental implant vs. mandible, etc. (2) Influence of mechanical loads on degradation of the degradable implants. (3) Mechanobiology of typical cells, such as bone cells, endothelial cells, vascular smooth muscle cells, bone marrow stem cells, etc. (4) Influence of mechanical loads on osseointegration, bone remodeling, and their numerical modeling.

**Innovation and Design-Centric BME Curriculum for MedTech Industry**

***James CH Goh***
*Department of Biomedical Engineering, National Univ of Singapore*

The Biomedical Sciences (BMS) Cluster is one of four key pillars of the Singapore economy. The Singapore Government has injected research funding for basic and translational research to attract companies to carry out their commercial R&D activities. To further intensify the R&D efforts, the National Research Foundation (NRF) was set up to coordinate the research activities of different agencies within the larger national framework and to fund strategic R&D initiatives. In recent years, funding agencies began to focus on support of translational and clinical research, particularly those with potential for commercialization. Translational research is beginning to have traction, in particular research funding for the development of innovation medical devices. Therefore, the Biomedical Sciences sector is projected to grow which means that there is a need to invest in human capital development to achieve sustainable growth. In support of this, education and training programs to strengthen the manpower capabilities for the Biomedical Sciences industry have been developed. In recent years, undergraduate and graduate degree courses in biomedical engineering/bioengineering have been developing at a rapid rate. The goal is to train students with skills to understand complex issues of biomedicine and to develop and implement of advanced technological applications to these problems. There are a variety of career opportunities open to graduates in biomedical engineering, however regardless of the type of career choices, students must not only focus on achieving good grades. They have to develop their marketability to employers through internships, overseas exchange programs, and involvement in leadership type activities. Furthermore, curriculum has to be developed with biomedical innovation in mind and ensure relevance to the industry. The objective of this paper is to present the NUS Bioengineering undergraduate program in relation to manpower development for the biomedical industry in Singapore.

**How to Make a Replaced Hip Joint as Good as a Normal Joint?**

***Jia Hua***
*Centre for Biomedical Engineering, Institute of Orthopaedics and Musculoskeletal Science, University College London, Royal National Orthopaedic Hospital Trust; Chief Implant Designer, Stanmore Implant Worldwide; Visiting Professor, Shanghai Jiao Tong University.*

Total hip replacement has been very popular in treating osteoarthritis and other hip disorders. It has been regarded as one of the most successful surgery in relieving pain, restoring function and correcting deformity of the hip. However, total hip replacements do fail and aseptic loosening of the implant is one of the most common causes.

Many researches have been conducted and advanced to improve clinical outcome of the total hip arthroplasty in design, manufacture, materials and bearing surfaces. This presentation will discuss and compare current updated implant designs with the function of the normal hip joint, and foresee future technologies in implant design and manufacture for total hip replacement.

**Micro and Nano Materials for Cell and Tissue Engineering**

***Song Li, Ph.D.,***
*Department of Bioengineering, University of California, Berkeley*

Cells as the basic building block of our body play a key role in tissue regeneration and disease development. There is accumulating evidence that biophysical factors such as mechanical forces and micro- and nano-features of the cell adhesion substrates regulate cell behavior and functions, including organization, proliferation, migration and differentiation. For example, anisotropic micropattern and nanofibrous structure can promote axon growth and myotube fusion, which can be used to guide nerve regeneration and engineer muscles. The structure and chemistry of nanofibrous scaffolds can be engineered to develop vascular grafts for in situ blood vessel regeneration. In addition, micropatterned surface and nanofibrous scaffolds can regulate cell shape and chromosome remodeling and thus enhancing the efficiency of fibroblast reprogramming into induced pluripotent cells. The understanding of how micro and nano structure regulates stem cell differentiation and cell reprogramming will enable the development of novel technologies for cell and tissue engineering.

**Carpal Tunnel Mechanics and Clinical Translation**

***Zong-Ming Li***
*Departments of Biomedical Engineering, Orthopaedic Surgery, and Physical Medicine and Rehabilitation, Cleveland Clinic, Cleveland, OH, USA*

The carpal tunnel at the wrist contains the median nerve, nine flexor tendons of the thumb and fingers, and other connective tissues. The median nerve within this confined space is particularly vulnerable to compression, leading to carpal tunnel syndrome. While the etiology of carpal tunnel syndrome is multifactorial, pathomechanics of the carpal tunnel plays a critical role in the development of carpal tunnel syndrome. Transecting the transverse carpal ligament is routinely performed as a surgical treatment to reduce the stress on the median nerve and therefore improve symptoms of carpal tunnel syndrome; but a treatment preserving the transverse carpal ligament is the ideal. The knowledge of carpal tunnel mechanics is a necessary step towards understanding the etiology, designing preventive strategies, and advancing therapeutic and surgical treatments for carpal tunnel syndrome. In this presentation, the author will review the biomechanical characteristics of the carpal tunnel together with its anatomical and morphological features, and describe the pathomechanics and pathophysiology associated with carpal tunnel syndrome. Several ongoing biomechanical projects related to the carpal tunnel mechanics will be featured, and their translational potential toward nonsurgical treatment will be discussed.

**Integrated Diagnostic and Therapeutic Techniques: Toward an Intelligent Medical System**

***Hongen Liao, Ph.D.***
*Professor, Dept of Biomedical Engineering, School of Medicine, Tsinghua University, Beijing, China*

Rapid technical advances in medical information and tools have attracted significant interest in close integration of research in medicine, life sciences, physics, chemistry, computer science, and engineering. However, most prediction and diagnosis techniques in conventional medicine have been used in a separate step prior to treatment. Technical advances in therapeutic delivery and a growing demand for patient-specific treatment have recently accelerated the clinical applications of related diagnosis and therapeutic techniques. Techniques for diagnosis and treatment have been integrated, e.g., through imaging modalities and intervention devices and thus provide high-precision minimally invasive treatment. There have been significant advances in the field of minimally invasive and noninvasive surgeries. Compared with conventional diagnosis and therapy, future research on and clinical trials of promoting minimally invasive surgery are expected to shift medical imaging from a primarily diagnostic modality to a therapeutic and interventional aid. Integrated diagnostic and therapeutic processes will be streamlined through the application of intra-operative medical information and robotic-assisted intervention and brought to clinical trials. This talk will provide a brief introduction of development and application of the minimally invasive precision diagnostic and therapeutic techniques for intelligent surgery based on bio-medical imaging, bio-robotics, precision and control engineering.

