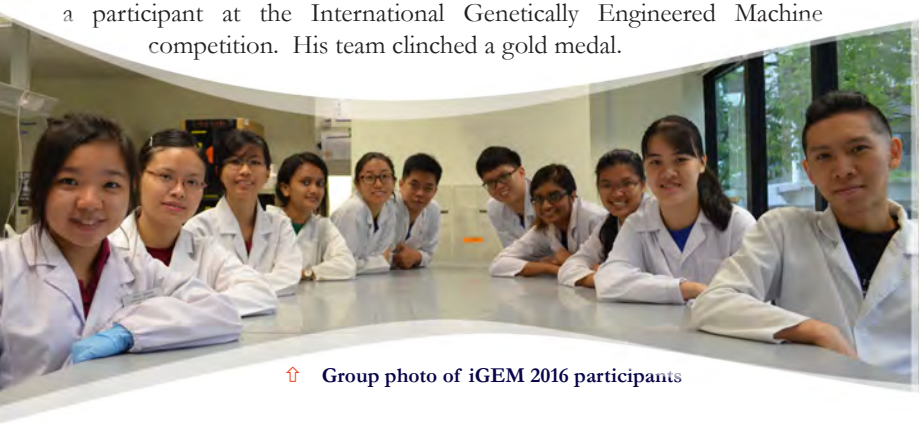
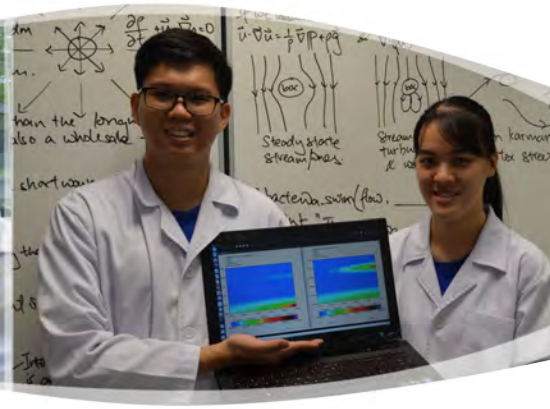
# Gold for team NUS at the International Genetically Engineered Machine competition

Final-year student Mr Chan Man Yau, Joseph, shared about his experience as a participant at the International Genetically Engineered Machine competition. His team clinched a gold medal.



⇧ Group photo of iGEM 2016 participants



⇩ Joseph working hard with his group mate for iGEM 2016

Artificial life, genetic engineering, micro-organisms, microscopes and zealous biologists in their lab coats are what come to mind whenever the term "synthetic biology" is mentioned. So it was rather strange to find a physics major joining life science, chemistry and pharmacy majors in the International Genetically Engineered Machine (iGEM) competition. iGEM is a premier international synthetic biology competition for students held annually in Boston, USA. There were 5600 participants from 42 countries last year. The goal was to create novel and applicable biological systems through the use of standardized DNA parts (BioBricks) and synthesizing new ones. The teams made their submissions and then gathered to present their works.

For the past two years, the Special Programme in Science (SPS) have organised teams to represent NUS in the undergraduate category of the competition. My team comprised of third- and final-year students. We aimed to develop a bacterial 'radar system' that could diagnose, locate and invade a broad range of human cancers. Our system is 'persuaded' to move towards the high lactate concentrations of cancer tumours. Cancer cell markers were then used to target and invade the cancer cells with the bacteria literally forcing its way in. Compared to chemotherapy and radiotherapy, this approach is more specific and does not require specialised equipment for administration. Considering the short nine months given for project preparation, we had been remarkably successful in generating new BioBricks for this system, as well as understanding its behavior.

Back to the oddity of having yours truly in this clearly biological undertaking, especially since my research focus is on meteorology (something different). As it turns out, synthetic biology is a huge playground for physicists. Many processes inside and outside of bacteria can be modelled using diffusion-reaction and diffusion-advection dynamics as first approximations, respectively. My role was to model these dynamics using a C-based approach. What I learned from A/P Paul Lim's module on *Computational Methods in Physics* became useful. It is surprisingly difficult to model intra-bacteria dynamics by conventional methods due to the tiny size of the bacteria (solving for diffusion by forward-time central-space method requires time steps of the order of $10^{-7}$ s).

Perhaps the biggest 'physics' challenge is to work out the constants or parametrisations of the processes in the bacteria. Processes within bacteria are typically understood qualitatively, but to figure out the mathematical and numerical details of bacterial processes from the literature requires great effort. Physics majors have an advantage in this field. We intuitively know if the model is generating sensible data, and have a firm foundation in the mathematics involved in modelling. Knowledge in numerical techniques (I strongly recommend Prof Wang Jiansheng's module on *Numerical Recipes with Applications*) helps: we can search for the best parameters for the modelled processes (eg, conjugate gradient, variational Monte Carlo).

I enjoyed myself during the iGEM competition. Boston trip aside, we often met and collaborated with teams from other countries. Furthermore, it was fascinating to witness the model I constructed taking shape, and to know how my other team-mates worked. I strongly recommend physics majors to join iGEM.