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RPPR Final Report
as of 08-May-2019

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Phone: (415) 502-1947
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STEM Degrees: **STEM Participants:**

Major Goals: BIOMOD is an international molecular design competition that provides opportunities for undergraduate students to understand, design, and construct nanoscale machines from biomolecules for scientific and technological purposes. To participate in BIOMOD, students self-organize into teams in the spring, and then spend the summer designing, building and analyzing their systems. In late October all teams travel to present their work at the “Jamboree” conference meeting in San Francisco.

BIOMOD is structured as follows. Early in the calendar year, university students form teams, conceive and perform original research under the direct supervision of a faculty mentor, and optionally additional graduate student or postdoc mentors. Topic areas typically include DNA nanotechnology, DNA computing, molecular self-assembly, protein engineering, cellular engineering, and synthetic biology. Students gain hands-on laboratory research experience during the summer months and subsequently create three project “deliverables” for evaluation by judges: a technical summary of their project in the form of a Project Website, a non-technical summary in the form of a 3-minute YouTube video, and a 15-minute presentation. Presentations are performed live at the Jamboree, followed by questions from the audience. Expert judges evaluate the project deliverables according to criteria that emphasize rigorous scientific study and strong communication skills. In addition to student presentations, we aim to schedule additional enrichment events such as keynote scientific lectures by scientific leaders, expert discussion panels to expose students to potential future career options related to bio-molecular engineering, and industry-sponsored workshops. The Jamboree concludes with an awards ceremony to recognize the top-performing teams. Breakfast and lunch are provided to all participants on both days of the conference, including a box lunch at the end of the conference with additional free time for interaction between teams and mentors.

Accomplishments: We successfully organized the BIOMOD competition and held the "Jamboree" event in San Francisco, California over the weekend of October 27–28, 2018. The venue was Genentech Hall Auditorium at the University of California, San Francisco.

RPPR Final Report
as of 08-May-2019

Training Opportunities: BIOMOD provided an organizational framework for students to gain hands-on research experience. Student participation in BIOMOD is complementary to other Science, Technology, Engineering, and Mathematics (STEM), but also offers unique elements that may not be available in traditional science laboratory coursework or even independent study in research labs. Students are required to conceive original research projects, perform their own laboratory experiments, and present their findings. Students must learn to work on teams because the project deliverables are too substantial for individuals to complete all of the requirements within the time constraints. Students must take intellectual ownership of their projects in ways that are similar to practicing scientists. Finally, organizing BIOMOD as a competition rather than a conference help fuel a competitive but friendly spirit among participants. Project awards are meaningful because they are earned with a great deal of hard work.

Results Dissemination: Competition winners were announced on the BIOMOD website (biomod.net) on the front page. Individual team rankings are posted and archived on the “Winners” page (biomod.net/winners/). Announcements are disseminated via social media accounts. We also announce any publications that are published by former BIOMOD participants.

Honors and Awards: Nothing to Report

Protocol Activity Status:

Technology Transfer: Nothing to Report

PARTICIPANTS:

Participant Type: PD/PI
Participant: Shawn Douglas
Person Months Worked: 2.00 **Funding Support:**
Project Contribution:
International Collaboration:
International Travel:
National Academy Member: N
Other Collaborators:

Participant Type: Other Professional
Participant: Rebecca Wheeler
Person Months Worked: 6.00 **Funding Support:**
Project Contribution:
International Collaboration:
International Travel:
National Academy Member: N
Other Collaborators:

BIOMOD 2018 Conference Proceedings

Prepared by: Rebecca Wheeler and Shawn Douglas, BIOMOD Foundation

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BIOMOD 2018 Introduction

BIOMOD is an international molecular design competition that provides opportunities for undergraduate students to understand, design, and construct nanoscale machines from biomolecules for scientific and technological purposes. To participate in BIOMOD, students self-organize into teams and design, build and analyze an original molecular design project.

Registration for BIOMOD 2018 opened in February 2018 and all 20 available slots were filled within a few days. A waitlist was established to both offer entry to waiting teams in the event that a registered team was unable to participate, and to ensure first chance at registration for the 2019 competition.

In early spring 2018, registered undergraduate students finalized their team composition and began to conceive and research their projects under the direct supervision of a faculty mentor from their institution, and optionally additional graduate student or postdoc mentors. Topic areas included DNA nanotechnology, DNA computing, molecular self-assembly, protein engineering, cellular engineering, and synthetic biology. Students gained hands-on laboratory research experience during the summer months and subsequently created three project "deliverables" for evaluation by judges: a technical summary of their project in the form of a Project Website, a non-technical summary in the form of a 3-minute YouTube video, and a 15-minute presentation.