**MR Cardiovascular Imaging**

***Zhi-Pei Liang***
*Franklin W. Woeltge Professor of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign*

Cardiovascular imaging has been an active and fruitful area of research for several decades. Through the dedicated efforts by academic, industrial, and medical researchers, significant advances have been made in cardiovascular imaging technologies (including electro-cardiography, cardiac ultrasound, cardiac CT, nuclear cardiology, and cardiac MR), which have provided unprecedented capabilities for diagnosis of cardiovascular diseases and for assessment of the therapeutic effects of various treatment procedures. Cardiovascular MR began in the 1970s with a focus on assessing high-energy phosphate myocardial metabolism using 31P spectroscopy. Clinical MR cardiovascular imaging has become possible since 1980s, first to assess cardiac morphology and function, and then to assess myocardial perfusion and viability and to characterize vasculature. Although cardiovascular MR has not reached its enormous potential because of imaging speed limitations, exciting opportunities exist to overcome the speed barriers due to the recent advances in sparse sampling theory and algorithms. This talk will provide a brief overview of MR cardiovascular imaging and then discuss new opportunities and challenges for high-resolution dynamic cardiovascular imaging.

**The Preparation of Injectable Angiogenic Bone Cement for Femoral Head Avascular Necrosis**

***Feng-Huei Lin***
*Professor, Institute of Biomedical Engineering, National Taiwan University, Chinese Taipei*

Human tissue depends on blood circulation to transport oxygen, nutrition, carbon dioxide, waste and so forth. If there are problems in transportation of these substances, one’s organ and tissue will be necrotic. When this happened in brain, it may lead to stroke or transient ischemia; in heart, it will probably bring myocardial infarction and stenocardia; in bone, it will cause osteonecrosis. Avascular necrosis of the femoral head is also known as aseptic necrosis of the femoral head or osteonecrosis of the femoral head. According to the literature, 300,000 to 600,000 people have avascular necrosis of the femoral head in the United States. It is a disease of weak osseous blood flow of femoral head. This disease commonly occurs in the people who are thirty to fifty years old. The ultimate purpose of every clinical treatment is to save patient’s femoral head but it’s not an easy work. Making a decision about therapy is related to the patient's other illness, previous life, living environment and so on.

Poly(propylene fumarate) (PPF) is an unsaturated linear polyester that can be cross-linked through the double bonds along its backbone to form a solid polymer. Cross-linking can be carried out through the addition of N-vinyl pyrrolidinone (NVP, a cross-linker), benzoyl peroxide (BP, an initiator) and N,N-dimethyl-p-toluidine (DMT, an accelerator). An orthopedic composite formulation can be formed through the addition of tetracalcium phosphate (TTCP) / dicalcium phosphate (DCPA) as an osteoconductive agent and ginsenoside (Rg1) as an angiogenic agent. Moreover, TTCP/DCPA can improve the mechanical strength of PPF. This composite forms an injectable paste that can be used to fill skeletal defect, acting both as a biodegradable scaffold with angiogenic agent for cell growth and as a mechanical support at the defect site.

The purpose of study is to fabricate an injectable bone cement with biodegradable and angiogenic functions. We anticipate this bone cement can benefit to supporting mechanical strength immediately after injection. As time goes by, it will be degraded within the body gradually followed by releasing angiogenic agent which can stimulate vascularization of surrounding tissue. With the nutritional supply of new microvessel, bone tissue will regenerate onto this cement. Finally, the cement will be replaced by newly formed bone.

## Regeneration of Tissues and Organs by Endogenous Stem Cells

***Jeremy J. Mao, MD, Ph. D.***
*Professor and Zegarelli Endowed Chair, Columbia University; Inducted Fellow, American Institute of Medical and Biological Engineers*

Regeneration of tissues that function as native replacements remains to be broadly realized. A common approach for tissue regeneration is cell delivery, including stem cells that are transplanted directly or as committed tissue progenitors. However, cell based therapy encounters several critical barriers in translation towards clinical therapeutics. Immune rejection, pathogen transmission, potential tumorigenesis, packaging/storage/shipping, and anticipated difficulties in clinical adoption, cost reimbursement and regulatory approval are among some of the roadblocks. Economic viability of cell delivery, especially if it requires substantial ex vivo cell manipulation, is far from trivial. I will present emerging data from my laboratory and others in several recent reports that chemotactic cell homing is responses for the regeneration of multiple and, in some cases, complex tissues, such as dermal, muscle, dental, cardiac, cartilage and bone. Data from these independent reports suggest an emerging concept that single or complex tissues can regenerate by the homing of endogenous cell lineages and potentially without cell transplantation. A multitude of approaches will be discussed to orchestrate cell homing including active recruitment of host endogenous cells by chemokines, cytokines, drugs, polymeric materials and bioengineering models. We will further explore the potential and limitations of tissue regeneration by cell homing and contrast cell homing with cell delivery approaches. Information on the mechanisms of cell homing will be explored primarily by in vitro studies of cell migration, cell recruitment and cell motility in 2D and 3D models. Endogenous stem cells may accelerate clinical application of stem cell technology.

## Modelling the Facial Construct: Simulation and 3D Surface Analysis

***John Middleton, DSc***
*Dental School, Cardiff University, Cardiff, Wales UK*

The modelling of the human face is presented from both the viewpoint of a detailed anatomical based finite element(FE) model and also studies to develop accurate surface-based methods for averaging facial images that can provide a basis for growth analysis. The FE based model considers the development of the facial construct such that clinically relevant data can be captured to assess the outcomes of post-surgical treatment scenarios. Here it is desirable, for both surgeon and patient, that facial changes and the resulting facial expressions resulting from surgery can be assessed and quantified to give an impression of post-surgical results. Here a novel approach to facial expressions is considered where the musculature of the individual facial expression is assigned with proposed modelling properties. The model is able to capture the complex behavior of muscle tissue, such as active, quasi-incompressible, fibre-enforced and hyper-elastic response. Material constants and muscle activation times have been taken from the literature and the resulting model has the ability to simulate various facial expressions.

