

World Premier International Research Center Initiative (WPI)

FY 2019 WPI Project Progress Report

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Common instructions:

* Unless otherwise specified, prepare this report based on the current (31 March 2020) situation of your WPI center.

* So as to execute this fiscal year's follow-up review on the "last" center project plan, prepare this report based on it.

* Use yen (¥) when writing monetary amounts in the report. If an exchange rate is used to calculate the yen amount, give the rate.

➤ Prepare this report within 10-20 pages (excluding the appendices, and including Summary of State of WPI Center Project Progress (within 2 pages)).

Summary of State of WPI Center Project Progress (write within 2 pages)

1. Advancing Research of the Highest Global Level

Summary of Activities in FY2019

Journal publications (Jan 2019 – Dec 2019): 134 peer-reviewed papers (35 papers = IF>10; 54 papers = IF>7; 4 Highly cited papers; 1 Hot paper)

Patent filings: 20 (3 cases based on interdisciplinary research)

Commercialization of molecules/catalysts: 4

Awards and honors (faculty members): 21

Research funds: 973 million yen (overseas PIs also obtained KAKENHI grants).

ITbM has continued its endeavors to advance cutting-edge science and developed transformative bio-molecules. Going forward with the mission/goal, ITbM is tackling the challenges on "parasitic plants", "chemistry-enabled plant adaptation", "clock diseases", "chemistry-enabled bioimaging", and "nanocarbon chemistry and biology".

Parasitic plants

ITbM developed SPL7 to control infestation of the parasitic plant *Striga*. The SPL7 is expected to be the long-awaited technology to pursue future food security in the African continent. ITbM has been tackling this issue to confirm its efficiency in research fields in Kenya. In FY2019, field experiments of SPL7 have started in Kenya in collaboration with Kenya Agricultural & Livestock Research Organization (KALRO). SPL7 was effective in inducing *Striga* germination in the soil from the Kenyan field. In addition to the SPL7, molecules that control *Striga* germination in many ways have been developed. Candidate molecules to control another parasitic plant *Orobanch*e have also been developed. ITbM's challenge to combat *Striga* was highlighted in TICAD7 and its official side-events.

Chemistry-enabled plant adaptation

Plants have inherent stress tolerance systems that enable them to adapt to environmental changes. However, recent global climate change exceeds the tolerance of the current abiotic stress response. ITbM aims to develop molecules to overcome such environmental stress to maximize the adaptive power of plants via an interdisciplinary approach. In FY2019, ITbM has elucidated several molecular mechanisms that regulate stomatal development and movement. Research on mechanistic investigations on plant fertilization and transporters have also been notably advanced.

Clock diseases

The circadian clock regulates virtually all physiological processes. Disturbances in the circadian system have a profound impact on health, and they have been linked to several pathologies, including obesity, psychiatric disorders, cardiovascular disease, and even cancer. ITbM will endeavor to develop transformative bio-molecules to understand and regulate the circannual clock, which will contribute to combating global climate and environmental changes. In FY2019, remarkable progress has been made on circadian clock study related to mammalian cell cycles, a seasonal clock of medaka fish, and circadian control of plants.

Chemistry-enabled bioimaging

ITbM has been working to develop new bioimaging molecules and tools that overcome many drawbacks of current fluorescence molecules and applicable to wide ranges of biology and medical sciences. In FY2019, several characteristic fluorescent molecules/tools have been developed, including MitoPB Yellow, LAQ1, and AP-C12.

Nanocarbon chemistry and biology

The Itami group has conducted the precise and bottom-up syntheses of nanocarbons and had a significant impact in the field of nanocarbon science. In FY2019, the group succeeded in the first experimental measurements of the ultimate tensile strengths of individual structure-defined, single-walled carbon nanotubes. Many unique nanocarbon entities have been synthesized, and their biological application has been investigated.

2. Generating Fused Disciplines

ITbM's interdisciplinary research has been making significant progress under the "Mix" concept. The ITbM Research Award, ITbM Workshop, and Tea Break Meeting are providing opportunities to find new partners and seeds for collaboration, where Administrative Department of ITbM plays vital roles.

ITbM's four supporting centers (Molecular Structure Center, Live Imaging Center, Chemical Library Center, and Peptide Protein Center) are also making a significant contribution to the promotion of ITbM's interdisciplinary research through their technical support.

In 2018, the Graduate Program of Transformative Chem-Bio Research (GTR) was launched as a "*Doctoral Program for World-leading Innovative & Smart Education (WISE program)*", which promotes collaboration widely of all the researchers/PhD students engaged in chemistry and biology. ITbM and GTR have also entered into partnerships with the Graduate School of Medicine and the WISE program CIBoG, expanding the collaboration toward biomedical sciences.

3. Realizing an International Research Environment

- Higashiyama hosted the EMBO Workshop with a practical course for the first time in Japan, which collects 51 researchers from 22 countries. ITbM also organized the annual symposium and awards.
- University of Texas at Austin became a partner according to the transfer of Torii in Oct 2019.
- In addition to the bilingual staff members in the office, ITbM has a staff member to provide local support to researchers and their families from overseas.
- ITbM concluded a contract with Japan IR&C to provide medical support to the researchers/families from overseas.

4. Making Organizational Reforms

Under President Matsuo's Initiatives for Reform, Autonomy and Innovation 2020 (NU MIRAI 2020), NU has been carrying out extensive system reform to become a world-class research university. In October 2019, Nagoya University Institute for Advanced Study (NAIAS) was established to strengthen NU's advanced basic research, and ITbM is positioned under this umbrella. NU also recognizes the importance of the ITbM's "Mix" concept for the education system of PhD students. In 2018 "Graduate Program of Transformative Chem-Bio Research (GTR)" was selected to a MEXT's WISE program, which will induce reformation of the graduate program of NU.

5. Efforts to Secure the Center's Future Development over the Mid- to Long-term

ITbM will take appropriate actions to secure the necessary funds to operate ITbM by all means. NU continues to provide the supports needed to sustain ITbM at the current level. NU launched NAIAS and has been requesting faculty positions to MEXT to strengthen ITbM's activities since 2017, which has been approved. ITbM has been establishing strong networks with industry through collaborative research and ITbM Consortium. To further increase funding, ITbM will cooperate with NU to strengthen the tie with industry and to find counterparts for future industry-academia collaborations. Acquisitions of external funds from overseas will also be necessary. Therefore, as of March 2020, ITbM hired a designated associate professor, locates in the U.S. office of NU (Technology Partnership of Nagoya University: NU Tech). ITbM will proactively access to overseas industries in cooperation with the NU Tech.

- * Describe clearly and concisely the progress being made by the WPI center project from the viewpoints below.
- In addressing the below-listed 1-6 viewpoints, place emphasis on the following:
 - (1) Whether research is being carried out at a top world-level (including whether research advances are being made by fusing disciplines).
 - (2) Whether a proactive effort continues to be made to establish itself as a "truly" world premier international research center.
 - (3) Whether a steadfast effort is being made to secure the center's future development over the mid- to long-term.

1. Advancing Research of the Highest Global Level

- * Among the research results achieved by the center, concretely describe those that are at the world's highest level. In Appendix 1, list the center's research papers published in 2019.
- * Regarding the criteria used when evaluating the world level of center, note any updated results using your previous evaluation criteria and methods or any improvements you have made to those criteria and methods.

Under the "Mix" concept, ITbM has continued its endeavors to advance cutting-edge science encompassing the three flagship research areas defined as plant chemical biology, chemical chronobiology, and chemistry-enabled live imaging. As a result, a number of unprecedented bio-functional molecules and new synthetic methods/catalysts that enable the on-demand synthesis of the molecules have been developed. Additionally, nanocarbon has recently emerged as a new ITbM flagship in accordance with the remarkable progress of new forms of synthetic nanocarbons and their potential bioactivity. All of the tour-de-force achievements have led scientists worldwide to place ITbM as an enabling institute where new bioactive molecules with targeted properties can be rapidly discovered, designed, and synthesized. Going forward with its mission/goal of developing transformative bio-molecules, ITbM is tackling the following challenges: "parasitic plants", "chemistry-enabled plant adaptation", "clock diseases", "chemistry-enabled bioimaging", and "nanocarbon chemistry and biology".* The representative research outcomes are shown below.

*ITbM has somewhat revised the research targets due to the negative result of the WPI program committee's screening of the extension.

(1) Research progress

(i) Parasitic plants

ITbM developed SPL7 to control infestation of the parasitic plant *Striga*. The SPL7 is expected to be the long-awaited technology to pursue future food security in the African continent. Through extensive cooperation with Dr. Makihara of the International Center for Research and Education in Agriculture (ICREA) of NU, ITbM has been tackling this issue to confirm its efficiency in field research in Kenya in collaboration with Kenya Agricultural & Livestock Research Organization (KALRO).

After the long application process, the export of SPL7 to Kenya was authorized in May 2019 by the Kenyan government, and ITbM immediately started the field experiments of SPL7 in July at KALRO Kibos in Kenya. Unfortunately, this very first trial did not provide clear evidence of SPL7's efficacy, since the *Striga* did not come out even in the control plots, probably because of unusual weather (little rain and cold summer) and viral infection. After this trial, we have continued to identify better experimental conditions in the screen house and confirmed that SPL7 is effective in inducing *Striga* germination in soil from the field in Kenya. The second field experiment started in March 2020, irrespective of many problems arising from the pandemic of the coronavirus (SARS-CoV-2).

In FY2019, SPL7 was subjected to toxicity checks, including AMES test of the metabolites, skin sensitization test (rat), skin irritation test (rabbit), acute oral/contact test of the honey bee, and acute toxicity test (aquatic animal, Medaka and Daphnia). So far, no negative results have been indicated. The toxicity checks were necessary as part of the export application process of SPL7 to Kenya.

In parallel with the field experiments, Tsuchiya has been working on the elucidation of *Striga*'s basic science. The team found a molecule that breaks the limit of the *Striga* germination threshold, which has been an important issue previously pointed to by the WPI Working Group. They also developed selective antagonists for various strigolactone receptor isoforms (with the Ooi group and the Chemical Library Center). These molecules will provide hints to the interaction of *Striga*'s eleven strigolactone receptor families. To identify the downstream components of strigolactone receptors, the team has performed chemical suppressor screening for SPL7 and identified more than 30 germination inhibitors. The target protein is expected as unknown components of strigolactone signal transduction. The team has also developed novel nucleic acid derivatives that metabolically label RNA after reacting with strigolactone receptors (with the Ooi group). This enables genome-wide identification of co-expressed genes with strigolactone perception.

Due to the considerable impact on the global society and contribution to STI for SDGs of Africa, ITbM's challenge was highlighted in multiple events of the 7th Tokyo International Conference on African Development (TICAD7) held in Yokohama on August 2019; Advisory Panel for the Promotion of Science and Technology Diplomacy (Chair: Dr. Teruo Kishi, Science and Technology Advisor to the Minister for Foreign Affairs of Japan) highlighted it in "Recommendations towards TICAD7: Achieving an innovation ecosystem together with Africa" as one of the important "science diplomats" of Japan to Africa (https://www.mofa.go.jp/press/release/press4e_002617.html); the TICAD7 official side event organized by MEXT, "Africa-Japan Ministerial Dialogue Meeting on STI for SDGs", invited Directors of ITbM and KALRO to provide a joint presentation as a good practice on Japan-Africa cooperation (https://www.mext.go.jp/en/news/topics/detail/mext_00015.html); Minister Hirai mentioned in his introductory remarks at TICAD7's thematic meeting "STI and Digital Transformation" as a new initiative to contribute STI for SDGs of Africa.

(ii) Chemistry-enabled plant adaptation

Plants have inherent stress tolerance systems that enable them to adapt to environmental changes and survive under stressful conditions that are essential functions due to their inability to move. However, recent global climate change exceeds the tolerance of the current abiotic stress response of plants, and they often face serious situations such as failing to fertilize, failing to develop, and eventual death. If such environmental stress can be overcome by synthetic molecules, food production can be maintained or increased even in a severe CO₂-rich environment, improving food security and combatting climate change. Based on our research outcomes, ITbM is tackling the development of such abiotic stress-overcoming molecules to maximize the adaptive power of plants via an interdisciplinary approach.

The Kinoshita group has been focusing on physiological aspects of stomatal movement. They demonstrated that light-induced stomatal opening and increase of stomatal conductance are larger in the plants grown under long-day conditions through increasing expression levels of FT and SOC1. Interestingly, the enhancement of light-induced stomatal opening and increase of SOC1 expression in guard cells by the long-day conditions retained at least one week after the plants transferred to the short-day conditions (Sci. Rep. 2019). They also revealed that endogenous plant hormone Brassinolide (BL) enhances the phosphorylation level of the PM H⁺-ATPase penultimate residue during hypocotyl elongation via the BL-insensitive 1 (BRI1)-BIN2 signaling pathway (Plant Cell Physiol. 2019). Furthermore, they revealed that the *Oryza sativa* H⁺-ATPase 1 (OSA1)-overexpressing rice showed enhanced light-induced stomatal opening, photosynthesis, ammonium uptake in roots, and biomass in hydroponic culture, as well as around 25% increase of grain yield in the field in China (papers submitted).