Presentations were performed live at the Jamboree on Saturday, October 27, 2018. Expert judges evaluated the projects according to criteria that emphasized rigorous scientific study and strong communication skills. In addition to student presentations, we schedule an additional enrichment event with Dynamicland in Oakland in an effort to expose interested students to potential future career options related to bio-molecular engineering.

The Jamboree concluded with an awards ceremony on Sunday, October 28, 2018 where the top-performing teams were recognized and presented with award certificates. The weekend ended with an off-site group lunch to allow time for social interaction among the teams.

BIOMOD 2018 Group Photo

BIOMOD 2018 Schedule

Friday, October 26th, 2018

2:15pm to 6:15pm

- Team Registration at the University of California (by prior arrangement)
- 600 16th Street, San Francisco, CA 94058 – Genentech Hall
- Check in at Security on the 1st floor. Present your valid ID for a visitor's badge
- Proceed to the Douglas Lab on the 4th Floor – Room S472 (follow the signs!)
- Pick up your BIOMOD ID badge and t-shirt!
- Practice your presentation in a UCSF Conference room (by prior arrangement)

Saturday, October 27th, 2018

07:30-07:45	Make your way to UCSF Mission Bay — Genentech Hall.
07:45-8:30	**Breakfast available to all registered participants**
08:30–08:45	Welcome — Opening Remarks
08:45–09:00	Team KANSAI
09:00–09:15	Season
09:15–09:30	Team Sendai
09:30–09:45	NanoGear-NTU
09:45–10:00	HUST-CHINA
10:00–10:30	**Coffee Break**
10:30–10:45	Crystalline Entity
10:45–11:00	Biodesigners
11:00–11:15	ATCGU
11:15–11:30	Tianjin U
11:30–11:45	Cheeky Nanos
11:45–12:00	YOKABIO
12:00–12:15pm	**Group Photo**
12:15–13:30	**Lunch**
13:30–13:45	Find'n'Bind
13:45–14:00	NANO-JLU
14:00–14:15	Team HANDAI
14:15–14:30	Team Tokyo
14:30–14:45	NanoWolves
14:45–15:00	NanoBioUANL
15:00–15:30	**Refreshment Break**
15:30–15:45	DNAliens
15:45–16:00	Osteotarget
16:00–16:15	UCalgary
16:15–16:30	Wrap up
16:30–17:00	Judges submit scores.

Sunday, October 28th, 2017

09:00-09:15	Make your way to UCSF, Genentech Hall.
9:15-10:00	**Breakfast available to all registered participants**
10:00-11:30	**Awards & Closing Ceremony**
11:30-12:30pm	Board of Directors Meeting (Shokat, Rothemund, Murata, Wickham, Douglas)
12:00pm-3:00	Socialize + Lunch at Spark Social (RSVP Required)

Team Name: ATCGU
Institution: Chang Gung University, Taoyuan City - Taiwan
Project Title: briDge aN erA
Abstract:
In recent years, the problem of drug resistance genes caused by antibiotic abuse has become more and more serious, and it is more likely to extend the super-strong drug-resistant bacteria. In order to suppress this situation, we have designed a detector that can quickly identify drug resistance genes, "briDge aN erA". "briDge aN erA" uses a specific conductive material to make two electrodes. First, using the complementary characteristics of DNA, two different probes can be designed for drug resistance genes, and the probes are respectively connected to the electrodes on both sides. Second, the characteristics of DNA conduction are used as connected bridges, simply use the measurement of electrical changes, so that not only can quickly detect long-segment DNA, but also can detect multiple gene fragments in parallel to increase the accuracy of drug administration and slow down more drug resistance.

Team Name: Biodesigners
Institution: Tecnologico de Monterrey, Monterrey - Mexico
Project Title: Electrochemical DNA based biosensor for the detection of the transcription factor Gal4
Abstract:
The gene expression mechanism, that establishes and maintains specific cell states in humans, is controlled by thousands of transcription factors. Many diseases and syndromes are associated with mutations in regulatory regions. These mutations can contribute to cancer, autoimmunity, neurological disorders, cardiovascular diseases, among others. However, the understanding of transcription factors related diseases has been a challenge due to the high-cost and time-consuming techniques currently available. Therefore, the construction of an electrochemical DNA based biosensor is proposed due to its rapid response, high sensitivity, good selectivity and experimental convenience, which can lead to an effective identification and quantification of these type of proteins. The proposed biosensor detects the Gal4 transcription factor as a binary expression system (Gal4/UAS) reported in D. melanogaster. This tool can be modified for the recognition of different transcription factors related diseases and as a crucial step for the isolation of these proteins.