In the second phase of the work geometric morphometrics is utilised as a tool to enable the analysis and quantification of the biological form of the facial construct. Here the study provides an accurate technique for surface-based groupwise superimposition (registration) and averaging of 3D facial images and therefore provides a base for further analysis. Here an arbitrary number of males, females, children and adults, both normal and with facial abnormalities have been analysed using laser/optical scanning systems and these have been processed to obtain facial shells accurate to within 0.5-1mm. Groupwise registration of the shells is undertaken in a similar way to Procrustes analysis this being the first and most important step in analysis of landmark configurations modelling the actual biological form. This approach which is based on whole surface data (10,000 to 100,000 biologically unfixed data points) is more accurate that the usual number of landmarks traditionally used (10 to 100 biologically fixed points). This provides a far more detailed analysis of the facial image ensuring higher accuracy (0.1 – 1mm) when compared to traditional landmark-based techniques (1-4mm). The method provides excellent data for 3D growth studies as well as the assessment and visualization of the individuals parameters (geometry, genetic and environmental, etc.) on the shape of the face.

## Initiation and Acceleration of Tissue Regeneration with Mechano-transductive Fluid Flow - a Mechano-bioreactor Approach

***Yi-Xian Qin***
*Department of Biomedical Engineering, Stony Brook University, Stony Brook, NY*

Mechanotransduction has demonstrated potentials for tissue adaptation in vivo and in vitro. Although a wide range of studies have been done, mechanism for this mechanical effect on bone regeneration is unknown and still under active investigation. A potential mechanism, by which bone cells may sense mechanotransductive signals, is through deformation and streaming of bone cells and their surface structures, to trigger osteogenesis. The purpose of this paper was to (1) review current state-of-arts of mechanobiology in bone remodeling and osteogenesis, and (2) to use various methodology to determine the morphological and biological responses of bone stem cells to fluid flow and mitigate osteopenia.

Loading induced bone fluid flow (BFF) creates a pressure gradient that further influences the magnitude of the mechanotransductory signals. Our group has recently introduced a novel, non-invasive dynamic hydraulic stimulation (DHS) and found its beneficial effects on bone structural quality in a rat hindlimb suspension model. Mesenchymal stem cells (MSCs) have the abilities of self-renewal and differentiation into the cells that form tissues such as bone. The objective of this study is to evaluate MSC quantification on day 3, day 7, day 14, and day 21 in response to DHS as a longitudinal sensitivity of the BFF on MSCs.

Flow cytometric measurements indicated MSC population as represented by cells positive for CD29, CD49e, and CD90.1, and negative for CD45 and CD11b. After 3 days of treatment, %MSC was similar in all three groups. HLS for 7 days and longer significantly reduced MSCs' quantity. The data of day 7 and day 14 showed an interesting trend in the DHS group, as the %MSC seemed to elevate in response to the treatment. However, this elevation diminished after 21 days of treatment.

The change in MSC proliferation is highly time sensitive. As suggested in our previous work, bone growth was already accomplished by 28 days. As an earlier event, it is reasonable to see enhanced MSC proliferation in response to the mechanical signals of DHS at earlier time points, i.e. 7 to 14 days, which clearly explained downstream cellular effect of DHS and its potential mechanism on bone quality enhancement.

**Biomechanics of Trapeziometacarpal Joint**

***Fong-Chin Su***
*Distinguished Professor, National Cheng Kung University, Department of Biomedical Engineering, Taiwan*

Due to greater range of motion and high compressive force, the trapeziometacarpal (TMC) joint has very high prevalence of osteoarthritis (OA). Especially, the TMC joint has more incongruent as well as smaller articular area in female than male. The TMC joint in female have more compression stresses, so that the probability of OA was greater in female than male. To understand the realistic biomechanics of TMC joint will help understanding of the OA etiology.

The joint displacement of the trapeziometacarpal joint was measured. The CT images of the hand were taken at neutral position, full flexion, full extension, full abduction, and full aduction for each subject in order to calcuate the TMC joint gliding duirng flexion-extension (FE) and abduction-aduction (AA). In circumduction, 6 sequential positions, thumb extension, thumb on the 2nd metacarpal, thumb on the 5th metacarpal, thumb above the 4th metacarpal with full range of motion, thumb perpendicular to palm, and mid-range between thumb extension and thumb perpendicular to palm, were performed. The joint displacement was reported in the trapezium coordination system and joint coordination system, respectively.

In vivo joint glidings of TMC joint in thumb motions, flexion/extension, abdudction/adduction and circumduction were investigated. The findings not only may provide information for the implant design of TMC joint implant, but also be used for diagnosis OA of TMC joint in clinical applications.

**Ultrahigh Frequency Ultrasound and Its applications to Cellular Bioengineering**

***K. Kirk Shung***
*Department of Biomedical Engineering, University of Southern California, Los Angeles, CA 90089, USA*

Although acoustic microscopy at ultrahigh ultrasound frequency (100 MHz – 1 GHz) has been used in non-destructive evaluation of materials and biomedical imaging for decades, its applications in biology and medicine have been limited. The reasons are (1) high cost and (2) few advantages over optical microscopy. Biomedical applications of ultrasound at these frequencies other then imaging however have been mostly overlooked. At UHF frequencies, the width of an ultrasound beam is of only a few microns, approaching the dimensions of many cells, hence it may be called "ultrasound microbeam". Ultrasound microbeam may have many applications in cellular bioengineering. Acoustic tweezer, and acoustic cell sorter are just two examples.