The Torii group collaborated with the Tama group and have revealed the molecular basis of how cell signaling component is recruited to the nucleus to inhibit a master regulatory transcription factor of stomatal development. Structural analyses of MPK6, a protein that downregulates SPEECHLESS (transcription factor initiating stomatal cell lineages), at the 2.75Å resolution unraveled bipartite binding of SCREAM with MPK6, and that the MAP6 is distinct from an upstream MAPKK. These findings revealed the mechanism directly linking extrinsic signals to transcriptional reprogramming during the establishment of stomatal cell-fate, and highlight a unique substrate-binding mode adopted by plant MAPKs (Nature Plants 2019).

The Torii-Uchida group has established an engineered, orthogonal auxin-TIR1 receptor pair, developed through a bump-and-hole strategy, that triggers auxin responses without interfering with endogenous auxin and TIR1. The combination of convex IAA (cvxIAA) and concave TIR1 (ccvTIR1^{F79G}) serves as a powerful tool for solving remaining questions in auxin biology and for precise manipulation of auxin-mediated processes. They further created a novel auxin derivative, pico-cvxIAA, having 100-fold increased activity, through pairing with another concave TIR1 (ccvTIR1^{F79A}). By using the pico-cvxIAA-ccvTIR1^{F79A} pair, they succeeded in developing a protein-knock down system in mammalian cells. In this system, a specific protein that is tagged by a ccvTIR1^{F79A}-interacting degron motif is rapidly degraded upon the treatment of cells with an extremely low concentration of pico-cvxIAA (bioRxiv, submitted). Additionally, the Torii-Uchida group continued developing molecules that influence stomatal development through extensive collaboration with the groups of Itami, the Molecular Structure Center, and the Chemical Library Center. They focused on one of the compounds, kC9, that triples the number of stomata, to determine the target molecules. The DARTS (Direct Analysis in Real Time) identified a plant-specific subtype of pyruvate kinase family as a kC9 target candidate.

The Higashiyama group has disclosed a molecular mechanism of how species-specific key-and-lock molecules control genome barriers. A key molecule in the pollen tube is the LURE attractant peptide. They analyzed how the key three amino acids in LURE are critical for species recognition. They have been working on LURE1 and its receptor PRK6 interaction, other LURE-type attractant molecules, long-distance attraction using *Arabidopsis* and its relating species. Regarding AMOR that induces competency of the pollen tube to respond to ovular attractant LURE peptides, they developed a more potent AMOR derivative, multivalent AMOR, and established monoclonal antibodies that recognize disaccharide structure of AMOR specifically. The antibody is expected to contribute significantly to plant glycobiology.

Higashiyama-Ueda group revealed that the vacuole actively changes its shape and size and positions along actin filaments by using live imaging techniques. To assess the biological role of vacuoles in the zygote, they identified *shoot gravitropism2 (sgr2)*, in which the vacuolar structural change was impaired, failed to form tubular vacuoles, and to polarly distribute the vacuole. They demonstrated that, in *sgr2*, large vacuoles occupied the apical tip, and thus nuclear migration was blocked, resulting in a more symmetric zygotic division. Furthermore, they revealed that tubular vacuole formation and asymmetric vacuolar distribution both depended on the longitudinal array of actin filaments. These results provide insights into cooperative organelle positioning during zygote polarization and the crucial roles of vacuoles in the initial steps of plant ontogeny (PNAS 2019).

The Frommer-Nakamura group has been actively collaborating with the groups inside/outside of ITbM. To understand the substrate selectivity of plant transporters, they have been collaborating with the Tama group to explore the substrate recognition of SWEETs and other transporters using docking studies and molecular dynamics. They have also teamed with the Yamaguchi group to investigate spatiotemporal imaging of Plasmodesmata dynamics by using super-photostable phospho-rhodamine. Upon establishing the technology, they have initiated a collaboration with Prof. Notaguchi to understand Plasmodesmata generation during plant grafting. Additionally, the group commenced chemical screening with the Chemical Library Center and Peptide Protein Center and identified seven hit small molecules that modulate phenotypes related to cell division and membrane trafficking. Using a hit cyclic peptide, they identified Leucine-rich repeat receptor kinase as a target molecule with the help of the Molecular Structure Center.

(iii) Clock diseases

The circadian clock regulates virtually all physiological processes. Disturbances in the circadian system have a profound impact on health, and they have been linked to several pathologies, including obesity, psychiatric disorders, cardiovascular disease, and even cancer. ITbM will endeavor to develop transformative bio-molecules to understand and regulate the circannual clock to combat global climate and environmental changes.

Triggered by the discovery of a highly potent circadian clock modulator, GO289, that shows the selective inhibitory effect on CK2 and acute myeloid leukemia cell growth through a collaboration of the groups of Kay-Hirota, Itami, and Tama with the Molecular Structure Center and the Peptide Protein Center (Oshima et al., *Science Advances* 2019), the Tama and Hirota groups have revealed molecular dynamic properties underlying the selective effect of GO289. Based on longdaysin, a casein kinase I (CKI) inhibitor that strongly lengthens the circadian period, the Hirota, Itami, and Tama groups in collaboration with Feringa lab (Univ Groningen) have achieved quantitative and light-inducible control over the CKI activity accompanied by an accurate regulation of circadian period in cultured human cells and mouse tissues, as well as in living zebrafish (Kolarski et al., *JACS* 2019). This research paves the way for the application of photodosing in achieving precise temporal control over the biological timing and opens the door for chronopharmacology to deeper understand the circadian clock system. The Tama and Hirota groups in collaboration with Partch lab (UC Santa Cruz) explored the structural and dynamical basis of functional divergence of the clock proteins CRY1 and CRY2 and pinpointed a key difference between these proteins that underlies their differential strengths as transcriptional repressors at an atomic basis (Fribourgh et al., *bioRxiv* 2019; *eLife* 2020). The Bode group with Hirota and Molecular Structure Center have developed a synthetic SUMO E2 probe (Zhang et al., *JACS* 2019), and the team is trying to trap and identify E3 ligase for the clock proteins by using the E2 probe.

The rhythm of life on the earth is also shaped by seasons. Plants and animals have approximately one year-rhythm 'circannual clock' and show profound annual cycles in morphology, behavior, and health such as flowering, hibernation, and seasonal affective disorders. Nevertheless,

the underlying mechanism by which the circannual clock operates remains unknown in any organism.

The Yoshimura group has been conducting the elucidation of biological functions related to the 'circannual clock' and has discovered a sensor of seasonal changes in the saccus vasculosus of fish (Nature Commun. 2013), dynamic seasonal changes in color perception in medaka (Nature Commun. 2017), and so on. In FY2019, they discovered that an uncharacterized long non-coding RNA (lncRNA), so-called LDAIR, is strongly regulated by photoperiod using genome-wide expression analyses in medaka. The group concluded that photoperiodic regulation of corticotropin-releasing hormone receptor 2 by LDAIR modulates adaptive behaviors to seasonal environmental changes (Nakayama et al., Nature Ecol. Evol. 2019). Furthermore, a chemical genomics analysis revealed that seasonal changes in the NRF2 pathway regulate winter depression-like behavior. The group identified the molecule 'Celastrol,' a traditional Chinese medicine that reversed the depressive behavior through NRF2 antioxidant path (with the Chemical Library Center, PNAS 2020). This study provides insights into the understanding and treatment of seasonally regulated affective disorders.

On the other hand, in Plant, Nakamichi (Kinoshita group) identified that an animal CDC7/CDK9 inhibitor, PHA767491, lengthens the *Arabidopsis* circadian period and this molecule binds to and inhibits multiple CKL proteins rather than CDC7/CDK9 homologs by affinity proteomics. Through a simultaneous knockdown experiment, they revealed that PHA767491 treatment induced accumulation of CKL4 phosphorylated transcriptional repressors PRR5 and TOC1, accompanied by decreasing expression of PRR5- and TOC1-target genes, and, as a result, lengthened the circadian period in plants (PNAS 2019).

Based on the discovery of PHA767491, they identified AMI-331, which exhibited about 100-fold more potent inhibitory activity than the original compound, and Casein Kinase 1 as one of the target molecules through affinity proteomics analyses through extensive collaboration with Prof. J. Yamaguchi (Waseda University), a former member of ITbM (Plant Direct 2019).

(iv) Chemistry-enabled bioimaging

The Yamaguchi group developed an outstandingly photostable fluorescent dye with a long lifetime, MitoPB Yellow, which enabled the visualization of nano-scale dynamics of mitochondrial cristae in living cells (with the Live Imaging Center, RIKEN, and U. Tokyo). They revealed that MitoPB Yellow showed the large Stokes shift and could conduct two-color STED imaging combined with a dye furnishing a small Stokes shift. By taking advantage of the exceptionally high photostability of MitoPB Yellow, they achieved the first ever monitoring of a rapid inter-cristae merge in a single mitochondrion and the inner-membrane fusion in the inter-mitochondria interaction was monitored for the first time (PNAS 2019). Based on the structure of MitoPB Yellow, they have developed a new small-molecule fluorescent probe LysoPB Yellow which can selectively stain the lysosomal membrane. They demonstrated that LysoPB Yellow displayed excellent retention ability as well as negligible cytotoxicity and application to the observation of living cells for 24 h by long-term time-lapse confocal imaging (ACS Materials Lett. 2020).

The Yamaguchi group and the Live Imaging Center have developed the LAQ1 that shows strong fluorescence only in the hydrophobic lipid droplets (LDs), and demonstrated the visualization of ultra-small LDs (< 500 nm) with a high signal-to-noise ratio. In addition, they achieved the recording of the movement of small LDs about 500 nm in size via time-lapse imaging, and visualized lipolysis and lipogenesis in living cells in time-lapse 3D imaging by using LAQ1 (Taki et al., ACIE under review). In lipid biology, Taki and Yamaguchi developed an environmentally sensitive fluorescent fatty acid (FA), AP-C12, as a practical molecular tool for visualizing fatty acid metabolism in living cells. They revealed that the environmental responsiveness of AP-C12 enables visualizing the distribution of fatty acid metabolites as different colors in the images. Taking advantage of the unique staining ability of AP-C12, they succeeded in detecting various stages of LD-bearing autophagosomes in lipophagy (manuscript in preparation).

(v) Nanocarbon chemistry and biology

The Itami group has conducted in the precise and bottom-up syntheses of nanocarbons and had a significant impact in the field of nanocarbon science. In FY2019, the group succeeded in the first experimental measurements of the ultimate tensile strengths of individual structure-defined, single-walled carbon nanotubes. Single-walled carbon nanotubes theoretically possess ultimate intrinsic tensile strength in the 100-200 GPa range, among the highest in existing materials. In this

study, they revealed the strength depends on the chiral structure of the nanotube, with small-diameter, near-armchair nanotubes exhibiting the highest tensile strengths. These findings highlight the target nanotube structures that should be synthesized when attempting to fabricate the strongest materials (Nature Commun. 2019).

In addition, the Itami group also succeeded in the syntheses of catenanes and a molecular trefoil knot consisting solely of para-connected benzene rings. They revealed that characteristic fluorescence of a heterocatenane associated with fast energy transfer between two rings was observed, and the topological chirality of the all-benzene knot was confirmed by enantiomer separation and circular dichroism spectroscopy. Surprisingly, the rigid all-benzene knot has rapid vortex-like motion in solution even at -95°C , resulting in averaged nuclear magnetic resonance signals for all hydrogen atoms. This interesting dynamic behavior of the knot was theoretically predicted, and could stimulate deeper understanding and applications of these previously untapped classes of topological molecular nanocarbons (Science 2019, collaboration with Dr. Hijikata, a former member of ITbM and current in ICRoDD, Hokkaido University).