Team Name: Cheeky Nanos
Institution: University of British Columbia, Vancouver BC - Canada
Project Title: DNA for leukemia rreatment: an antibody-drug conjugate alternative
Abstract:
Over the past few years, many novel cancer treatments have made their way into a physician's toolbox. While Chemotherapy has made large strides in improving the odds of cancer patients world over, it is by no means a perfect solution. A promising new category of medicine, Antibody-Drug Conjugates (ADCs) are one of the fastest growing classes of oncology therapeutics. Using an Antibody, the drug is able to selectively target specific cancer cells based on a specific surface protein. This year, our team worked to create a DNA nanotechnology-based version of ADCs to target Acute Myeloid Leukemia. We replaced antibodies with an aptamer, allowing the structure to target the specific protein of interest. To attach the drug, we used DNA intercalators chemotherapeutics, bypassing the complex conjugation chemistry required for ADCs.

Team Name: Crystalline Entity
Institution: Colorado State University, Fort Collins, Colorado - USA
Project Title: Re-engineered protein-DNA co-crystals: Linking DNA blocks into DNA tiles
Abstract:
Traditional x-ray crystallographic structure determination methods are haphazard, expensive, and time-consuming. High-resolution DNA crystals, composed of designed tiles, could hypothetically organize third-party molecules (e.g. proteins), limiting their movement. These guest molecules could then be observed in atomic detail via X-ray diffraction. This host-guest paradigm could supplement or replace current methods. Towards this end, our team is engineering crystals composed of scaffold DNA and scaffold proteins. To improve the self-assembly of these crystals, we have designed DNA tiles that could substitute for multiple smaller DNA blocks. To match the geometry of the intended crystal assembly, the DNA tiles consisted of two parallel double helices connected by modified linkers. The DNA tiles also possess sticky ends, allowing for more favorable tile-tile interactions. To design the DNA tile, while preserving the ability to bind scaffold proteins, we used the NUPACK software suite, wrapped with PYTHON scripts. In addition to proposing specific DNA strand sequences, our scripts also assessed the likely assembly yield for various input tile designs. We obtained DNA strands corresponding to our first design and annealed these strands to form a tile. The annealed tiles were incubated with protein before crystallization trials. Protein-DNA co-crystals were successfully formed. We will confirm via X-ray Diffraction that the obtained crystals have adopted the intended packing arrangement. Notably, the intended packing arrangement provides solvent pores and exposed DNA segments sufficient in principle to capture and organize a third-party DNA-binding protein, engrailed homeodomain.

Team Name: DNAliens
Institution: University of Sydney, Sydney - Australia
Project Title: A DNA-origami microbial destroyer
Abstract:
Antimicrobial resistance is a growing global public health problem. In 2016 alone, nearly 500 000 people died from multidrug resistant tuberculosis. Resistance is costly to healthcare as traditional treatments become ineffective, longer hospitalisations and more expensive drugs are required. In our project, we are designing a DNA nanobot that selectively destroys microbes to combat resistance. Our project has two sections; targeting and destruction. The targeting section involves using DNA aptamers which are structures that can selectively bind to a particular microbe. Destruction methods we are exploring include disrupting microbial membranes with DNA-origami lipid nanopores. We are hiding our nanopore inside a DNA nanobot, and it is switched on for ‘destruction-mode’ only when it binds to a specific microbe. This technology could offer an alternative to antimicrobials such as antibiotics, which have been implicated in the emergence of superbugs.

Team Name: Find'n'Bind
Institution: TU Dresden, Dresden - Germany
Project Title: Two-component liposomal drug delivery system
Abstract:
The project is a novel two-component cancer drug delivery system. One component is a liposomal drug carrier and the other is a trigger system. The latter one is a gold nanoparticle functionalized with liposome destroying peptides. The drug carrier hosts the drug molecules and has an antibody attached to it, which is specific to a protein that has been over-expressed in the cancer cell. The trigger system also has an antibody, specific to another protein that is also over-expressed in the same target cancer cell. It is the simultaneous co-expression of the two proteins that signal the release of the encapsulated drug, and it is this dual interaction mode that keeps any non-specific interactions at a minimum.