Both sensitive UHF single element transducers and driving and receiving electronics must be developed for the further advance of ultrasound microbeam. Traditionally the piezoelectric material ZnO has been used for UHF transducer fabrication. This material, although possesses a desirable low dielectric constant for single element transducers, has a very serious shortcoming, a very low electromechanical coupling coefficient. In order to improve the performance of UHF transducers, a variety of piezoelectric thin films including PZT and KNN-LSO have been developed and evaluated. Transducers at frequencies as high as 200 MHz have been prepared from these materials, yielding a bandwidth of 50-60%. They have been successfully used for applications in cell-sorting and trapping. Preliminary experimental results have been obtained to demonstrate potential cellular applications of ultrasound microbeam. Efforts are now underway to utilize ultrasound microbeam in interrogating intercellular interactions e.g., quantitating intercellular forces and in studying mechanotransduction.

**Acupuncture Research by MRI**

***Jie Tian***
*IEEE Fellow (from 2010), IAMBE Fellow (from 2012), SPIE Fellow (from 2013), Professor, the Institute of Automation, Chinese Academy of Sciences*

Acupuncture is receiving a wide round of applause as an alternative and complementary therapy in the world. In spite of its popularity and public acceptance, a proper niche has not yet been given to acupuncture in the modern biomedical theory due to absence of a scientific explanation of its neurobiological mechanism. Noninvasive functional magnetic resonance imaging (fMRI) technique has opened a "window" into the brain, allowing us to investigate the central physiological functions involved in acupuncture administration. Of all research interests in acupuncture, the central representation of the peripheral acupoint stimulation and its functional specificity gain the most attention. Acupoint specificity, lying at the core of acupuncture, is still a controversial issue and lacks scientifically rigorous evidence. Previous neuroimaging studies have mainly focused on spatial distributions of the acute effect of acupuncture. However, abundant clinical reports have indicated that effects of acupuncture may actually peak long after needling administration. Due to its sustained effect, the typical block-designed model-based analysis may be susceptible to errors of statistical significance. Our recent study provided solid evidence supporting the idea that acupuncture is a slow-acting agent and has a specific pattern of the dynamics for the entire coupled neural system. This emerging picture indicates that both designing paradigms and statistical models involved in acupuncture studies should be applied with great care. Given that the model-based block-designed analysis is not optimal to acupuncture fMRI studies, we adopt the non-repeated event-related design paradigm, combining with several data-driven analyses, in order to explore the spatial-temporal characteristics involving acupuncture. Results from our findings demonstrated that different effects of acupoints might lead to the resource redistributions in both spatial and temporal domains because of their different function-guide actions. These findings may pose great implications for the design and interpretation of a range of acupuncture neuroimaging studies. Such a concept may open up new ways by which the actual effect of acupuncture can be appropriately studied.

Learning objectives

- To understand the methodology of acupuncture studies by fMRI
- To know how and by what way the sustained effects of acupuncture exert influences on the block-designed model-based analysis
- How the spatiotemporal encoding underlying functional specificity of acupuncture in human brain

Take home messages

- Our recent study provided solid evidence supporting the idea that acupuncture is a slow-acting agent and has a specific pattern of the dynamics for the entire coupled neural system.
- Different effects of acupoints might lead to the resource redistributions in both spatial and temporal domains because of their different function-guide actions.
- These findings may pose great implications for the design and interpretation of a range of acupuncture neuroimaging studies.

**TSC-Based Mechanism of Tendinopathy and Its Treatment with PRP**

***James H-C. Wang, Ph. D.***
*MechanoBiology Laboratory, Department of Orthopaedic Surgery, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA*

Tendinopathy affects millions of Americans every year. However, the precise pathogenic mechanisms of tendinopathy remain elusive. As a result, current treatments are largely empirical and palliative. Recent studies have shown that in addition to tenocytes, the dominant residential cells in tendons, tendons contain tendon stem/progenitor cells (TSCs), and that these tendon-specific stem cells have multi-differentiation potential. Because tendons are constantly subjected to mechanical loading in vivo, we aimed to determine TSC-based mechanisms of tendinopathy due to excessive mechanical loading placed on the tendons. Our in vitro study showed that small mechanical loading induces differentiation of TSCs into tenocytes, while large mechanical loading also directs differentiation of TSCs into non-tenocyte lineages of cells, including adipocytes, chondrocytes, and osteocytes. Our in vivo study also showed that even short periods of intensive mouse treadmill running lead to high expression levels of genes related to non-tenocytes (adipocytes, chondrocytes, and osteocytes) in tendons. Based on these data, we suggest that the aberrant differentiation of TSCs into non-tenocytes may play a role in the development of tendinopathy, which frequently occurs in both athletic and occupational settings. Platelet-rich plasma (PRP) is widely used in clinics to treat tendinopathy. However, the efficacy of PRP treatment for tendinopathy remains highly controversial. We showed that PRP induces differentiation of TSCs into active tenocytes that proliferate quickly and produce abundant collagen; we also showed that PRP treatment is anti-inflammatory. These results indicate that PRP treatment for tendinopathy is likely safe and able to relieve pain and repair the degenerated matrices in tendinopathic tendons.

**Nanotoxicity Mechanisms of Engineered Nanomaterials**

***Yuliang Zhao***
*CAS Key Laboratory for Biomedical Effects of Nanomaterials and Nanosafety, National Center for Nanoscience and Technology of China; and Institute of High Energy Physics, Chinese Academy of Sciences (CAS)*

There are a growing range of innovations in the fields of biological sciences and medical engineering with integrating newly emerging nanosciences and related technology, in particularly, the wide applications of engineered nanomaterials. However, the increased number of engineered nanomaterials and their novel physicochemical properties also pose a new challenge of understanding the full spectrum of their interactions at the nano/bio interface, including the potential to engage in hazardous interactions with living system and the environment. These interactions and toxicity mechanisms of different engineered nanomaterials differ with nanosize/nanosurface which directly correlates to the biological/chemical activities of engineered nanomaterials in vivo.The talk will focus on our view of the impact of new properties of engineered nanomaterials on nanotoxicity and novel nanomedicine. We will discuss this issue from the perspective of recently experimental findings and show how tuning of these properties can be used to control the biomedical functions or toxicological properties of engineered nanomaterials in biomedical applications. The knowledge assisted us in developing biomedically safer nanomaterials and their applications, which resulted in a new approach in the management of human deseases and a de novo design of nanomedicines.