The unique structures and physicochemical properties of nanocarbon molecules, far off from one of the druggable molecules, have been proposed to control not only target biomolecules but also dynamics in mesoscopic areas such as the interaction of biomolecules, e.g., protein-protein interaction, membrane trafficking, and cell-cell communications. By taking advantage of atomically precise nanocarbon molecules, the Itami group and the Chemical Library Center created a chemical library consisting of eighty, structurally diverse and uniform, and atomically precise nanocarbon molecules (120 nanocarbon molecules, as of the end of March). This resource motivated biology groups inside/outside of ITbM to explore the as yet uncovered biological functions of these nanocarbon molecules in living organisms. In collaboration with Dr. Nakamichi (Kinoshita group), they discovered that *AT1G05880* (*ARIADNE 12*) gene, categorized into 'response to hypoxia' genes, was up-regulated by nanocarbon molecules, suggesting that this gene is usable as a biomarker for treatment of nanocarbon molecules (manuscript submitted). In addition, they already initiated collaborations with the groups of Yoshimura, Kay-Hirota, and Frommer-Nakamura in ITbM, industries, and discussions with several research groups not only of biologists but also radio-biochemists. Scientists in various research fields gathered to create a novel interdisciplinary research field, "nanocarbon biology."

(vi) Other topical research progress **Synthesis and catalysis**

Enol silyl ethers are a versatile synthon in organic synthesis, particularly for selective α -functionalization of carbonyl compounds. They are also known to undergo one-electron oxidation to generate the radical cations that spontaneously form α -carbonyl radicals via elimination of the silyl groups. The Ooi group has developed a strategy for the allylic C–H alkylation of enol silyl ethers and their derivatives, which relies on the combined use of appropriate photoredox and Brønsted base catalysts for the generation of requisite allylic radicals while suppressing undesired desilylation process. Under the hybrid catalysis, a series of enol silyl ethers smoothly react with electron-deficient olefins to give the corresponding functionalized enol silyl ethers (Nature Commun. 2019). In addition, they have demonstrated that the catalytic C–H alkylation of various nitrogen- or oxygen-containing organic compounds with electron-deficient olefins proceeds smoothly under light irradiation using amidyl radicals generated from zwitterionic triazolium amidates and photoredox catalysts (ACS Catal. 2020), and an application of the catalyst system for direct functionalization of complex natural circadian clock modulators (collaboration with Yoshimura group) is also currently underway.

The Yamaguchi group has actively developed various types of fluorescent molecules. Through studying the structure-properties relationship both experimentally and theoretically, they identified the crucial role of the boron moiety in fluorescent molecules for gaining intense NIR emission (collaboration with Yanai group, manuscript in preparation). In addition, the group succeeded in identifying the water-soluble fluorophores (Chem. Eur. J. 2019), deep-blue emissive dyes which showed narrow full-width-at-half-maximum width with high color purity (Org. Biomol. Chem., 2019), and boron-containing NIR dyes by embedding a boron atom into the fluorescein (Chem. Sci. 2019).

The Crudden-Nambo group has developed new chemical transformations of readily available sulfone derivatives through carbon–sulfonyl (C–SO₂) bond activation. They identified that the strong electron-withdrawing triflyl group was crucial for the desulfonylative cross-coupling of α -fluorinated benzylic sulfones with aryl boronic acids to provide medicinally important α -

fluoroarylmethanes (Nature Commun. 2019). They also revealed a previously unknown ligand for gold(0) nanoclusters, N-heterocyclic carbenes (NHCs), which feature a robust metal–carbon single bond and impart high stability to the corresponding gold cluster. The addition of a single NHC to gold nanoclusters results in significantly improved stability and catalytic properties in the electrocatalytic reduction of CO₂ (Nature Chem. 2019).

The Bode group accomplished the synthesis of the SUMO-conjugating enzyme Ubc9 in the combination of native chemical ligation (NCL), α -ketoacid–hydroxylamine (KAHA) ligation, and serine/threonine ligation (STL). They demonstrated the selective formation of Ubc9–SUMO conjugates and the trapping of an E3 ligase (RanBP2) to form the stable, covalently linked SUMO1–Ubc9–RanBP2 ternary complexes, as denoted above. The powerful combination of ligation methods, which minimizes challenges of functional group manipulations, will enable chemical probes based on E2 conjugating enzymes to trap E3 ligases and facilitate the synthesis of other protein classes (JACS 2019). In addition, the group has been developing the monomers for KAHA ligation (threonine-forming oxazetidine, ACIE, 2019; potassium acyltrifluoroborates, ACIE, 2019; cyclic acetals of serinehydroxylamine, Synthesis 2019) and has discovered beta-peptides targeting penicillin-binding proteins (ACS Chem. Biol. 2019).

Theoretical sciences

As mentioned above, the Tama group has actively been collaborating with the biology groups of Kay-Hirota, Torii, and Higashiyama, to reveal the precise biological mechanism of both animals and plants. The Yanai group, launched in 2018, has been collaborating actively with the multiple groups of ITbM. Based on his capabilities, the group demonstrated a docking study and molecular dynamics simulation of B-AZ and its potential target molecule CK1 d (Nakamichi et al., PCP 2019), investigation of electronic properties of carbon nanobelts (with the Itami group), the computational design of the FRET system to enhance its efficacy (with the Yamaguchi group), and *in silico* drug discovery of antiviral drugs (with the Ooi group and the Kimura group in Medical School of NU).

The ITbM four centers' activities

The four collaborative centers (Molecular Structure Center, Live Imaging Center, Chemical Library Center, and Peptide Protein Center) have also been making remarkable contributions to the promotion of ITbM's interdisciplinary research. To date, ITbM has collaborated with over 1100 users inside and outside of ITbM and has been a part of nearly 110 publications on interdisciplinary research.

The Live Imaging Center (Chief: Y. Sato) has been an advanced imaging and processing site providing access to researchers worldwide. In addition to the advantages of hardware, users can receive varied support from coordinators, from experimental design to data acquisition and interpretation. Since the launch of ITbM, the center has performed more than a hundred facility tours and supported over 200 researchers. The visibility of the center has increased year by year and the facility has been selected one of the main eight joint usage facilities in Japan (<http://www.bioimage.jp/centers>). The center supported 70 papers and half of them (34 papers) were published in high impact journals ($7 > IP$). Furthermore, it is characteristic of ITbM that the 21 papers (30% of total publications) are joint research between chemistry and biology, making our center unique.

The Chemical Library Center (Chief: A. Sato) has created 46 collaborations and executed a total of 124 with academia, research institutes, and industries, distributed a total of 1.2 million compounds, and filed additional three patents. In FY2019, the center has also contributed to the medical field through the identification of several hit compounds. Among them, the center succeeded in identifying lead compounds that inhibited at least one of carbapenemases, and showed significant activities against multi-drug resistant bacteria, which cannot be killed by almost all the antibiotics (mBio, 2020; PCT/JP2019/019133). The center has begun the lead optimization stage toward clinical trials with the AMED and the Drug Discovery Initiative, U. Tokyo. The center also initiated R&D programs on the novel coronavirus disease (COVID-19) with several research groups (ITbM, NU, Gifu Univ, Kagoshima Univ, and the UK). In addition, the center co-registered a venture company, "BasicBio" on February 20, 2020, which focuses on phosphatases drug discovery for cancer.

The Peptide/Protein Center (Chief: Oishi) has actively been collaborating with ITbM's biology groups (Higashiyama, Torii, Yoshimura, Kinoshita, and Frommer groups), other academia, research institutes, and industry by using a cyclic peptide library (CYCLAMEN) consisting of 300 structurally

diverse, mid-size in molecular weight (MW 1000–4000), and genome-based designed cyclic peptides. The center has filed the technology of designing the genome-based cyclic peptide library for PCT patent (PCT/JP/2019/031716) as a sole inventor. CYCLAMEN is being extended to bicyclic peptides libraries collaborating with the Bode group using their original KAT ligation technologies. The center has established a spin-off company "Craftide. Co., Ltd.," in December 2018, to apply the technologies of the center to mid-sized drug development. The Craftide is working on peptide-based drug development for cancer, Alzheimer's disease, and infectious diseases, including COVID-19, collaborating with academic research groups.

The Molecular Structure Center (Chief: Kuwata) has succeeded in the identification of target proteins by installing biochemical protocols such as immunoprecipitation, stable isotope labeling of amino acids in cell culture (SILAC), phosphoproteomics, and mass spectrometry (MS) imaging. The center was able to respond to the various types of customers' demands (proteome, metabolome, imaging-MS, native-MS, HRMS, etc.), and thus the center has published 38 papers, filed nine patents, had 279 collaborators in total including industry, and accepted over 300 requests per year. A reagent "DIUTHAME" for imaging MS is now commercially available through a collaboration with industry. The center has contributed the "Integrative system of autonomous environmental signal recognition and memorization for plant plasticity" (Kinoshita Shingakujutsu, Grant no. JP15H05962, JP15H05955) with a Grant-in-Aid for Scientific Research on Innovative Areas, a MEXT. The center also initiated consulting contracts with several companies.

(2) Journal publications, invited lectures, and awards

In 2019, 136 papers (WPI papers: 110 papers) were published in peer-reviewed journals, including 36 papers published in journals with an Impact Factor (2018) > 10, and 54 papers published in journals with an Impact Factor (2018) > 7. They also include 1 Hot Paper (top 0.1%) and 4 Highly Cited Papers (top 1%), and the cumulative numbers for 2012-2019 are 8 for Hot papers and 59 for Highly Cited Papers. The outcomes have been highlighted in a range of national and international media, including newspapers, TV programs, magazines, and internet sites (see Appendix 1).

ITbM's PIs and researchers have presented their research in a total of 119 international conferences and academic meetings, which represents ITbM researchers' high international visibility.

A total of 21 awards and honors have been granted to the faculty members of ITbM. Yamaguchi has been awarded the Humboldt Research Award. During FY2019, 3 ITbM PIs, Itami, Higashiyama and Frommer, have been recognized by Clarivate Analytics as 2019 Highly Cited Researchers.

(3) Research funds (see Appendix 3-1)

The record of competitive research funds is a benchmark of ITbM's activity. In FY2019, the total amount of research funding granted to ITbM researchers was 973 million yen. Representative grants are; Grant-in-Aid for Scientific Research on Innovative Areas (2 projects as Area Representative, 1 project as Planned Research), Grant-in-Aid for Specially Promoted Research (1 project), Grant-in-Aid for a Scientific Research (S) (2 projects), JST-ERATO (1 project), JST-CREST (1 project), JST-PRESTO (4 projects), JST-ALCA (1 project), JST-A-Step (1 project). The JST-CREST is the interdisciplinary research project achieved by ITbM's young faculty member team from multiple research fields.

It is noteworthy that the overseas PIs have also been successful in obtaining KAKENHI (Grant-in-Aid for Scientific Research). Representative grants of FY2019 are; Grant-in-Aid for a "Scientific Research (A)" (3 projects granted respectively to Bode, Frommer, and Torii); "Scientific Research (B)" (1 project granted to Crudden), and "Scientific Research on Innovative Areas" (3 projects granted respectively to Bode and Torii).

ITbM is also hosting 14 JSPS Postdoctoral Fellowships for Research in Japan.

(4) Patent, material & technology transfer, commercialization, and venture start-up

In FY2019, ITbM made 20 patent applications, including 11 domestic, 6 PCT, and 2 to foreign countries. Among the 20 cases, 3 were based on inventions that were arising from the interdisciplinary research between biology and chemistry.

Technology transfer activities led to the conclusion of a total of 20 agreements on patent licensing, assignment, and material transfer. In addition, efforts have been made to expand the academia-industry partnership across industries including agrochemical, pharmaceutical, seed and seedling, reagents for research, etc. In FY2019, ITbM had 20 joint research activities with a total of 16

companies, 9 of which became a partner of ITbM for the first time since its establishment.

Commercialization of research outputs from ITbM has been making notable progress. A total of 4 compounds were introduced to the market in FY2019 for research use, SPL7, 5-Adamantyl-IAA, AMI-331, and PREX710. PREX710 is a near-infrared (NIR) emitting photostable fluorescent dye, which has applications ranging from long term single-molecule imaging to *in vivo* deep imaging. SPL7 is the most potent *Striga* germinator and will contribute to elucidate its parasitizing mechanism and further to develop eradication tools for parasitic plants. 5-Adamantyl-IAA is a synthetic auxin that binds specifically to the modified TIR1 receptor ccvTIR1, whose binding affinity and selectivity are considerably higher than that of our cvxIAA commercialized prior in FY2018. AMI-331 is a potent and selective CK1 inhibitor which lengthened the circadian period. All 4 molecules were immediately commercialized after journal publications, which represents their high value. Additionally, many unique ITbM molecules have been attracting agro and materials firms. ITbM has been working toward its societal implementation through MTA and collaboration with industries. In October 2019, ITbM concluded a contract with Taoka Chemical Industry Co., Ltd. for the manufacture and commerce of a series of uniform graphene nanoribbons. ITbM continues to deliver such high impact molecules and research outputs via cooperation with the Department of Academic Research & Industry-Academia-Government Collaboration of NU.

A designated assistant professor at ITbM has launched a start-up company in early 2020 specializing in methods of image analysis using advanced machine learning to be used in AI agriculture and plant science.