Team Name: Team HANDAI
Institution: Osaka University, Osaka - Japan
Project Title: Get together!! DNA swarm robots
Abstract:
Self-organizing swarm robots communicate each other to perform tasks as a group. Here we made nano-meter scale swarm robots using DNA origami, forming network between individual robots. Upon environmental signal recognition (e.g. protein), individual robots activate the connection module and form multimer complex. Our nano-meter scale swarm robots may be applicable into therapeutics where the robots autonomously detect the wound location and can cover the wound, providing medicines through programmable manner.

Team Name: HUST-CHINA
Institution: Huazhong University of Science and Technology, Wuhan - China
Project Title: Butterfly effect
Abstract:
Benzene is a photoresponsive compound which contains two symmetrical benzenes like a pair of butterfly wings. It isomerizes from trans to cis with light switching from the visual to UV ,like a butterfly waving its wings, which generates the Butterfly Effect. Once it's inserted between adjacent nucleobases, the tran-to-cis isomerization triggers DNA unwinding as light changes. The same magic also applies to derivatives of azobenzene, S-DMAzo. Based on their outstanding properties, we design a light-driven nanomachine. The nanomachine consists of a ring as walker and a rod as track. As light of two different wavelengths switches, the doors made of two kinds of photoresponsive DNA strands on the rod open in turns so the ring carrying cargo moves along the track step by step. In a nutshell, this photo-driven nanomachine absolutely prevents the contamination compared with fuel-motivated nanomachines and also provides a new view on oriented molecule transport.

Team Name: Team KANSAI
Institution: Kansai University, Osaka - Japan
Project Title: Nano QR code Ver.2
Abstract:
We retry to make QR code using DNA origami method this time. Our team previously tried to make QR code using DNA origami method, in BIOMOD 2014. By using the dumbbell hairpin for the QR code dots, the DNA origami structure was expressed with a height difference. Therefore three DNA origami structures were required due to the position of the dumbbell hairpin in order to produce QR code. However, it was difficult to bond due to repulsion among DNA origami structures, and QR code could not be expressed. Then, we will reconsider the position of dumbbell hairpins and express the QR code with one DNA origami structure. We read QR code of DNA origami structures from AFM images using the camera application. Then if we can say that we succeeded in developing the smallest information medium in the world.

Team Name: NANO-JLU
Institution: Jilin University, Changchun Jilin - China
Project Title: Substrate-free covalent self-assembly of DNA three-way junctions into multiple nanostructures at room temperature
Abstract:
Recently, DNA-based nano biomaterials have been greatly developed and widely applied owing to their sequence programmability, accurate self-recognition and instinct biocompatibility. However, DNA self-assembled nanostructures, like DNA rotors, DNA polyhedras and DNA walkers, are mostly formed through hybridization of ssDNA, which might bring perturbation to some active molecules or enzymes because of the high temperature needed. Herein, we propose a substrate-free method to construct a covalently bonded two-dimensional DNA nanostructure at room temperature. AFM and TEM images demonstrate that DNA vesicles are

successfully constructed with monodisperse properties and stability. Based on above, we modified the vesicle with biotin and i-motif respectively. Fluorescence microscopy indicates that the vesicle could be readily functionalized with streptavidin through biotin-avidin interaction when modified with biotin, and DLS confirms that the vesicle size could respond to pH changes when modified with i-motif. We believe these vesicles would have wide applications in many areas, especially drug delivery.

Team Name: NanoBioUANL
Institution: Universidad Autonoma de Nuevo Leon, San Nicolás de los Garza - Mexico
Project Title: Levodop(e) biosensor
Abstract:
Neurodegenerative diseases are one of the main health problems society faces, some of them such as Parkinson's (PD) or Alzheimer's Disease (AD) show a progressive cognitive decline presumed to be consequence of multiple factors, one of them is the dopaminergic system. Early diagnosis and monitoring are important, for health care facilities and physicians, so they can provide better treatments for patients. In order to determine if a patient has one of the neurodegenerative disorders mentioned, they must take tests that require a cerebrospinal fluid sample, which extraction represent a painful and dangerous procedure for patients. Therefore, we developed an optical biosensor for levodopa (dopamine precursor) detection made of carbon nanotubes and functionalized nanoparticles, given that levodopa levels in bodily fluids can be correlated with dopamine levels and the neurodegenerative disease stage, thus making our biosensor a fast and noninvasive alternative for early detection and monitoring of these diseases.