**Progress in Tissue Engineering Scaffolds**

***Tingfei Xi***
*Academy for Advanced Interdisplinary Studies, Peking University, Beijing, 100871, China*

**Introduction:** Since 2003, there are no amazing breakthroughs in tissue engineering research all over the world. Moreover, no novel tissue engineering medical products have been approved by FDA ever since then, and then, research and industrialization of tissue engineering really saw its low stage. Therefore, some changes or adjustments must be employed in research priorities and development plans of the whole industry.

**Methods:** In "To advance tissue science and engineering: a multi-angency strategic plan" launched by US National Science, bottlenecks, such as stem cell industrilization, bioresorbable stents, encountered during the growth of tissue engineering were spread out, and related solutions were put forward. Taking into account the less than status quo of tissue engineering industry in China, some better ideas or development guidance should come up for the sake of sustainable development of the whole industry. In addition, based on a careful survey on status of companies, products, standards and research of the tissue engineering medical products, the most promising scaffolds to be translated into products will be focused on in this paper.

**Results:** After sever thought and investigation, some basic strategies or objectives of tissue engineering should be adjusted to match the requirements of clinical application. More and more tissue engineering scaffolds have been designated to regenerate different tissues including skin, bone, nerve, cornea ect, however, only very few tissue engineering medical products such as ActivSkin have been approved by cFDA up to now. During the potential related products, more scaffolds originated from ECM or acellular matrix, other than polymer (natural or non-natural) or inorganic material, have obtained "Inspection Reports" from NIFDC or been in the progress of clinical trials or animal trials.

**Conclusions:** The current investigations imply that scaffolds from acellular matrix or ECM show most promise as tissue engineering medical products in the near future.

**Diagnosis of Osteoarthritis using the Principle of Cartilage Mechanics**

***Leping Li, Ph.D***
*Department of Mechanical & Manufacturing Engineering, Schulich School of Engineering; Centre for Bioengineering Research & Education; Faculty of Kinesiology University of Calgary, Alberta, Canada*

Osteoarthritis is the most common cause of disability among the elderly. The disease is associated with articular cartilage degeneration in the joint, mostly in the knee and hip. It is important to detect the onset of the disease, because articular cartilage has very limited ability in self-repair, and it is too late to prevent the progression of osteoarthritis once the patient feels pain in the joint. We have been trying to develop clinical tools to detect the onset of arthritis using the electromechanical response of articular cartilage. A minimally invasive arthroscopic probe was first developed based on intensive modelling of the streaming potentials of cartilage, which is an electric potential produced during tissue compression. The streaming potentials are produced by the fluid pressure gradients in cartilage, which varies with the health state or mechanical properties of the tissue. Therefore, the health state of cartilage can be determined by measuring the streaming potentials. The potentials can be detected by the probe that is currently marketed by Biomomentum (Montreal, Canada). Recently, efforts are made to develop a non-invasive methodology by measuring the surface electrical potentials from the skin of the knee. The distribution of potentials around the knee is measured, while the patients stand straight on a vibration plate (Dr. Savard's lab, Ecole Polytechnique de Montreal). Modelling is required to correlate the potentials measured from the knee surface to the properties of articular cartilage inside the knee. Currently, we are able to model the fluid pressure in the normal and arthritic knees. The streaming potentials in the cartilages of patient's knees can be determined by the measured surface potentials using electrical modelling. The streaming potentials are then correlated to the field of fluid pressure in the cartilages, and thus to the mechanical properties of the cartilages. The knee surface potentials are therefore correlated to the health state of articular cartilage in the knee.

## 7TH WACBE WORLD CONGRESS ON BIOENGINEERING
## 6 - 8 JULY 2015, SINGAPORE

The 1st WACBE congress was held in Taiwan from 11-14 December 2002, with the second congress held in Beijing, China from 27 to 30 September 2004. The 3rd WACBE World Congress was held in Bangkok, Thailand on 9-11 July 2007 with the 4th Congress held in Hong Kong in July 2007. The 5th and 6th congresses were respectively held in Taiwan (August 2011) and Beijing (August 2013). All these congresses had brought together many biomedical engineers from all over the world to share their experiences and to exchange views on the future development of biomedical engineering. The 7th WACBE World Congress on Biomedical Engineering 2015 in Singapore will continue to offer such a networking forum for biomedical engineers to keep abreast of the latest development in the field.

Topics to be presented will include: Artificial Organs, Bioengineering Approaches to studying Cancer & Infectious Diseases, Bioinformatics & Digital Medicine, Bioinstrumentation & Biosignal Processing, Biomaterials, Biomechanics, Biomedical Imaging and Processing, Biosensors & Lab-on-Chip, Cell & Biomolecular Mechanics, Cell Engineering, Clinical Engineering, Computer-Integrated & Computer-Assisted Surgery, Controlled Drug Delivery, Cardiovascular Bioengineering, Computational Bioengineering, Engineering in Traditional Chinese Medicine, Medical Robotics, Mechanobiology, Micro/Nano Biomedical Engineering Systems, Nanobiotechnology, Neuromuscular Control & Neural Systems Engineering, Pharmaceutical Sciences & Engineering, Physiological System Modeling & Identification, Rehabilitation Engineering & Assistive Technology, Regenerative Medicine & Tissue Engineering & Telemedicine & Healthcare.

Participants at the congress will include young and experienced biomedical engineers, physicians and scientists working in research institutions, universities and hospitals, medical device manufacturers, as well as students in this field. The next WACBE World Congress 2015 will be a memorable event for colleagues and friends from all over the world to establish friendships, to promote academic exchanges at an international level and to promote the interests of biomedical engineers.

On behalf of the Organizing Committee of WACBE World Congress 2015, it gives me great pleasure to warmly welcome you and your colleagues and students to attend this World Congress. I look forward to seeing you in Singapore in 2015.