2. Generating Fused Disciplines

* Describe the content of measures taken by the center to advance research by fusing disciplines. For example, measures that facilitate doing joint research by researchers in differing fields. If any, describe the interdisciplinary research/fused discipline that have resulted from your efforts to generate fused disciplines. You may refer to the research results described concretely in "1. Advancing Research of the Highest Global Level."

ITbM has been promoting interdisciplinary research through various initiatives under the concept of "Mix". ITbM has also been establishing collaborative networks with national and overseas institutions. In 2018, the Graduate Program of Transformative Chem-Bio Research (GTR) was launched at NU as a MEXT "*Doctoral Program for World-leading Innovative & Smart Education (WISE program)*". The program reflects ITbM's "Mix" concept and provides opportunities for interdisciplinary research collaboration widely to all the researchers/PhD students of NU who engage in research related to chemistry and biology. Recently, ITbM and GTR have entered a collaboration with the Graduate School of Medicine and its WISE program CIBoG, and ITbM's collaboration has started to expand toward biomedical sciences.

(1) Internal collaboration of ITbM

(a) Initiatives to promote collaboration at ITbM

ITbM has been implementing various initiatives to promote interdisciplinary research as represented by; **ITbM Research Award**, which supports bottom-up interdisciplinary research proposed by young researchers at ITbM; **ITbM Workshop** works well as a platform for reporting progress on joint research and proposing new joint research projects to call for potential collaborators. ITbM will continue these initiatives to promote interdisciplinary collaboration.

(b) ITbM's organization to promote Mix

The activity of such internal and external collaborations is strongly supported by the **Administrative Department** of ITbM. The **Research Promotion Division (RPD)** has been assuming the role to find inventions and scientific discoveries from each research group at an early stage, while the **Strategic Planning Division (SPD)** is expanding ITbM's networks with industries and advancing societal implementation of the research outcomes.

As presented in the research progress denoted in Section 1, ITbM's **four supporting centers** (Molecular Structure Center, Live Imaging Center, Chemical Library Center, and Peptide Protein Center) have been making a major contribution to the promotion of ITbM's interdisciplinary research. As a result, brand-new bio-functional molecules have been developed via the extensive collaboration of chemistry and biology (see Section 1).

(c) Interdisciplinary research projects selected for the ITbM Research Awards 2019

ITbM Research Award has been playing a significant role in promoting bottom-up research collaboration. The awarded projects are officially approved as ITbM's new projects and receive financial support. In 2019, two proposals were selected for the new projects of FY2020, and have just launched. Of note is that one of them is a joint proposal between ITbM and the Graduate School of Medicine of NU.

(d) Joint publications and patent applications

In 2019, ITbM published 11 joint publications among the following research groups. In addition to the bilateral publications, multilateral papers are increasing in number: Yamaguchi/Hijikata, Bode/Hirota, Kinoshita/Yanai, Itami/Torii, Tama/Torii, Itami/Kinoshita/Yoshimura/Kay, Hirota/Itami/Tama, Itami/Kinoshita/Yamaguchi/Tama/Kay, Kinoshita/Itami/Yamaguchi/Y. Sato, Crudden/Yokogawa. The number of patent filings in FY2019 was 20, of which 3 patent applications were based on the inventions arising from interdisciplinary research between biology and chemistry. The number of joint publications in ITbM is increasing on an annual basis. So far, 60 papers are based on multidisciplinary research outcomes, 318 papers are published by international collaboration, and 46 patents are based on multidisciplinary collaboration.

(2) Collaboration with other Departments at NU: Graduate Program of Transformative Chem-Bio Research (GTR) as a WISE program

NU recognizes the significance of the "Mix" concept to nurture young researchers. NU and ITbM drew up a concept for the "*Doctoral Program for World-leading Innovative & Smart Education (WISE program)*"; and it was selected in 2018. In this program, ITbM is positioned as a hub for promoting interdisciplinary research in the field of chemistry and biology, and many groups who share the ambition are joining from other departments of NU. Thus, ITbM's "Mix" concept is widely spread throughout this program. In 2019, NU launched "Convolution of Informatics and Biomedical Sciences on Glocal Alliances (CIBoG)" as a WISE program, which positions the Graduate School of Medicine as its core. ITbM/GTR and the Graduate School of Medicine/CIBoG agreed to collaborate, and the 1st joint workshop was held on October 3, 2019. This collaboration significantly expands ITbM's scope. Significantly, one piece of collaborative research has been selected for the ITbM Research Award, and several more collaborations have been started.

(3) Collaboration with other national/overseas institutes

ITbM has been strategically extending its collaborating networks, which has been largely contributing to the promotion of interdisciplinary research. For instance, ITbM's target ID platform is being advanced through collaboration, especially with RIKEN CSRS and the Institute of Chemistry (IoC) of Academia Sinica (AS).

Collaboration with AS has been expanding since the first joint workshop in 2016 at NU. AS expressed a desire to appoint Director Itami as a Joint Appointment Research Fellow of AS, and finally concluded the agreement as of August 1, 2019. Of note is that this position was newly established to appoint Director Itami, indicating their willingness to strengthen the tie with ITbM. AS also decided to install an Itami lab in their IoC, and allocate a faculty staff and students. This appointment will further accelerate the interdisciplinary collaboration between ITbM and AS.

RIKEN CSRS has been an important partner in Japan. The CSRS-ITbM Joint Workshop has taken place annually organized to promote collaboration, and its 6th event was held on January 8, 2020, at RIKEN Wako campus. A transfer of Hagihara (ex Itami group) from ITbM to CSRS as a CSRS Team Leader of in 2018 has further promoted the collaboration. ITbM and CSRS are jointly using the research support platform, and several collaborative types of research are ongoing.

In addition to those conducted by ITbM as a whole, many research collaborations have been conducted proactively by respective researchers mainly with overseas universities through researcher exchange. In FY2019, ITbM accepted 15 researchers/PhD students from overseas institutes.

3. Realizing an International Research Environment

* Describe what's been accomplished in the efforts to raise the center's recognition as a genuine globally visible research institute, along with innovative efforts proactively being taken in accordance with the development stage of the center, including the

following points, for example:

- Efforts being developed based on the analysis of number and state of world-leading, frontline researchers (in Appendix 2); exchanges with overseas entities (in Appendix 4); number and state of visiting researchers (in Appendix 5)
- Proactive efforts to raise the level of the center's international recognition
- Efforts to make the center into one that attracts excellent young researchers from around the world (such as efforts fostering young researchers and contributing to advancing their career paths)

(1) ITbM international symposia/awards and a series of ITbM Seminars

ITbM's symposia and awards have been contributing to the expansion of ITbM's international network and providing opportunities to attract overseas researchers.

ITbM has organized its seventh annual international symposium (ISTbM-7) in December 2019 at NU. It was held as a memorial symposium of late professor Koji Nakanishi (Professor Emeritus of the University of Columbia and University Professor of NU), who had largely supported ITbM as a great mentor. Three lecturers were invited to ISTbM-7: Professors Ueli Grossniklaus (University of Zürich, Switzerland), Gong Chen (Nankai University, China), Vy Dong (University of California at Irvine, USA), all of whom carry out research in ITbM-related fields.

ITbM also organized the 15th Hirata Award and the 5th Tsuneko & Reiji Okazaki Award at the same time as ISTbM-7. The 15th Hirata Award was presented to Professor Abigail Doyle (Princeton University, USA), in recognition of her development of new Ni-catalyzed synthetic methods applicable to provide wide-variety organic compounds. The 5th Tsuneko & Reiji Okazaki Award was presented to Professor Kay Tye (The Salk Institute of Biological Studies, USA) for her research on neural circuit mechanisms of emotional and social processing. The symposium and the award lectures were a great success, with about 400 participants.

The EMBO Workshop "Functional live imaging of plants" with an experimental course was held for the first time in Japan at ITbM from May 21-30, 2019 (Organizer: Higashiyama). The course features lectures (40% of course time) along with practical sessions and image analysis (60%), and the participants rotated through five practical sessions in the Live Imaging Center of ITbM. In addition to 57 domestic researchers, 51 researchers from 21 overseas countries were also invited, and had this proved an excellent opportunity to improve the recognition of ITbM.

ITbM has been holding a series of ITbM Seminars inviting researchers from related fields. In FY2019, ITbM invited 13 top scientists as lecturers.

(2) Researchers from overseas countries

ITbM has 5 overseas PIs and many postdoctoral researchers from overseas countries. In addition, ITbM has been accepting researchers from overseas institutes. As noted in Section 2, ITbM accepted 15 researchers/PhD students from the US, Germany, Portugal, UK, Spain, and China in FY2019. The proportion of non-Japanese researchers is 35% as of March 31, 2020.

(3) Bilingual Operation

The Administrative Department was organized to provide an environment in which ITbM researchers can fully focus on their research projects fully. Led by the Administrative Director, the Department consists of 3 divisions; Management Division, Research Promotion Division (RPD), and Strategic Planning Division (SPD). The Management Division has 11 staff consisting of the Division Head, 5 staff in the General Affairs Unit and 5 staff in the Accounting Unit. Half of the staff are competent English speakers, and the Department is able to manage all issues requiring English.

The RPD & SPD have 8 staff, who are experienced individuals with specialized skills, including a science designer and a patent attorney. Most of them hold a PhD or a Masters Degree in related fields and are proficient in English. Their high performance strongly supports various aspects of ITbM's interdisciplinary research. In FY2019, the RPD employed new staff members in order to reinforce international dissemination of ITbM's activities.

ITbM has 10 secretaries employed to assist the PIs both at NU and overseas, and the 4 supporting centers to ensure smooth communication with the groups via cooperation with the Administrative Department.

(4) Local Support

A staff member in the Research Promotion Division (RPD) is mainly responsible for providing local support to ITbM's foreign researchers and their families staying in Japan. They co-operates with the administrative office of ITbM to provide on-scene support to foreign researchers at ward offices,

including help with national health insurance and the pension system, as well as assistance in immigration affairs and other matters that may arise in their daily lives. The service also includes seminars on tax adjustment, orientation for renting an apartment in Japan, health consultations, and information on cultural events such as Japanese flower arranging (Kado) and Origami lessons.

(5) International public relations and outreach activities

In order to disseminate ITbM's research activities and achievements to the global audience, ITbM has been releasing international press releases on research accomplishments, international awards/events and other information. The releases are presented in a way that complex scientific results are conceivable to people in different fields and that the excitement of the research can be shared with the readers. As ITbM is carrying out interdisciplinary research, emphasis is also being put into conveying the joy and challenges of conducting research between different disciplines. ITbM has been highlighted in various national/international media and is receiving recognition by the international community, including journalists, researchers, and companies. ITbM cooperates with them in ensuring maximum publicity.

(6) International collaboration

Overseas PIs' host institutions are important partners of ITbM. According to the transfer of Torii from the University of Washington to the University of Texas at Austin in October 2019, ITbM concluded an MOU. ITbM has been extensively collaborating with these host institutions through researcher/student exchange. For instance, the Bode group members from ITbM visit ETH every summer to share their research progress, and several PhD students from ETH come on a regular basis to work at ITbM.

ITbM has also been collaborating with the **NSF Center for Selective C-H Functionalization (CCHF, USA)** and its partner, **the Institute for Basic Science (IBS, KAIST, Korea)**. ITbM hosted the 1st joint workshop "2016 International C-H Functionalization Workshop", with members of CCHF and IBS. The 2nd workshop was held at KAIST in South Korea on July 11-12, 2019, and had an extensive discussion to promote collaboration. ITbM and CCHF have been exchanging graduate students every year. In FY2019, ITbM sent 2 students to CCHF (UC Berkeley and the University of North Carolina at Chapel Hill), and accepted 3 CCHF students from UCLA, the University of Wisconsin, and the University of Washington).

ITbM and the **Institute of Chemistry (IoC) of Academia Sinica (AS)** have organized joint workshops in 2016 & 2017 and deepened the collaborative relationship, as noted in Section 2(3). Director Itami becoming the first Joint Appointment Research Fellow at Academia Sinica and the establishment of the Itami lab at IoC will accelerate the collaboration between ITbM and IoC.

In FY2019, NU concluded an MOU with the **Kenya Agricultural & Livestock Research Organization (KALRO)** for scientific and technical collaboration in research and education. In this framework, the cooperation of ITbM and KALRO was officially started, and the molecule to combat *Striga* has been tested in the research fields of KALRO in Kenya. The collaboration of KALRO is also essential for ITbM to apply ITbM's bio-functional molecules to adapt plants under the stressful natural conditions in Africa.