Team Name: NanoGear-NTU
Institution: National Taiwan University, Taipei City - Taiwan
Project Title: Nanogear
Abstract:
In recent years, DNA has become a powerful tool to construct nanoscale machinery. However, so far there are limited methods to drive movements of DNA. We invent a novel approach for circular motion of DNA by utilizing optical tweezers. Optical tweezers, a highly focus laser beam, have been discovered to transfer spin angular momentum to induce rotation of certain objects. In our project, we aim to build a DNA nano-gear with a property of optical asymmetry, and trigger its circular motion by circularly polarized laser beam, which is a new source of power in biology under nanoscale. In future application, our photo-driven DNA nano-gears can be used to form more complex nanomachines with its high-precision activating region. Our design can benefit the structure of recent nanomachines from simple to diverse, and can initiate a new era in the “industrial revolution” of nanomachines.

Team Name: NanoWolves
North Carolina State University, Raleigh, North Carolina - USA
Project Title: Genetically encoding functional RNA origami: anti-coagulants
Abstract:
Thrombin plays important roles in platelet activation and blood clotting and is a critical control point in a variety of therapeutic applications. Here, we describe a single-molecule, functional RNA origami bearing two RNA aptamers and demonstrate anticoagulant activity. The construct was designed in silico and produced by in vitro transcription. We significantly improved the RNA’s functionality as an anticoagulant and stability in human plasma by incorporation of 2’-fluoro-modified nucleotides during transcription. The modified RNA origami is stable in RNase A over 6 hours and in human plasma for at least 24 hours, which is more stable than DNA. We demonstrate anticoagulation activity of RNA origami six-fold higher than free aptamer. Moreover, inhibition of thrombin’s enzymatic activity is shown to be reversible by addition of single-stranded DNA antidotes complementary to the aptamers. This project paves the way for

development of RNA origami for therapeutic applications including as safer surgical anticoagulant.

Team Name: Osteotarget
Institution: Hong Kong Baptist University, Hong Kong - China
Project Title: Development of a novel osteoclast-targeted cathepsin K inhibitor to suppress bone resorption in postmenopausal osteoporosis
Abstract:
As osteoporosis becomes one of the most prevalent bone diseases in postmenopausal women worldwide without a proper treatment that can limit the side effects for long-term used, the new anti-resorptive drugs are urgently needed. Our project is basically focus on the usage of a new promising targeting moiety, which is the eight repeated sequences of aspartate (D-Asp8). What we have done is to find out how to combine it properly with Odanacatib, the drug reached Phase III Randomized Controlled Trials and suspended by Merck for its increased risk of cardio/cerebrovascular events, with the minimal impairment of it function and maximum specific-bind feature to reach the osteoclasts. In order to find the best site to combine, we have also done some subsequent experiments to prove the effectiveness and specificity of our new conjugate (D-Asp8)-ODN. We believe that through our work, a new CatK inhibitor candidate may come out for the treatment of postmenopausal osteoporosis.

Team Name: Season
Institution: Ocean University of China, Shandong Sheng - China
Project Title: Chinese characters in DNA library
Abstract:
Recently, researchers on storing information into DNA sequences has aroused considerable interest due to the high storage density and long storage time of DNA. However, existing DNA storage strategy rarely covers the field of Chinese character’s storage. So, we put forward an encoding scheme based on the idea of “split” and “etymon” to store Chinese characters into DNA, which are complex and enormous. Then, we synthesized, cyclized, and amplified our DNA sequences. Fortunately, we obtained the target DNA fragment, therefore we sequenced them by MinION and translated by the software we written. In the end, we successfully recovered information we want to store. At the same time, we designed a simple picture encoding scheme according to this idea. In future, we may store complete Chinese books and apply this scheme on other language or aspects which confirms our scheme is generalized.

Team Name: Team Sendai
Institution: Tohoku University, Miyagi - Japan
Project Title: DNA transfolder
Abstract:
Self-assembly of biomolecules has allowed the autonomous configuration of nano-structures through bottom-up methods. However, controlling their movements to perform coordinated functions has been a challenge in designing dynamic devices. Here, we designed a planar DNA Origami based on "Miura Folding", a folding pattern composed of repeated parallelograms which can fold and transform in unison as a whole. The designed structure is composed of units of four parallelogram panels made of double-stranded DNA which are connected by flexible single-stranded hinges at the edges. A strut DNA supports the panels, reacting with signals to open and close the structure. With this, structure transformation can be regulated according to specific signals, and individual units can move synchronously to perform dynamic transformation together. Furthermore, repeating these units can form larger signal-reacting macromolecules with high functionality. In the future this may realize highly designable and regulatable DNA origami robots or add transformability to self-assembled products.