**Goh Cho Hong, James**
**WACBE2015 Congress Chair**

## THE 2013 DR SAVIO & MRS PATTIE WOO TRAVELLING FELLOWSHIPS

**Arthur Mak**

We are grateful to our Founding President Professor Savio LY Woo and his wife Mrs. Pattie Woo for establishing the Dr Savio & Mrs Pattie Woo Travelling Fellowships and availing the Travelling Fellowships to young investigators attending the WACBE Congresses on Bioengineering. The Travelling Fellowships were awarded for the first time in WACBE 2011 in Tainen.

The objective of the Travelling Fellowships is to support a number of young BME researchers to take the opportunities around the time of a WACBE Congress to visit some leading BME laboratories in the territory hosting the WACBE Congress. To be eligible to apply, an applicant should (a) be a current PhD student, a postdoctoral trainee, or a young investigator (within 5 years after PhD graduation) at the time of application, (b) should have an abstract accepted as part of the scientific programme of the WACBE Congress; c) should submit a visit plan; and (d) should submit a support letter from the his/her advisor, who should be a WACBE member.

For 2013, the Fellowship Selection Panel consisted of Prof. Abraham Lee, Prof Mian Long, Prof Arthur Mak, Prof Kirk Shung, and Prof Fong-Chin Su. The Panel recommended and the Council approved awarding the Travelling Fellowships to the following three young and deserving WACBE 2013 delegates:-

- Ms Sophia HA, The Chinese University of Hong Kong
- Dr Ke LI, The Cleveland Clinic
- Dr Paul WEN, The University of Hong Kong

**The 2013 Dr Savio & Mrs Pattie Woo Travelling Fellowships Awardees**

*From left: Dr Zong-Ming Li, Dr Paul Wen, Dr Ke Li, Ms Sophia Ha, Mrs Pattie Woo, Dr Savio Woo and Dr Arthur Mak.*

**Reports from the 2013 Dr. Savio & Mrs. Pattie Woo Travelling Fellowship Awardees**

***Ke Li, PhD***

*Postdoctoral Fellow (Supervisor: Dr. Zong-Ming Li)*

*Hand Research Laboratory*

*The Cleveland Clinic*

With the 2013 Dr. Savio & Mrs. Pattie Woo Travelling Fellowship, I visited the Med-X Research Institute of Shanghai Jiao Tong University (SJTU), College of Biomedical Engineering and Instrument Science of Zhejiang University (ZJU), and School of Control Science and Engineering of Shandong University (SDU) during August 21-26, 2013.

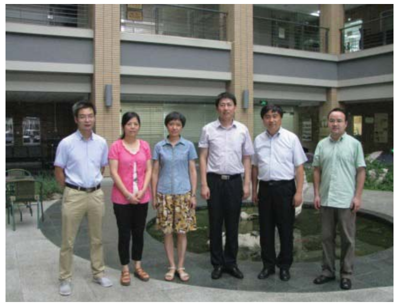
In the Med-X Research Institute of SJTU, I visited the Institute of Rehabilitation Engineering (IRE), and the Engineering Research Center of Digital Medicine (ERCDM). The IRE was initially established in 1988 and was re-organized in 2001. The mission of IRE is to promote research, teaching, clinical applications, and delivery of rehabilitation technologies to clinical and domestic uses. In IRE, Prof. Ning Lan's team introduced me to their work in modeling and simulation of motor control, development of functional electrical stimulation (FES) system and design of intelligent prostheses. Prof. Jinwu Wang's team introduced me to their work in biological material for bone regeneration and clinical application of FES. I also observed the neuro-robotics, virtual reality, exoskeletal assistive device developed at the laboratory of Prof. Le Xie.

The ERCDM of SJTU, established under the Ministry of Education, aims at the innovative research and the development of digital medicine. In the ERCDM, Prof. Chengtao Wang introduced me to the 'Chinese Mechanical Virtual Human', Navigation system for computer-assisted hard and soft tissues surgery, and the 'Integrated Digital Operating Room'. In the laboratory of R&D of Digital Technology of Medical Implants, I was shown the application of 3-D printing technique in forming the individualized artificial joints, and the translational study of tissue specimens, database and information service platform for the medical implants.

During the visit, I had the honor to meet with Professor Ke-Rong Dai, member of Chinese Academy of Engineering. Academician Dai gave me an introduction of ERCDM and IRE, and encouraged our young investigators to do better job in both the basic and translational research.

The College of Biomedical Engineering and Instrument Science of ZJU offered the first Biomedical Engineering program in China in 1977. It was also the first one to award master's degree program, doctoral degree program, and post-doctoral research program of Biomedical Engineering in China. In ZJU, I first visited the laboratory of Prof. Xiaoxiang Zheng, whose work focuses on invasive and non-invasive brain machine interfaces and in the rehabilitation of neural dysfunction. The laboratory of Prof. Zheng developed a portable multi-channel telemetry system which can be used for brain stimulation and neuronal activity recording. With this system a rat navigation system has been developed, with which a rat can be controlled to run in a customized route. The laboratory of Prof. Zheng also realized a system through which they could monitor the brain activity of monkeys and use the information collected from brain to control a robotic hand.

After visiting Prof. Zheng's lab, I had a tour around the other laboratories in the BME department. Prof. Zhouyan Feng introduced her study in micro-electrode array technique, deep-brain stimulation, electro-encephalogram analysis for synaptic potentials of pyramidal cells in the cerebral cortex, and neural mechanisms of epilepsy. Prof. Gangmin Ning introduced a Holter system and precision instruments for marine monitoring that have been developed at his lab. Prof. Ling Xia introduced his work on the advanced modeling of cardiovascular system.



*With professors of Zhejiang University*

The Executive Dean of College of Biomedical Engineering and Instrument Science of ZJU, Professor Jinsong Li provided a cordial reception and went all along with me for a lab tour. At his lab, Professor Li introduced a developing medical information system which aims to integrate the information necessary to the basic research, medical education, patient treatment, diseases tracking and public health monitoring.

In Shandong University, I visited Professor Yibin Li's lab. Professor Yibin Li implemented movement control of the four-legged robot. The robot can walk under multiple conditions, including icy, sandy or declining road surfaces, with tremendous load power. Professor Li explained the robotic system in detail and disclosed what they plan to do next--to add visual and force feedback into the robot.