(7) Promotion of ITbM's researchers

Mentoring young researchers is a key to the future development and global standing of ITbM. Since ITbM's launch, a notable number of postdoctoral researchers have carried out research at ITbM, and are now in key positions in academia or industry in Japan and overseas. Thus, In FY2019, 15 researchers joined ITbM from overseas institutions, and 13 overseas researchers working at ITbM have been promoted to other institutions. Thus, ITbM has been a key part of the global talent stream. The records are listed in Appendix 3-1.

4. Making Organizational Reforms

* Describe the system reforms made to the center's research operation and administrative organization, along with their background and results.

* If innovated system reforms generated by the center have had a ripple effect on other departments of the host institutions or on other research institutions, clearly describe in what ways.

* Describe the center's operation and the host institution's commitment to the system reforms.

(1) Innovative systems at ITbM

(a) Decision making system

According to NU's commitment stated in the Research Center Project, the Director has the authority to make final decisions over all matters concerning the operation and management of ITbM, such as the appointment of personnel, the Center's budget and research priorities. The role of the President of NU is limited to the appointment of the Director according to the suggestion of the WPI program committee.

(b) Evaluation system and incentives

ITbM has established a system to provide incentives to the Director, the Vice Director, PIs, and the Administrative Director based on the evaluation of their performance and responsibilities. In FY2019, their full amounts were provided in reference to their continuous remarkable records of achievements and valuable contributions to achieve the high activity of ITbM. The evaluation was carried out based on an annual report submitted in March regarding their research activity. The review of Co-PIs and postdoctoral researchers were carried out by each PI, followed by a secondary evaluation by the Director, which was reflected in the renewal of their contract.

(2) Ripple effect to NU

Under President Matsuo's vision for Reform, Autonomy and Innovation 2020 (NU MIRAI 2020), NU has been carrying out extensive system reform to become a world-class research university. In the initiative, ITbM is positioned as a core research center of Nagoya University, and thus the basic policy and the measures of system reform have been established to match ITbM's needs.

(a) "Designated National University" named by MEXT

NU was recognized for its abilities to develop world-leading education and research activities and was selected as a "Designated National University" as of March 20, 2018. ITbM's high-profile activities significantly contributed to this designation. NU will make all efforts to become an internationally leading university and play a leading role in the reform of national universities by actively disseminating the concrete results of their influence and efforts that have contributed to the development of the society and the economy.

(b) Nagoya University Institute for Advanced Study (NAIAS)

Together with the Institutes of Innovation for Future Society (established in 2014) that promotes advanced applied research, NAIAS was established in October 2019 to strengthen the NU's advanced basic research further. The institute includes ITbM, Kobayashi-Maskawa Institute for the Origin of Particles and the Universe (KMI) as world-leading research hubs, and the Institute for Advanced Research (IAR) that supports the development of new research fields through programs such as the Young Researchers Development Program. With the establishment of NAIAS, researchers from multiple fields will work together to create new research horizons, and will lead NU to becoming a world-class research university as a whole.

(c) Basic agreement of NU and RIKEN for research cooperation

NU concluded a basic agreement on June 13, 2017 with RIKEN regarding the promotion of their partnership and cooperation to begin an inter-institutional partnership with the aim to produce world-class, top-level research achievements and innovation. ITbM's collaboration with RIKEN CSRS is the base of the agreement.

(d) Graduate Program of Transformative Chem-Bio Research (GTR) as a WISE program

NU recognizes the significance of the "Mix" concept to nurture young researchers. Graduate Program of Transformative Chem-Bio Research (GTR) was selected in 2018 as a MEXT WISE program. In the program, ITbM is positioned as a hub for promoting interdisciplinary research in the field of natural sciences. Through this program, ITbM's Mix concept will be more widely spread.

(e) WPI-next and related research support programs at NU

In 2014, NU launched the "WPI-next" program to support world-leading science at NU, which referred to ITbM's unique concepts, such as the Co-PI system. This program was reorganized as the "Cutting-edge International Research Units" program, and two more programs, "Research Units Geared toward Young International Researchers" and "Young Researcher Units for the Advancement

of New and Undeveloped Fields” were launched in the framework of the Program for Promoting the Enhancement of Research Universities.

(f) International Public Relations

ITbM has shared its expertise and experience on international public relations to the Academic Research and Industry-Academia-Government Collaboration Department and the public relations office of NU. As a result, NU has started to prepare international press releases on research accomplishments for the entire university.

(g) Medical support of foreign researchers and their families

ITbM has recognized that a medical support system in English is essential to ITbM members from abroad. For this purpose, ITbM has continued the contract with International SOS for 2016-2018, and it was switched to Japan IR&C from April 2019. Japan IR&C provides services of consultation and advice 24/7 in 3 languages (English, Chinese, and Japanese) in the case of accident or trouble. ITbM shared its experience with NU, who consequently decided to make a contract with the Japan IR&C to cover the whole of NU, starting from April 2020.

(h) Information distributed in English

With respect to English e-mail distribution by ITbM, NU started to circulate information on grants, funding and other announcements in both English and Japanese from the end of FY2013. ITbM launched the bulletin board website (ITbM Notifications Archive) that collects all the previous e-mails of notifications, including those of the recent COVID-19 outbreak. The website is shared with NU's headquarters and other departments and is highly appreciated.

5. Efforts to Secure the Center’s Future Development over the Mid- to Long-term

* Address the following items, which are essential to mid- to long-term center development:

- Future prospects with regard to the research plan, research organization and PI composition; prospects for fostering and securing of next-generation researchers
- Prospects for securing resources such as permanent positions and revenues; plan and/or implementation for defining the center's role and/or positioning the center within the host institution's institutional structure
- Measures to sustain the center as a world premier international research center after program funding ends
- Host institution's organizational reforms carried out for the center's autonomous administration simultaneously with the creation of the center.

ITbM will continue its effort to develop transformative bio-molecules, with particular attention on societal implementation of the research outcomes and development of new scientific fields. For this purpose, ITbM is expanding its collaborative networks, as noted in Section 2.

In FY2018, the new graduate program GTR was launched as a MEXT WISE program, which has ITbM as a core. Accordingly, ITbM is involved as a part of the education system of NU, and more PhD students will be allocated to the PI groups, especially to the overseas PI groups.

In early 2020, ITbM’s Director and NU President started to review NU’s support plan to sustain ITbM after the WPI support ends in 2022. NU promised to continue providing ongoing support to ITbM, including covering salaries and provision of space. In addition, NU will make all efforts to secure the employment of ITbM’s faculty members and staff. NU established the NAIAS in 2019, and positioned ITbM under this umbrella. Through this structure, NU has been requesting faculty positions to MEXT to strengthen ITbM’s activities since 2017. The request has been partially approved every year, and so far 3 positions have been allocated to ITbM as of April 1, 2020. NU will continue this request in the following several years. In addition, NU will review its budget plan to secure faculty positions to ITbM.

After the WPI support ends, acquisition of external budgets is also critical to secure ITbM’s activity at the current level or higher. To further increase funding, ITbM will cooperate with NU to strengthen its ties with industry and to find counterparts for future industry-academia collaborations. Acquisition of external funds from overseas will also be necessary. Therefore, as of March 2020, ITbM hired a designated associate professor located in the U.S. office of NU (Technology Partnership of Nagoya University: NU Tech) and has a strong science background and several years of technology transfer experiences. ITbM will proactively access to overseas industries in cooperation with NU Tech.

6. Others

* Describe what was accomplished in the center's outreach activities last year and how the activities have contributed to enhancing the center's "globally visibility." In Appendix 6, describe concretely the contents of these outreach activities. In Appendix 7, describe media reports or coverage, if any, of the activities.

* In addition to the above 1-5 viewpoints, if there is anything else that deserves mention regarding the center project's progress, note it.

(1) Outreach activities

The Research Promotion Division (RPD) has been involved in various outreach activities, including science education and experiments for high school students, and has been carrying out science demonstrations for the general public, including the Science Agora. Lab tours and seminars to introduce ITbM have also been held for students and teachers from local and overseas high schools as well as for other visitors.

In FY2019, ITbM hired a designated lecturer who is mainly in charge of outreach activities, which enables us to set more opportunities to transmit ITbM's research outcomes to the academic community and younger students. ITbM organized booth exhibitions at the Super Science High School Presentation (4000 high school students), the WPI Science Symposium (600), Tokai Festa (1100), and Kagaku Zanmai in Aichi (900). Many of the PIs, staff, and RPD members are also involved in holding public lectures to high school students and to adults interested in science. ITbM's research activities were presented to over 5,000 high school students and the general public, and the RPD held over 50 outreach events: Chunichi Culture Center lectures entitled "Molecules to change the world: ITbM's challenges" (six lectures by Itami, Torii, Tsuchiya, Higashiyama, Kinoshita, and Yoshimura), lectures to high school students (more than ten high schools: Yokkaichi, Asahigaoka, Mahidol HS, etc.), and hands-on-training in chemistry and biology at Gifu and Ise high schools, Science Agora, University festival, and Chunichi Culture Center. These are effective for fostering future scientists (high school students and younger generations) as well as their parents to develop a curiosity towards molecules. For this purpose, ITbM launched the "MoleQrious!" project. The final goal of this campaign is to create a society in which molecules are recognized at the same level as common scientific words, such as the "genome."

Such a campaign has had a substantial payoff in establishing a network with high school in Aichi. In FY2019, ITbM expanded the network to the wider Tokai area (Aichi, Gifu, and Mie). Particularly in Mie prefecture, ITbM has established a strong tie with the five of the six high schools designated as Super Science High Schools (Ise, Matsusaka, Tsu, Yokkaichi, and Kuwana high schools). The PIs and the RPD members have served as steering committee members of the Kuwana and Yokkaichi high schools.

(2) Concern for the environment and safety

ITbM set up the Environment and Safety Committee so that researchers at ITbM are always aware of the appropriate issues when conducting their research. The annual meeting has been held, and the recent progress of ITbM's research projects, safety management of the molecules synthesized/discovered in ITbM, development of control environment for legal compliance, and far-sighted activities of science communication to society has been discussed.

7. Center's Response to Results of Last Year's Follow-up

* Transcribe the item from the "Actions required and recommendations" section in the site visit report and the Follow-up report, then note how the center has responded to them.

* If you have already provided this information, indicate where in the report.

Comment 1: Since ITbM has achieved great success in the basic science of plant chemical biology, it is recommended that ITbM starts to communicate with researchers/institutes in the field of "precision agriculture," which is being actively pursued in Europe and the US.

<Action of ITbM>

The "Precision/Smart Farming" has been recognized as an important practice to increase crop production and farm efficiency. A designated assistant professor of ITbM has launched a start-up company in early 2020 specializing in methods of image analysis using advanced machine learnings to be used in AI agriculture and plant science. Through these novel technologies, ITbM's plant-control molecules could be implemented in "Precision/Smart Farming" to optimize plant growth

conditions under various factors such as soil, climate, and weather.

Not only in Japan but also in overseas, to introduce our wide range of cutting-edge technologies, ITbM has hired a designated associate professor located in the US office of NU (Technology Partnership of Nagoya University: NU Tech), who has a strong science background and several years of technology transfer experiences (see Section 5). As well as collecting the most recent trends in the area of precision agriculture from the US or EU, ITbM could expand overseas our "Precision/Smart Farming" technology for practical use under the aegis of NU Tech.

Comment 2: Adding a little more detail to the Center's research projects, real-world scientists such as ecology modelers could contribute to the advancement of ITbM's plant science/field application projects in Africa, while new involvement by talented professors (in fields of agricultural research) in ICREA of Nagoya University is very much appreciated. In addition, usage of ITbM's rich chemical library may allow the discovery of molecules that increase root biomass, which captures carbon from the air. This could be an effective way of sequestering CO₂ through agriculture. Such a challenge seems to fit well with the aim of ITbM.

<Action of ITbM>

ITbM has been conducting needs inspired basic research, and has developed a good number of molecules that are potent for practical use, such as those for stomata control or the *Striga* germination inducer. ITbM needs to find opportunities for well-designed field trials, and started collaboration with KALRO in Kenya. ITbM is also cooperating with three NU institutes for this purpose: the International Center for Research and Education (ICREA), the Bioscience and Biotechnology Center (BBC), and the Graduate School of Bioagricultural Sciences. On the other hand, ITbM recognizes that an ample understanding of whole ecological systems is essential to make a precise "Precision/Smart Farming". To fill unpredicted objectives which ITbM has not yet recognized, ITbM has started to share roles with the NU Tech, which will play a role as an ecological modeler while utilizing a broad network of US research institutes. The NU Tech will enable close collaboration between the experts in charge of collecting data who have the required experience in the field of ecological experiments. All data from the collaborators will feedback to the researchers at ITbM to improve their model predictions.