Team Name: Team Tokyo
Institution: University of Tokyo, Tokyo - Japan
Project Title: Dynamically moving DNA hydrogel
Abstract:
We aim to develop DNA hydrogel which causes mm-scale structure change. The gel consisted of X-motif adopts hairpin structure and swells by opening the hairpin structure and shrinks by reforming it. Hairpin structure can be controlled simply by adding strands. It is possible to construct mm-scale DNA hydrogel and in theory the gel can swell by maximum 1.6 times. This means mm-scale dynamic movement can be realized. The dynamic movement change can work against macro structures in vivo, such as cells or tissues For example, the gel can control differentiation or development by changing the distribution of cells, which is critical for them. This contributes the research of differentiation or development. In addition, the gel can also constrict blood vessel to construct and swell around blood vessel. The system constricts blood vessel physically, so can realize vasoconstrictor with fewer side effects.

Team Name: Tianjin U
Institution: Tianjin University, Tianjin - China
Project Title: Cancer Terminator- A DNA origami-based self-assembly nanorobot
Abstract:
Cancer has been a worldwide issue towards human health. Recent years, we have witnessed the blooming of cancer treatment techniques including anti-cancer drugs, chemotherapy and radiotherapy. However, certain drawbacks still exist among these methods, bringing side effects to patients more or less. Due to full biocompatibility and multi-functionality, DNA has been a widely used material for drug delivery and disease therapy. Herein, we intent to construct a DNA origami-based self-assembly nanorobot. Our nanorobot is functionalized with the DNA aptamer AS1411, which could be triggered by the nucleolin, an over-expressed protein at the surface of tumor cells. Once triggered, the nanorobot will gelate inside the blood vessels around the tumor cells, which efficiently blocks the substance transportation, and induces the starvation and apoptosis of cancer cells in the end. Our nanorobot is capable of curing the cancer with little side effects, which opens new opportunities in clinical applications.

Team Name: Team UofC
Institution: University of Calgary, Calgary - Canada
Project Title: Nanoscience in fingerprinting – caught red-handed
Abstract:
Fingerprints are widely used as biometric identifiers, even in everyday life, especially with increased use in technology. This project aims at enhancing the capabilities of fingerprint analysis used in the forensic world. The core idea is to immobilize bright and colourful nanoparticles made of cadmium telluride on the fingerprint ridges. To label the fingerprints only, the nanoparticles are functionalized with aptamer molecules that target lysozyme, a protein that is abundant in sweat, which makes up fingerprints. As a proof of concept, we begin with labelling patterns drawn on glass with a concentrated lysozyme solution. We have successfully synthesized cadmium telluride nanoparticles. The procedure yields bright particles with emission colours spanning the entire visible range of wavelengths. We selected one of these wavelengths as the basis for cadmium sulfide shell growth around the nanoparticles cores which resulted in further enhancement of emission intensities. During the shell growth, lysozyme specific DNA aptamers were incorporated and immobilized in the shell. This attachment was proven by mixing the particles with a solution of complimentary DNA aptamers functionalized with a fluorophore. By performing fluorescence spectroscopy with this mixture, energy transfer between the two fluorescent molecules was observed. This phenomenon is called Forster Resonance Energy Transfer and occurs between closely linked emitting particles. These particles were tested along with non-functionalized particles and the functionalized particles were shown to target complimentary aptamers and lysozyme directly. The non- functionalized

particles do not exhibit energy transfer or attachment to lysozyme. These findings allow for the labeling and fluorescent development of a pattern drawn using a lysozyme solution. We hope to fine-tune and expand this application to be able to label and develop fingerprints as well.

Team Name: YOKABIO
Institution: Kyushu Institute of Technology, Fukuoka - Japan
Project Title: DPgate bridge ~DNA circuit for controlling protein system
Abstract:
As a problem in current cancer treatments, healthy cells other than cancer cells are also adversely affected, so carious side effects appear. In recent years, researchers are developing Drug Delivery System(DDS) that transport drugs directly to cancer cells using nanoscale structure made of biomolecules. There are many merits by using this technology, but due to the difficulty of its control, it is not a proctical level at present. We propose a new cancer treatment method focusing on energy for cell's life activity. Our proposed DNA system covers a wide range of cells like conventional cancer treatment. In addition, this will cause only cancer cells to die, normal cells will hardly be affected. We believe that our research will become a foothold for the future development of cancer treatment.