SJTU and ZJU also organized meetings for academic exchange. This visit gives me a chance to access the excellent BME laboratories, understand their work, and share our knowledge, perspectives and research experience on the issues of common concern.

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***Paul Wen, PhD***
*Postdoctoral Fellow (Supervisor: Dr. William Lu)*
*Dept of Orthopedics & Traumatology*
*The University of Hong Kong*

I visited the School of Biomedical Engineering in Beihang University on August 2nd and attend the 6th WACBE congress with the support of Dr. Savio and Mrs. Pattie Woo Traveling Fellowship. Thanks for the hospitality of Prof. Fan Yubo and Dr. LiZhen Wang to host the meeting for knowledge exchange and to Mr. Yao Jie for the lab tour.

In Beihang University, I shared my HKU experiences on the application of advanced bionanotechnology to orthopaedic research, with the focus on osteoarthritis. The colleagues from Beihang University reported the preliminary finite element analysis of the influence of kneeling on the stress distribution in the knee joint. We agreed that osteoarthritis is basically a mechanical problem. The expertise and contributions from mechanical engineers will definitely help understand in depth the pathogenesis and pathophysiology of osteoarthritis. Two points were discussed. One was ***how to model the course of subchondral bone disturbance at micron scale*** in the development osteoarthritis, from repetitive subchondral bone micro-damages, bone marrow lesion, subchondral cyst formation and subsequently sclerotic changes of trabecular bone. The other was ***the influence of squatting on the stress distribution in the knee in macro scale***.

In the WACBE 2013 congress, I reported our previous work in the nanomechanical performance of collagen fibrils extracted from articular cartilage using atomic force microscopy and nanoindentation. Good feedbacks were received from the audience. We have heated discussion on the prospective of bionanotechnology and nanomedicine with the scientists from Dr. Long Mian's group and from Dr. Zhu Jie's group.

During the WACBE 2013 congress, we continued our discussion on the modeling of subchondral bone disturbance in osteoarthritis with Dr. Gong HE, Dr. Wang Lizhen, and Mr Yao jie. We discussed how to link the pattern of mechanical loading on subchondral bone with the protein expression profile by proteomics. In this context, it is essential to model single trabeculae, which provide mechanical cue for stem cell differentiation towards osteoblastic lineage and form the niche for bone remodeling.

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***Sophia Chui-Wai HA***
*PhD student (Supervisors: Dr KM Chan & Dr Daniel Fong)*
*Dept Orthopaedics & Traumatology*
*The Chinese University of Hong Kong*

*With Prof Savio Woo*

Firstly I would like to express my deepest gratitude to Prof. Savio Woo once again for offering me this award. It allowed me to visit Beihang University on 30 July – 2 August 2013, and build my network with Beihang University before WACBE 2013. I would also like to thank the School of Biomedical Science and Medical Engineering of Beihang University. My hosts there have been very helpful and friendly to me throughout the visit programme. Special thanks were due to Prof. Cheng-Kung Cheng and Prof. Yubo Fan for sharing with me their professional knowledge on computational simulation. Their inspirational lectures were provoking. I gained a lot from their lectures.

Before visiting, Frank Jiao helped to do the connection. Jie Yao, a PhD student from Beihang, showed me around the School of Biomedical Science and Medical Engineering. The helps of these young scholars were much appreciated. I was shown a large variety of researches there - from astronauts' gloves to the biomechanics of woodpecker's head. Everything was related to improving the human lives using the latest technology. They were all very impressive. The research most related to my PhD research is the biomedical modeling of the foot and ankle. Researchers there have created a finite element model of the foot and ankle joint to investigate the possible ways of injury prevention.

I attended the 2013 National Summer School in Biomechanics and Mechanobiology with other postgraduate students from different universities around China. I was impressed by the learning attitudes of the students there. The first lecture by Prof. Savio Woo was on how to write academic papers for publication. He illustrated his passion for writing impactful papers. I enjoyed his interactive lecture.

The other impressive lectures included "Lower-limb Biomechanics Research" by Prof. Ming Zhang and "Introduction of Orthopaedic Biomechanics" by Prof. Cheng-Kung Cheng. Both were foundation seminars with well organized details to help us start our studies. I realized I had lots to learn - basic textbook knowledge as well as more recent journal papers for updates. The summer school and WACBE conference helped me know my deficiencies.

I treasured the network I have established with Beihang through this travelling fellowship. I hope to visit Beihang again in November 2013 when I would come to Beijing again for another congress on Orthopaedics.

## Biomedical Engineering is the Best Job in America

*Contributed by Zong-Ming Li*

Biomedical Engineering is the best (ranked #1) job in America according to a recent article published by CNNMoney (http://money.cnn.com/pf/best-jobs/). The ranking is based on the growth of the field, competitive salary, and job satisfaction. According to the article, the median pay for biomedical engineers is $87,000 with a top pay of $134,000. The 10-year job growth is projected at 61.7%. The article describes what biomedical engineers do, how they get the job, and why the field is great. Historically, biomedical engineers have helped make many wonders (for example MRI, pacemaker, and artificial joints) what they are today. Biomedical engineers work to design, create and improve medical devices such as prosthetics, artificial organs, and bioengineered tissues. In the job market, biomedical engineers typically have a bachelor's or master's in the field, and may have an MBA, law degree, or M.D. as well. Employers value team players who can communicate complex ideas well; being research-oriented is another plus. Quality of life for biomedical engineers is ranked particularly high. For those with a technical aptitude, it's an opportunity to make the world a better place. Every day, there's the potential to create something groundbreaking. The article also cautions that the working hours can be long since exciting research doesn't tend to fit the 40-hour work week. After all, we love our work in biomedical engineering; "choose a job you love and you will never have to work a day in your life," says our Chinese philosopher, Confucius.