Comment 3: The tight cooperation of ITbM with Nagoya University should be continued toward sustaining ITbM and facilitating system reform in Nagoya University. In order to nurture the young generation (students and researchers in Nagoya University) within ITbM's interdisciplinary atmosphere, it is recommended to carefully design a new education program for graduate students based on the recently approved GTR with ITbM at its core.

<Action of ITbM>

ITbM and NU are working together to secure the employment of ITbM's faculty members and staff. NU launched the "Nagoya University Institute for Advanced Study (NAIAS)" in 2019, and positioned ITbM under this umbrella. Irrespective of this structure, the Director of ITbM will retain the authority to make key decisions at ITbM. Through the reorganization, NU has been requesting funding from MEXT, and has been given 3 positions as of April 2020. NU considers this request to provide the positions to ITbM as its highest priority, and will continue to in the following years. In addition to these 3 positions, 7 more faculty positions for ITbM were secured in FY2019.

The GTR is another key to sustain ITbM. Through its planning, other departments of NU have been recognizing the significance of ITbM's initiatives, especially the Mix Lab concept to nurture PhD students and young researchers. ITbM is now indispensable as a core of the GTR, which endorses ITbM's continuation. Through this program, more PhD students will be allocated to ITbM.

Appendix 1 FY 2019 List of Center's Research Results and Main Awards

1. Refereed Papers

- List only the Center's papers published in 2019. (Note: The list should be for the calendar year, not the fiscal year.)

- (1) Divide the papers into two categories, A and B.
 - A. WPI papers
List papers whose author(s) can be identified as affiliated with the WPI program (e.g., that state "WPI" and the name of the WPI center (WPI-center name)). (Not including papers in which the names of persons affiliated with the WPI program are contained only in acknowledgements.)
 - B. WPI-related papers
List papers related to the WPI program but whose authors are not noted in the institutional affiliations as WPI affiliated. (Including papers whose acknowledgements contain the names of researchers affiliated with the WPI program.)

Note: On 14 December 2011, the Basic Research Promotion Division in MEXT's Research Promotion Bureau circulated an instruction requiring paper authors to include the name or abbreviation of their WPI center among their institutional affiliations. From 2012, the authors' affiliations must be clearly noted.

- (2) Method of listing paper
 - List only refereed papers. Divide them into categories (e.g., original articles, reviews, proceedings).
 - For each, write the author name(s); year of publication; journal name, volume, page(s), and article title. Any listing order may be used as long as format is consistent. (The names of the center researchers do not need to be underlined.)
 - If a paper has many authors (say, more than 10), all of their names do not need to be listed.
 - Assign a serial number to each paper to be used to identify it throughout the report.
 - If the papers are written in languages other than English, underline their serial numbers.
 - Order of Listing
 - A. WPI papers
 1. Original articles
 2. Review articles
 3. Proceedings
 4. Other English articles
 - B. WPI-related papers
 1. Original articles
 2. Review articles
 3. Proceedings
 4. Other English articles
- (3) Submission of electronic data
 - In addition to the above, provide a .csv file output from the Web of Science (e.g.) or other database giving the paper's raw data including Document ID. (Note: the Document ID is assigned by paper database.)
 - These files do not need to be divided into paper categories.
- (4) Use in assessments
 - The lists of papers will be used in assessing the state of WPI project's progress.
 - They will be used as reference in analyzing the trends and whole states of research in the said WPI center, not to evaluate individual researcher performance.
 - The special characteristics of each research domain will be considered when conducting assessments.
- (5) Additional documents
 - After all documents, including these paper listings, showing the state of research progress have been submitted, additional documents may be requested.

A. WPI papers (Jan 1, 2019 – Dec 31, 2019)

1. Original Articles

- (1) Tsuyoshi Oshima, Yoshimi Niwa, Keiko Kuwata, Ashutosh Srivastava, Tomoko Hyoda, Yoshiki Tsuchiya, Megumi Kumagai, Masato Tsuyuguchi, Teruya Tamaru, Akiko Sugiyama, Natsuko Ono, Norjin Zolboot, Yoshiki Aikawa, Shunsuke Oishi, Atsushi Nonami, Fumio Arai, Shinya Hagihara, Junichiro Yamaguchi, Florence Tama, Yuya Kunisaki, Kazuhiro Yagita, Masaaki Ikeda, Takayoshi Kinoshita, Steve A. Kay, Kenichiro Itami and Tsuyoshi Hirota, *Sci. Adv.* 2019, 5, eaau9060. "Cell-based screen identifies a new potent and highly selective CK2 inhibitor for modulation of circadian rhythms and cancer cell growth" (DOI: 10.1126/sciadv.aau9060)
- (2) Eigo Ando and Toshinori Kinoshita, *Plant Signal Behav* 2019, 14, 1561107. "Fluence rate dependence of red light-induced phosphorylation of plasma membrane H⁺-ATPase in stomatal guard cells" (DOI: 10.1080/15592324.2018.1561107)
- (3) Takaharu Mori, Marta Kulik, Osamu Miyashita, Jaewoon Jung, Florence Tama and Yuji Sugita, *Structure* 2019, 27, 161-174.e3. "Acceleration of cryo-EM Flexible Fitting for Large Biomolecular Systems by Efficient Space Partitioning" (DOI: 10.1016/j.str.2018.09.004)

- (4) Simon Baldauf and Jeffrey W. Bode, *Synthesis* 2019, 51, 1273-1283. "Synthesis and Evaluation of Cyclic Acetals of Serine Hydroxylamine for Amide-Forming KAHA Ligations" (DOI: 10.1055/s-0037-1611635)
- (5) Naoya Shindo, Hirokazu Fuchida, Mami Sato, Kosuke Watari, Tomohiro Shibata, Keiko Kuwata, Chizuru Miura, Kei Okamoto, Yuji Hatsuyama, Keisuke Tokunaga, Seiichi Sakamoto, Satoshi Morimoto, Yoshito Abe, Mitsunori Shiroishi, Jose M. M. Caaveiro, Tadashi Ueda, Tomonori Tamura, Naoya Matsunaga, Takaharu Nakao, Satoru Koyanagi, Shigehiro Ohdo, Yasuchika Yamaguchi, Itaru Hamachi, Mayumi Ono and Akio Ojida, *Nat. Chem. Biol.*, 2019, 15, 250-258. "Selective and reversible modification of kinase cysteines with chlorofluoroacetamides" (DOI: 10.1038/s41589-018-0204-3)
- (6) Mariko Asaoka, Shin-ichiro Inoue, Shizuka Gunji, Toshinori Kinoshita, Masayoshi Maeshima, Hirokazu Tsukaya and Ali Ferjani, *Plant Cell Physiol.* 2019, 60, 875-887. "Excess Pyrophosphate within Guard Cells Delays Stomatal Closure" (DOI: 10.1093/pcp/pcz002)
- (7) Anzu Minami, Koji Takahashi, Shin-ichiro Inoue, Yasuomi Tada and Toshinori Kinoshita, *Plant Cell Physiol.* 2019, 60, 935-944. "Brassinosteroid Induces Phosphorylation of the Plasma Membrane H⁺-ATPase during Hypocotyl Elongation in *Arabidopsis thaliana*" (DOI: 10.1093/pcp/pcz005)
- (8) Arpita Srivastava, Florence Tama, Daisuke Kohda and Osamu Miyashita, *Proteins* 2019, 87, 81-90. "Computational Investigation of the Conformational Dynamics in Tom20-Mitochondrial Presequence Tethered Complexes" (DOI: 10.1002/prot.25625)
- (9) Jae Wook Lee, Tsuyoshi Hirota, Daisuke Ono, Sato Honma, Ken-ichi Honma, Keunwan Park and Steve A. Kay, *J. Med. Chem.* 2019, 62, 1989-1998. "Chemical Control of Mammalian Circadian Behavior through Dual Inhibition of Casein Kinase I α and δ " (DOI: 10.1021/acs.jmedchem.8b01541)
- (10) Yuki Nishikawa, Takayuki Miki, Masashi Awa, Keiko Kuwata, Tomonori Tamura and Itaru Hamachi, *ACS Chem. Biol.*, 2019, 14, 397-404. "Development of a Nitric Oxide-Responsive Labeling Reagent for Proteome Analysis of Live Cells" (DOI: 10.1021/acscchembio.8b01021)
- (11) Yusuke Kimata, Takehide Kato, Takumi Higaki, Daisuke Kurihara, Tomomi Yamada, Shoji Segami, Miyo Terao Morita, Masayoshi Maeshima, Seiichiro Hasezawa, Tetsuya Higashiyama, Masao Tasaka and Minako Ueda, *PNAS* 2019, 116, 2338-2343. "Polar vacuolar distribution is essential for accurate asymmetric division of *Arabidopsis* zygotes" (DOI: 10.1073/pnas.1814160116) Highly Cited Paper.
- (12) Tetsuro Nagai, Florence Tama and Osamu Miyashita, *Biophys. J.* 2019, 116, 395-405. "Cryo-Cooling Effect on DHFR Crystal Studied by Replica-Exchange Molecular Dynamics Simulations" (DOI: 10.1016/j.bpj.2018.11.3139)
- (13) Takayuki Nakamuro, Kazushi Kumazawa, Hideto Ito and Kenichiro Itami, *Synlett* 2019, 30, 423-428. "Bay-Region-Selective Annulative π -Extension (APEX) of Perylene Diimides with Arynes" (DOI: 10.1055/s-0037-1611668)
- (14) Yosuke Toda, Toru Kudo, Toshinori Kinoshita and Norihito Nakamichi, *Sci Rep* 2019, 9, 2983. "Evolutionary Insight into the Clock-Associated PRR5 Transcriptional Network of Flowering Plants" (DOI: 10.1038/s41598-019-39720-2)
- (15) Shuya Yamada, Takeshi Kaneda, Philip Steib, Kei Murakami and Kenichiro Itami, *Angew. Chem.-Int. Edit.* 2019, 58, 8341-8345. "Dehydrogenative synthesis of 2,2'-bipyridyls through regioselective pyridine dimerization" (DOI: 10.1002/anie.201814701)
- (16) Natsuki Tanaka-Takada, Akie Kobayashi, Hideyuki Takahashi, Takehiro Kamiya, Toshinori Kinoshita and Masayoshi Maeshima, *Plant Cell Physiol.* 2019, 60, 1331-1341. "Plasma Membrane-Associated Ca²⁺-Binding Protein PCaP1 is Involved in Root Hydrotropism of *Arabidopsis thaliana*" (DOI: 10.1093/pcp/pcz042)
- (17) Wataru Ota, Yusuke Nakane, Makiko Kashio, Yoshiro Suzuki, Kazuhiro Nakamura, Yasuo Mori, Makoto Tominaga and Takashi Yoshimura, *Sci Rep* 2019, 9, 3706. "Involvement of TRPM2 and TRPM8 in temperature-dependent masking behavior" (DOI: 10.1038/s41598-019-40067-x)
- (18) Yuki Hirakawa, Naoyuki Uchida, Yasuka L. Yamaguchi, Ryo Tabata, Sakiko Ishida, Kimitsune Ishizaki, Ryuichi Nishihama, Takayuki Kohchi, Shinichiro Sawa and John L. Bowman, *PLoS Genet.* 2019, 97, 1120-1131. "Control of proliferation in the haploid meristem by CLE peptide signaling in *Marchantia polymorpha*" (DOI: 10.1371/journal.pgen.1007997)
- (19) Tsuyoshi Shimmura, Mai Tamura, Shosei Ohashi, Asuka Sasaki, Takamichi Yamanaka, Nobuhiro Nakao, Kunio Ihara, Shinsaku Okamura and Takashi Yoshimura, *Sci Rep* 2019, 9, 3978. "Cholecystokinin induces crowing in chickens" (DOI: 10.1038/s41598-019-40746-9)