BIOMOD Judging Process

Our aim is to always maintain an open and fair process for evaluating each team's performance. Teams are scored by judges using a point system. The judging process will have two stages: online content (worth up to **75 points**) and live presentation (worth up to **25 points**).

Online content scoring

- Maximum combined score for online content is **75 points** (= 50 points for wiki + 25 points for internet video)
- Scores are determined by a range-voting system.
- Five (5) judges are randomly assigned to each team.
- Judges evaluated each project according to a rubric (see below) and assigned a point value in each category.
- Highest and lowest judges' total scores were excluded to remove outliers.
- Three remaining judges' scores are each weighted by 1/3 and combined to determine the total scores for each category.

Website (up to 50 points)

Project Idea (20 points)

- Relevance: Did the team made a strong case that their project idea is scientifically and/or technologically interesting? **(5 points)**
- Specification: Were the project goals well-defined? (i.e. Did the team explicitly state what criteria needed to be met in order to consider the project a success?) **(5 points)**
- Feasibility: Was the proposed solution feasible? (i.e. Was it reasonable to expect that the solution could be implemented by a BIOMOD team in one summer?) **(5 points)**
- Merit: Was the proposed solution a good one? Was it particularly elegant or innovative? **(5 points)**

Project Documentation (20 points)

- Clarity: Was the project description well-written and easy to understand? Did it include the background and motivation of the project, methods, results, and discussion? Were the figures easy to understand? **(10 points)**
- Transparency: Was all of the raw experimental data and source files easily accessible? Would it be straightforward to attempt to reproduce the team's results? **(5 points)**
- Layout: Was the team's project page arranged in a clear and logical fashion? **(5 points)**

Project Execution (10 points)

- Execution: Did the team accomplish what they set out to do? **(10 points)**

YouTube video (up to 25 points)

- Overall impact: Was the video interesting? **(10 points)**
- Clarity: Was the project described in a simple and clear manner that could be easily understood by a wide audience? **(10 points)**
- Production: Was the sound and video high quality? Were the images focused and scaled properly? **(5 points)**

Presentation scoring (up to 25 points)

- Content: Were the slides clear and easy to understand? Did the project narrative have a logical flow, with clearly stated goals and results? **(10 points)**
- Delivery: Did the speaker(s) give a well-rehearsed, well-paced presentation? Did the speaker(s) engage with the audience and maintain good eye contact? **(10 points)**

- Impact: Was the presentation interesting? fun? clever? memorable? **(5 points)**

Judges

- Judges were selected from a pool of BIOMOD faculty mentors and outside experts.
- Mentors do not evaluate their own team.
- The 2018 BIOMOD Jamboree Judges were:

Akinori Kuzuya
Alexandre Baccouche
Alice Williamson
Amanda Musgrove
Birka Lalkens
Chenxiang Lin
Christopher Snow
Chunxi Hou
Dayong Yang
Edward Chern
Elisa Franco
Francesco Ricci
Francis Stewart
Grisel Fierros Romero
Hans-Georg Braun
Henry Hess
Hisashi Tadakuma
Huang Chao
Ibuki Kawamata
Jeng-Shiung Jan
Jin Liu
Jorgen Kjems
Joseph Schaeffer
Junichi Taira
Kalaumari Mayoral Peña
Kei Fujiwara
Keisuke Morishima
Ken Komiya
Kishio Ono
Lawrence Lee
Manish Gupta
Marcos de Donato Capote
Mario Alberto García-Ramírez
Masahiro Takinoue
Masami Hagiya
Max Anikovskiy
Oxana Kharissova
Patrick Yue
Peng Wang
Philip Lukeman
Philip Tinnefeld
Ralf Jungmann
Robert Yung-Liang Wang
Saba Nojoumi
Satoshi Murata
Shelley Wickham
Shin-Ichiro Nomura
Shizhen Wang
Shogo Hamada
Shuwen Guan
Szecheng Lo
Takashi Nakakuki
Thorsten-Lars Schmidt
Tural Aksel
Vikramaditya Yadav
Yanzhi Xia
Yi Zhan
Yibing Huang
Yonggang Ke
Yu-Fon Chen
Zhang Ge

Award Categories

The following prizes were awarded:

Top Prizes

- Grand prize = 1st highest total combined points from wiki + video + presentation - **Winner: Team Sendai, Tohoku University**
- 1st runner up = 2nd highest total combined points from wiki + video + presentation – **Winner: NanoWolves, North Carolina State University**