**Best 100 Jobs in America:**

1 Biomedical Engineer
2 Clinical Nurse Specialist
3 Software Architect
4 General Surgeon
5 Management Consultant
6 Petroleum Geologist
7 Software Developer
8 IT Configuration Manager
9 Clinical Research Associate
10 Reservoir Engineer
11 Research Analyst
12 User Interface Engineer
13 Hand Therapist
14 Database Administrator
15 Video Game Designer
16 Telecommunications Network Engineer
17 Information Assurance Analyst
18 Bank Examiner
19 Portfolio Manager
20 Compliance Manager
21 Physician Assistant
22 Applications Engineer
23 Tax Accounting Manager
24 Forensic Accountant
25 Petroleum Engineer
26 Marketing Consultant
27 Optometrist
28 Business Development Associate
29 Customer Support Manager
30 ERP Consultant
31 Consulting Software Engineer
32 IT Data Scientist
33 Nurse Educator
34 Occupational Therapist
35 Certified Financial Planner
36 Forensic Computer Analyst
37 Pricing Analyst
38 Computer Security Specialist
39 Pediatrician
40 Clinical Applications Specialist
41 Family Physician
42 IT Business Analyst
43 Cost Accounting Manager
44 Physical Therapist
45 Community Relations Manager
46 Network Manager
47 Informatics Nurse
48 Web Analyst
49 Patent Attorney
50 Investment Manager
51 Corporate Counsel
52 Clinical Documentation Specialist
53 Computer Systems Integrator
54 Actuary
55 Geophysicist
56 Epidemiologist
57 Network Security Analyst
58 Data Management Analyst
59 Major Gifts Officer
60 Software Development Manager
61 Event Coordinator
62 Tax Analyst
63 Certified Public Accountant
64 Bereavement Coordinator
65 IT Training Specialist
66 Curator
67 Biochemist
68 Employee Trainer
69 Database Manager
70 Construction Estimator
71 Compliance Analyst
72 Auditor
73 Technical Support Engineer
74 Commercial Loan Officer
75 Transportation Engineer
76 Instructional Designer
77 Business Intelligence Manager
78 Software Quality Assurance Manager
79 Grant Coordinator
80 Employment Recruiter
81 Regulatory Affairs Manager
82 Civil Engineer
83 Environmental Health Scientist
84 Geotechnical Engineer
85 Geographic Information Systems Specialist
86 Technical Writer
87 Healthcare Product Manager
88 Community Health Specialist
89 Government Program Manager
90 Community Outreach Coordinator
91 Public Health Educator
92 Environmental Engineer
93 Education Program Manager
94 Career Development Specialist
95 Banking Relationship Manager
96 Licensing Manager
97 Supply Chain Manager
98 Business Development Executive
99 Underwriting Manager
100 Energy Analyst

## List of WACBE Life members

1. CHAN Kai-Ming. The Chinese University of Hong Kong
2. CHANG Hsin-kang, City University of Hong Kong
3. CHEN Zhongping, Univ. of California, Irvine
4. CHEN Jiajin, National Cheng Kung University
5. CHEN Weiyi, Taiyuan University of Technology
6. CHENG Cheng-Kung, National Yang Ming University
7. CHEUNG Tak-Man Jason, The Hong Kong Polytechnic University
8. CHIEN Shu, University of California, San Diego
9. CHING, Tak Shing, National Chi Nan University
10. CHOW Hung Kay Daniel, The Hong Kong Polytechnic University
11. CHUNG Pau-Choo, Cheng-Kung University
12. FAN Yubo, Beihang University
13. FONG Tik-Pui Daniel, The Chinese University of Hong Kong
14. FU Bingmei, The City College of New York
15. GOH Cho-Hong James, National University of Singapore
16. GONG He, Beihang University
17. GUO X. Edward, Columbia University
18. GUO Xia, The Hong Kong Polytechnic University
19. HSIEH Adam, University of Maryland
20. HU Xiaoping, Georgia Tech & Emory University
21. JI Julie, Indiana University Purdue University Indianapolis
22. JU Ming-Shaung, National Cheng Kung University
23. LEE Abraham, University of California, Irvine
24. LEONG Kam W, Duke University
25. LEUNG Kam Lun, The Hong Kong Polytechnic University
26. LI De Yu, Beihang University
27. LI Guoan, Harvard Med. Sch.
28. LI Zeng Yong, Shandong University
29. LI Zong-Ming, Cleveland Clinic
30. LIANG Zhi-pei, Univ. of Illinois at Urbana-champaign
31. LIM Chwee Teck, National University of Singapore
32. LIN Feng-Huei, National Tawian University
33. LIU Yu, Shanghai University of Sports
34. LONG Mian, Institute of Mechanics, CAS
35. LU Helen H, Columbia University
36. NIU Wenxin, Tongji University
37. MAK Arthur F T, The Chinese University of Hong Kong
38. MOW Van C, Columbia University
39. QIN Ling, The Chinese University of Hong Kong
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42. SHUNG K Kirk, University of Southern California
43. SU Fong-Chin, National Cheng Kung University, Taiwan
44. SUNG Lanping Amy, University of California, San Diego
45. TAM Wing Cheung Eric, The Hong Kong Polytechnic University
46. TOH Siew Lok, National University of Singapore
47. TONG Kai Yu Raymond, The Hong Kong Polytechnic University
48. TSUI Benjamin M W, Johns Hopkins University
49. WANG James HC, University of Pittsburgh
50. WANG Jaw-Lin, National Taiwan University
51. WANG Yadong, University of Pittsburgh
52. WONG Wai Hing Kenneth, Queen Mary Hospital
53. WOO Savio L-Y, University of Pittsburgh
54. YANG King H, Wayne State University
55. YANG Mo, The Hong Kong Polytechnic University
56. YANG Guangzhong, Imperial College London
57. YEN Michael, University of Memphis
58. YU Hanry, National University of Singapore
59. YUE Guang H, Cleveland Clinic Lerner College of Medicine
60. ZHANG Ming, The Hong Kong Polytechnic University
61. ZHENG Yongping, The Hong Kong Polytechnic University
62. ZHAO Chunfeng, Mayo Clinic
63. ZHU Cheng, Georgia Institute of Technology


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