- (20) Shiori Yamamoto, Yuji Uchida, Tomomi Ohtani, Erina Nozaki, Chunyang Yin, Yoshihiro Gotoh, Nayuta Yakushiji-Kaminatsui, Tetsuya Higashiyama, Takamasa Suzuki, Tatsuya Takemoto, Yo-ichi Shiraishi and Atsushi Kuroiwa, *Dev. Growth Diff.* 2019, 61, 228-251. "Hoxa13 regulates expression of common Hox target genes involved in cartilage development to coordinate the expansion of the autopodal anlage" (DOI: 10.1111/dgd.12601)
- (21) Tsuyoshi Ohtani, Yuto Tsuchiya, Daisuke Uruguchia and Takashi Ooi, *Org. Chem. Front.* 2019, 6, 1734-1737. "Photocatalytic borylcyclopropanation of α -boryl styrenes" (DOI: 10.1039/c9qo00197b)
- (22) Stefanie Griesbeck, Matthias Ferger, Corinna Czernetzi, Chenguang Wang, Rüdiger Bertermann, Alexandra Friedrich, Martin Haehnel, Daniel Sieh, Masayasu Taki, Shigehiro Yamaguchi and Todd B. Marder, *Chem.-Eur. J.* 2019, 25, 7679-7688. "Optimization of Aqueous Stability versus p-Conjugation in Tetracationic Bis(triarylborane) Chromophores: Applications in Live-Cell Fluorescence Imaging" (DOI: 10.1002/chem.201900723)
- (23) Yosuke Toda and Fumio Okura, *Plant Phenomics*, 2019, 9237136. "How Convolutional Neural Networks Diagnose Plant Disease" (DOI: 10.34133/2019/9237136)
- (24) Soichiro Ogi, Natsumi Fukaya, Arifin, Bastian Bjerkem Skjelstad, Yuh Hijikata and Shigehiro Yamaguchi, *Chem.-Eur. J.* 2019, 25, 7303-7307. "Seeded Polymerization of an Amide - Functionalized Diketopyrrolopyrrole Dye in Aqueous Media" (DOI: 10.1002/chem.201901382)
- (25) Quan Manh Phung and Kristine Pierloot, *J. Chem. Theory Comput.* 2019, 58, 7345-7356. "Understanding the Reactivity of Mn-Oxo Porphyrins for Substrate Hydroxylation: Theoretical Predictions and Experimental Evidence Reconciled" (DOI: 10.1021/acs.jctc.9b00166)
- (26) Tomoya Nakayama, Tsuyoshi Shimmura, Ai Shinomiya, Kousuke Okimura, Yusuke Takehana, Yuko Furukawa, Takayuki Shimo, Takumi Senga, Mana Nakatsukasa, Toshiya Nishimura, Minoru Tanaka, Kataaki Okubo, Yasuhiro Kamei, Kiyoshi Naruse and Takashi Yoshimura, *Nat. Ecol. Evol.* 2019, 3, 845-852. "Seasonal regulation of the lncRNA LDAIR modulates self-protective behaviours during the breeding season" (DOI: 10.1038/s41559-019-0866-6)
- (27) Mina R Narouz, .Kimberly M Osten, .Phillip J. Unsworth, Renee W. Y. Man, Kirsi Salorinne, Shinjiro Takano, Ryohei Tomihara, Sami Kaappa, Sami Malola, Cao-Thang Dinh, J. Daniel Padmos, Kennedy Ayoo, Patrick J. Garrett, Masakazu Nambo, J. Hugh Horton, Edward H. Sargent, Hannu Hakkinen, Tatsuya Tsukuda and Cathleen M. Crudden, *Nat. Chem.* 2019, 11, 419-425. "N-heterocyclic carbene-functionalized magic-number gold nanoclusters" (DOI: 10.1038/s41557-019-0246-5)
- (28) Iain A. Stepek, Cao Trung, Anika Koetemann, Satomi Shimura, Bernd Wollscheid and Jeffrey W. Bode, *ACS Chem. Biol.* 2019, 14, 1030-1040. "Antibiotic Discovery with Synthetic Fermentation: Library Assembly, Phenotypic Screening, and Mechanism of Action of β -Peptides Targeting Penicillin-Binding Proteins" (DOI: 10.1021/acscchembio.9b00227)
- (29) Yuanming Li, Akiko Yagia and Kenichiro Itami, *Chem. Sci.* 2019, 10, 5470-5475. "Synthesis of sterically hindered 4,5-diarylphenanthrenes via acid-catalyzed bisannulation of benzenediactaldehydes with alkynes" (DOI: 10.1039/C9SC00334G)
- (30) Stefanie Griesbeck, Evripidis Michail, Chenguang Wang, Hiroaki Ogasawara, Sabine Lorenzen, Lukas Gerstner, Theresa Zang, Joern Nitsch, Yoshikatsu Sato, Ruediger Bertermann, Masayasu Taki, Christoph Lambert, Shigehiro Yamaguchi and Todd B. Marder, *Chem. Sci.* 2019, 10, 5405-5422. "Tuning the π -bridge of quadrupolar triarylborane chromophores for one- and two-photon excited fluorescence imaging of lysosomes in live cells" (DOI: 10.1039/c9sc00793h)
- (31) Tomoko Nozoye, Nicolaus von Wiren, Yoshikatsu Sato, Tetsuya Higashiyama, Hiromi Nakanishi and Naoko K. Nishizawa, *Front. Plant Sci.* 2019, 10, 502. "Characterization of the Nicotianamine Exporter ENA1 in Rice" (DOI: 10.3389/fpls.2019.00502)
- (32) Mikinori Ando, Mika Sakai, Naoki Ando, Masato Hirai and Shigehiro Yamaguchi, *Org. Biomol. Chem.* 2019, 17, 5500-5504. "Planarized B,N-phenylated dibenzoazaborine with a carbazole substructure: electronic impact of the structural constraint" (DOI: 10.1039/C9OB00934E)
- (33) Takahiro N Uehara, Yoshiyuki Mizutani, Keiko Kuwata, Tsuyoshi Hirota, Ayato Sato, Junya Mizoi, Saori Takao, Hiromi Matsuo, Takamasa Suzuki, Shogo Ito, Ami N. Saito, Taeko Nishiwaki-Ohkawa, Kazuko Yamaguchi-Shinozaki, Takashi Yoshimura, Steve A. Kay, Kenichiro Itami, Toshinori Kinoshita, Junichiro Yamaguchi and Norihito Nakamichi, *PNAS* 2019, 116, 11528-11536. "Casein kinase 1 family regulates PRR5 and TOC1 in the Arabidopsis circadian clock" (DOI: 10.1073/pnas.1903357116)
- (34) Damiano Ricciarelli, Quan Manh Phung, Leonardo Belpassi, Jeremy N. Harvey and Paola Belanzoni, *Inorg. Chem.* 2019, 58, 7345-7356. "Understanding the Reactivity of Mn-Oxo Porphyrins for Substrate

- Hydroxylation: Theoretical Predictions and Experimental Evidence Reconciled" (DOI: 10.1021/acs.inorgchem.9b00476)
- (35) Kailong Zhu, Tsuyoshi Ohtani, Chandra Bhushan Tripathi, Daisuke Uraguchi and Takashi Ooi, *Chem. Lett.* 2019, 48, 715-717. "Formal Hydroformylation of α,β -Unsaturated Carboxylic Acids under Photoexcited Ketone Catalysis" (DOI: 10.1246/cl.190197)
- (36) Hiroyuki Okabe, Asuka Naraoka, Takahiro Isogawa, Shunsuke Oishi and Hiroshi Naka, *Org. Lett.* 2019, 21, 4767-4770. "Acceptor-Controlled Transfer Dehydration of Amides to Nitriles" (DOI: 10.1021/acs.orglett.9b01657)
- (37) Jacky C.-H. Yim, Masakazu Nambo, Yasuyo Tahara and Cathleen M. Crudden, *Chem. Lett.* 2019, 48, 975-977. "Copper-Catalyzed Desulfonylative Cross-Coupling of Benzhydryl Sulfones with Azoles" (DOI: 10.1246/cl.190334)
- (38) Kohsuke Ohmatsu, Tsubasa Nakashima, Makoto Sato and Takashi Ooi, *Nat. Commun.* 2019, 10, 2706. "Direct allylic C–H alkylation of enol silyl ethers enabled by photoredox–Brønsted base hybrid catalysis" (DOI: 10.1038/s41467-019-10641-y)
- (39) Aarthi Putarjunan, Jim Ruble, Ashutosh Srivastava, Chunzhao Zhao, Amanda L. Rychel, Alex K. Hofstetter, Xiaobo Tang, Jian-Kang Zhu, Florence Tama, Ning Zheng and Keiko U. Torii, *Nat. Plants* 2019, 5, 742-754. "Bipartite anchoring of SCREAM enforces stomatal initiation by coupling MAP kinases to SPEECHLESS" (DOI: 10.1038/s41477-019-0440-x)
- (41) Yuichiro Tsuchiya, Daisuke Uraguchi and Takashi Ooi, *Regulation of Plant Growth & Development*, 2019, 54, 49-53. "The design principle of synthetic strigolactones" (DOI: 10.18978/jscrp.54.1_49)
- (42) Akihiro Oochi, Jakub Hajny, Kosuke Fukui, Yukio Nakao, Michelle Gallei, Mussa Quareshy, Koji Takahashi, Toshinori Kinoshita, Sigurd Ramans Harborough, StefanKepinski, Hiroyuki Kasahara, Richard Napier, Jiri Friml and Ken-ichiro Hayashi, *Plant Physiol.* 2019, 180, 1152-1165. "Pinstatic Acid Promotes Auxin Transport by Inhibiting PIN Internalization" (DOI: 10.1104/pp.19.00201)
- (43) Simon Baldauf, Dominik Schauenburg and Jeffrey W. Bode, *Angew. Chem.-Int. Edit.* 2019, 58, 12599-12603. "A threonine - forming oxazetidine amino acid for the chemical synthesis of proteins with the KAHA ligation" (DOI: 10.1002/anie.201906486)
- (44) Naoki Ando, Hiroki Soutomea and Shigehiro Yamaguchi, *Chem. Sci.*, 2019, 10, 7816-7821. "Near-Infrared Fluorescein Dyes Containing a Tricoordinate Boron Atom" (DOI: 10.1039/C9SC02314C)
- (45) Masaki Ishikawa, Mio Morishita, Yohei Higuchi, Shunsuke Ichikawa, Takaaki Ishikawa, Tomoaki Nishiyama, Yukiko Kabeya, Yuji Hiwatashi, Tetsuya Kurata, Minoru Kubo, Shuji Shigenobu, Yosuke Tamada, Yoshikatsu Sato and Mitsuyasu Hasebe, *Nat. Plants* 2019, 5, 681-690. "Physcomitrella STEMIN transcription factor induces stem cell formation with epigenetic reprogramming" (DOI: 10.1038/s41477-019-0464-2)
- (46) Waka Nakanishi, Shohei Saito, Naoki Sakamoto, Akihiro Kashiwagi, Shigehiro Yamaguchi, Hideki Sakai and Katsuhiko Ariga, *Asian J. Org. Chem.*, 2019, 14, 2869-2876. "Monitoring Fluorescence Response of Amphiphilic Flapping Molecules in Compressed Monolayers at the Air–Water Interface" (DOI: 10.1002/asia.201900769)
- (47) Akira Takakura, Ko Beppu, Taishi Nishihara, Akihito Fukui, Takahiro Kozeki, Takahiro Namazu, Yuhei Miyauchi and Kenichiro Itami, *Nat. Commun.* 2019, 10, 3040. "Strength of carbon nanotubes depends on their chemical structures" (DOI: 10.1038/s41467-019-10959-7)
- (48) Chaolumen, Hideto Ito and Kenichiro Itami, *Chem. Commun.*, 2019, 55, 9606-9609. "An axially chiral 1,1'-biazulene and its π -extended derivative: synthesis, structures and properties" (DOI: 10.1039/c9cc03510a)
- (50) Takayuki Nimura, Tsubasa Itoh, Hanako Hagio, Takuto Hayashi, Vincenzo Vi Di Donato, Miki Takeuchi, Takeaki Itoh, Fuduki Inoguchi, Yoshikatsu Sato, Naoyuki Yamamoto, Yu Katsuyama, Filippo Del Bene, Takashi Shimizu and Masahiko Hibi, *Dev. Biol.* 2019, 455, 393-408. "Role of Reelin in cell positioning in the cerebellum and the cerebellum-like structure in zebrafish" (DOI: 10.1016/j.ydbio.2019.07.010)
- (51) Takafumi Suzuki, Aki Muramatsu, Ryota Saito, Tatsuro Iso, Takahiro Shibata, Keiko Kuwata, Shin-ichi Kawaguchi, Takao Iwawaki, Saki Adachi, Hiromi Suda, Masanobu Morita, Koji Uchida, Liam Baird and Masayuki Yamamoto, *Cell Reports*, 2019, 28, 746-758.e4. "Molecular Mechanism of Cellular Oxidative Stress Sensing by Keap1" (DOI: 10.1016/j.celrep.2019.06.047)
- (52) Yasutomo Segawa, Motonobu Kuwayama, Yuh Hijikata, Masako Fushimi, Taishi Nishihara, Jenny Pirillo,