- 2nd runner up = 3rd highest total combined points from wiki + video + presentation – **Winner: Cheeky Nanos, University of British Columbia**

Category awards

- Best Website = 1st place, 2nd place, 3rd place. **Winners: Team Sendai, NanoWolves, Cheeky Nanos**
- Best YouTube Video = 1st place, 2nd place, 3rd place **Winners: Team Sendai, HUST-China (Huazhong University of Science and Technology), Osteotarget (Hong Kong Baptist University)**
- Best Presentation = 1st place, 2nd place, 3rd place **Winners: DNAliens (University of Sydney), Team Sendai, NanoWolves**
- Audience Favorite = 1st place, 2nd place, 3rd place

Special Awards

- The 8th Annual Molecular Robotics Award (by MOLBOT, Japan)
- Audience Choice Award – Best Project
- Best Team T-shirt Award

BIOMOD Board of Directors

The BIOMOD Foundation is currently run by its board of directors: Shawn Douglas (UCSF), Satoshi Murata (Tohoku University), Paul Rothemund (Caltech), Kevan Shokat (UCSF), and Shelley Wickham (University of Sydney) and is supported by Rebecca Wheeler (lead organizer), and Robert Pierce (legal).

BIOMOD History

Over 1700 students, mentors, and judges have participated in the BIOMOD competition since 2011.

The competition was begun at Harvard University by the Wyss Institute for Biologically Inspired Engineering, which conducted the competition during the years 2011 to 2015. The mission of the competition was to inspire a generation of students to learn to engineer biomolecules at the nanometer scale. In 2016, BIOMOD Foundation assumed management of the competition.

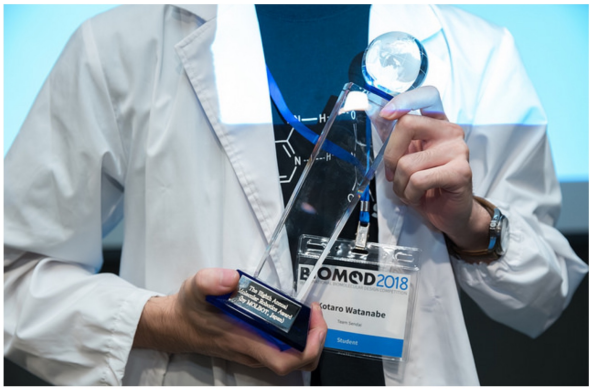
From 2011–2015, the lead events coordinator at the Wyss Institute was Jermaine Reid, who was instrumental in making BIOMOD a success. Jermaine worked closely with Mary Tolikas (Director of Operations), along with Alison Reggio, Mary Wozniak, and Caitlin Wells.

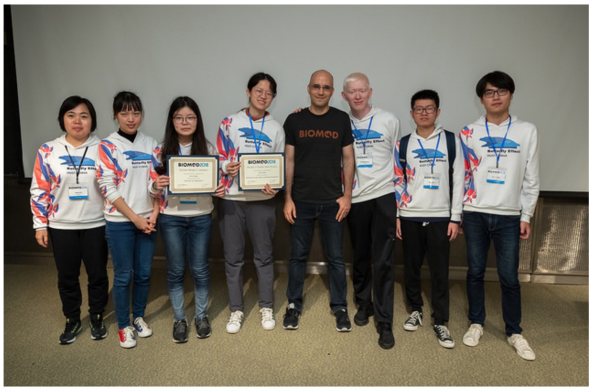
The BIOMOD website and Competition Management Software were originally developed by Kristian St.Gabriel and Byron Hinebaugh.

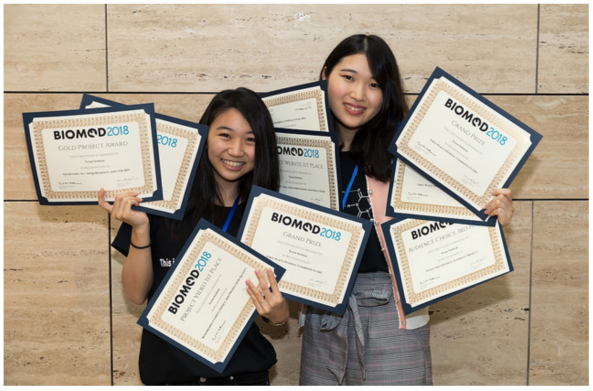
BIOMOD 2018 Photos

BIOMOD 2018 Registration Check-in and Selected Student Presentations

Additional BIOMOD 2018 Student Presentations







BIOMOD 2018 Award Ceremony