- Junya Shirasaki, Natsumi Kubota and Kenichiro Itami, *Science* 2019, 365, 272-276. "Topological molecular nanocarbons: all-benzene catenane and trefoil knot" (DOI: 10.1126/science.aav5021)
- (53) Stefanie Griesbeck, Evripidis Michail, Florian Rauch, Hiroaki Ogasawara, Chenguang Wang, Yoshikatsu Robert M. Sato, Edkins, Zuolun Zhang, Masayasu Taki, Christoph Lambert, Shigehiro Yamaguchi and Todd B. Marder, *Chem.-Eur. J.*, 2019, 25, 13164-13175. "The Effect of Branching on the One - and Two - Photon Absorption, Cell Viability, and Localization of Cationic Triarylborane Chromophores with Dipolar versus Octupolar Charge Distributions for Cellular Imaging" (DOI: 10.1002/chem.201902461)
- (54) Saya Aoki, Shigeo Toh, Norihito Nakamichi, Yuki Hayashi, Yin Wang, Takamasa Suzuki, Hiroyuki Tsuji and Toshinori Kinoshita, *Sci Rep* 2019, 9, 10054. "Regulation of stomatal opening and histone modification by photoperiod in *Arabidopsis thaliana*" (DOI: 10.1038/s41598-019-46440-0)
- (55) Chenguang Wang, Masayasu Taki, Yoshikatsu Sato, Yasushi Tamura, Hideyuki Yaginuma, Yasushi Okada and Shigehiro Yamaguchi, *PNAS*, 2019, 116, 15817-15822. "A Photostable Fluorescent Marker for the Super-Resolution Live Imaging of the Dynamic Structure of the Mitochondrial Cristae" (DOI: 10.1073/pnas.1905924116)
- (56) Yuuki Maekawa, Zachary T. Ariki, Masakazu Nambo and Cathleen M. Crudden, *Org. Biomol. Chem.* 2019, 17, 7300-7303. "Pyridine-catalyzed desulfonative borylation of benzyl sulfones" (DOI: 10.1039/c9ob01099h)
- (57) José I. Urgel, Marco Di Giovannantonio, Yasutomo Segawa, Pascal Ruffieux, Lawrence T. Scott, Carlo A. Pignedoli, Kenichiro Itami and Roman Fasel, *J. Am. Chem. Soc.*, 2019, 141, 13158-13164. "Negatively Curved Warped Nanographene Self-Assembled on Metal Surfaces" (DOI: 10.1021/jacs.9b05501)
- (58) Takeshi Hirakawa, Keiko Kuwata, Maria E. Gallego, Charles I. White, Mika Nomoto, Yasuomi Tada and Sachihiro Matsunaga, *Plant Physiol.*, 2019, 181, 499-509. "LSD1-LIKE1-Mediated H3K4me2 Demethylation Is Required for Homologous Recombination Repair" (DOI: 10.1104/pp.19.00530)
- (59) Hiromasa Maki, Satomi Sakaoka, Tomotaka Itaya, Takamasa Suzuki, Kaho Mabuchi, Takashi Amabe, Nobutaka Suzuki, Tetsuya Higashiyama, Yasuomi Tada, Tsuyoshi Nakagawa, Atsushi Morikami and Hironaka Tsukagoshi, *Sci Rep*, 2019, 9, 11358. "ANAC032 regulates root growth through the MYB30 gene regulatory network" (DOI: 10.1038/s41598-019-47822-0)
- (60) Kenta Kato, Hsing-An Lin, Motonobu Kuwayama, Mai Nagase, Yasutomo Segawa, Lawrence T. Scott and Kenichiro Itami, *Chem. Sci.*, 2019, 10, 9038-9041. "Two-step synthesis of a red-emissive warped nanographene derivative via a ten-fold C-H borylation" (DOI: 10.1039/c9sc03061a)
- (61) Wei Xiao, Shihao Su, Tetsuya Higashiyama and Da Luo, *Development*, 2019, 146, dev177410. "A homolog of the ALOG family controls corolla tube differentiation in *Torenia fournieri*" (DOI: 10.1242/dev.177410)
- (62) Yinfeng Zhang, Tsuyoshi Hirota, Keiko Kuwata, Shunsuke Oishi, Subramanian G Gramani and Jeffrey W. Bode, *J. Am. Chem. Soc.*, 2019, 141, 14742-14751. "Chemical Synthesis of Atomically Tailored SUMO E2 Conjugating Enzymes for the Formation of Covalently Linked SUMO-E2-E3 Ligase Ternary Complexes" (DOI: 10.1021/jacs.9b06820)
- (63) Mamiko Sano, Noritada Kaji, Amy C. Rowat, Hirotohi Yasaki, Long Shao, Hidefumi Odaka, Takao Yasui, Tetsuya Higashiyama and Yoshinobu Baba, *Anal. Chem.*, 2019, 91, 12890-12899. "Microfluidic Mechanotyping of a Single Cell with Two Consecutive Constrictions of Different Sizes and an Electrical Detection System" (DOI: 10.1021/acs.analchem.9b02818)
- (64) Eric A. Mosser, Cindy N. Chiu, T. Katherine Tamai, Tsuyoshi Hirota, Suna Li, May Hui, Amy Wang, Chanpreet Singh, Andrew Giovanni, Steve A. Kay and David A. Prober, *Sci Rep* 2019, 9, 12405. "Identification of pathways that regulate circadian rhythms using a larval zebrafish small molecule screen" (DOI: 10.1038/s41598-019-48914-7)
- (65) Mina R. Narouz, Shinjiro Takano, Paul A. Lummis, Tetyana, I Levchenko, Ali Nazemi, Sami Kaappa, Sami Malola, Goonay Yousefalizadeh, Larry A. Calhoun, Kevin G. Stampelcoskie, Hannu Hakkinen, Tatsuya Tsukuda and Cathleen M. Crudden, *J. Am. Chem. Soc.* 2019, 141, 14997-15002. "Robust, Highly Luminescent Au¹³ Superatoms Protected by N-Heterocyclic Carbenes" (DOI: 10.1021/jacs.9b07854)
- (66) Marta Michniewicz, Cheng-Hsun Ho, Tara A. Enders, Eric Floro, Lauren K. Gunther, Suresh Damodoran, Samantha K. Powers, Elizabeth M. Christopher N. Frick, Topp, Wolf B. Frommer and Lucia Strader, *Dev. Cell*, 2019, 50, 599-609.e4. "TRANSPORTER OF IBA1 Links Auxin and Cytokinin to Influence Root Architecture" (DOI: 10.1016/j.devcel.2019.06.010)

- (67) Dušan Kolarski, Akiko Sugiyama, Ghislain Breton, Christin Rakers, Daisuke Ono, Albert Schulte, Florence Tama, Kenichiro Itami, Wiktor Szymanski, Tsuyoshi Hirota and Ben L. Feringa, *J. Am. Chem. Soc.* 2019, 141, 15784-15791. "Controlling the Circadian Clock with High Temporal Resolution through Photodosing" (DOI: 10.1021/jacs.9b05445)
- (68) Yusuke Nakane, Ai Shinomiya, Wataru Ota, Keisuke Ikegami, Tsuyoshi Shimmura, Sho-Ichi Higashi, Yasuhiro Kamei and Takashi Yoshimura, *PLoS One*, 2019, 14, e0222106. "Action spectrum for photoperiodic control of thyroid-stimulating hormone in Japanese quail (*Coturnix japonica*)" (DOI: 10.1371/journal.pone.0222106)
- (69) Azusa Ono, Ayato Sato, Kazuhiro J Fujimoto, Hiromi Matsuo, Takeshi Yanai, Toshinori Kinoshita and Norihito Nakamichi, *Plant Cell Physiol.* 2019, 60, 2360–2368. "3,4-Dibromo-7-Azaindole Modulates Arabidopsis Circadian Clock by Inhibiting Casein Kinase 1 Activity" (DOI: 10.1093/pcp/pcz183)
- (70) Ami N. Saito, Hiromi Matsuo, Keiko Kuwata, Azusa Ono, Toshinori Kinoshita, Junichiro Yamaguchi and Norihito Nakamichi, *Plant Direct*, 2019, 3, e00172. "Structure–function study of a novel inhibitor of the casein kinase 1 family in Arabidopsis thaliana" (DOI: 10.1002/pld3.172)
- (71) Quan Manh Phung and Kristine Pierloot, *Chem.-Eur. J.* 2019, 25, 12491-12496. "Electronic Structure of N - Bridged High - Valent Diiron - Oxo" (DOI: 10.1002/chem.201902766)
- (72) Kenta Kato, Yasutomo Segawa and Kenichiro Itami, *Synlett* 2019, 30, 370-377. "Symmetric Multiple Carbohelices" (DOI: 10.1055/s-0037-1610283)
- (73) Masakazu Nambo, Jacky C-HYim, Luiza B. O. Freitas, Yasuyo Tahara, Zachary T. Arika, Yuuki Maekawa, Daisuke Yokogawa and Cathleen M. Crudden, *Nat. Commun.* 2019, 10, 4528. "Modular synthesis of α -fluorinated arylmethanes via desulfonylative cross-coupling" (DOI: 10.1038/s41467-019-11758-w)
- (74) Joon-Seob Eom, Dangping Luo, Genelou Atienza-Grande, Jungil Yang, Chonghui Ji, Van Thi Luu, Jose C. Huguet-Tapia, Si Nian Char, Bo Liu, Hanna Nguyen, Sarah Maria Schmidt, Boris Szurek, Casiana Vera Cruz, Frank F. White, Ricardo Oliva, Bing Yang, and Wolf B. Frommer, *Nat. Biotechnol.* 2019, 37, 1372–1379. "Diagnostic kit for rice blight resistance" (DOI: 10.1038/s41587-019-0268-y)
- (75) Ricardo Oliva,; Ji, Chonghui; Atienza-Grande, Genelou; Huguet-Tapia, Jose C.; Alvaro Perez-Quintero, Ting Li, Joon-Seob Eom, Chenhao Li, Hanna Nguyen, Bo Liu, Florence Auguy, Coline Sciallano, Van T. Luu, Gerbert S. Dossa, Sebastien Cunnac, Sarah M. Schmidt, Inez H. Slamet-Loedin, Casiana Vera Cruz, Boris Szurek, Wolf B. Frommer, Frank F. White and Bing Yang, *Nat. Biotechnol.* 2019, 37,1344–1350. "Broad-spectrum resistance to bacterial blight in rice using genome editing" (DOI: 10.1038/s41587-019-0267-z)
- (76) Jelmer J. Lindeboom, Masayoshi Nakamura, Marco Saltini, Anneke Hibbel, Ankit Walia, Tijs Ketelaar, Anne Mie C. Emons, John C. Sedbrook, Viktor Kirik, Bela M. Mulder and David W. Ehrhardt, *J. Cell Biol.* 2019, 218, 190-205. "CLASP stabilization of plus ends created by severing promotes microtubule creation and reorientation" (DOI: 10.1083/jcb.201805047)
- (77) Takashi L. Shimada, Tomoo Shimada, Yozo Okazaki, Yasuhiro Higashi, Kazuki Saito, Keiko Kuwata, Kaori Oyama, Misako Kato, Haruko Ueda, Akihiko Nakano, Takashi Ueda, Yoshitaka Takano and Ikuko Hara-Nishimura, *Nat. Plants* 2019, 5, 1154–1166. "HIGH STEROL ESTER 1 is a key factor in plant sterol homeostasis" (DOI: 10.1038/s41477-019-0537-2)
- (78) Tsuyoshi Nishikawa, Hiroki Narita, Soichiro Ogi, Yoshikatsu Sato and Shigehiro Yamaguchi, *Chem. Commun.* 2019, 55, 14950-14953. "Hydrophobicity and CH/ π -interaction-driven self-assembly of amphiphilic aromatic hydrocarbons into nanosheets" (DOI: 10.1039/c9cc08070h)
- (79) Masakazu Nambo, Yasuyo Tahara, Jacky C. -H. Yim and Cathleen M. Crudden, *Chem.-Eur. J.* 2019, 25, 1923-1926. "Cu-Catalyzed Desulfonylative Amination of Benzhydryl Sulfones" (DOI: 10.1002/chem.201805638)
- (80) Sakiho Hayakawa, Ayumi Kawasaki, Yongseok Hong, Daisuke Uruguchi, Takashi Ooi, Dongho Kim, Tomoyuki Akutagawa, Norihito Fukui and Hiroshi Shinokubo, *J. Am. Chem. Soc.* 2019, 141, 19807-19816. "Inserting Nitrogen: An Effective Concept To Create Nonplanar and Stimuli-Responsive Perylene Bisimide Analogues" (DOI: 10.1021/jacs.9b09556)
- (81) Yusuke Kubo, Shinobu Satoh, Haruka Suzuki, Toshinori Kinoshita and Nobuyoshi Nakajima, *Hortscience* 2019, 54, 1896–1901. "Characterization of Ethylene-mediated Curling of Japanese Radish (*Raphanus sativus* var. *longipinnatus*) Cotyledons" (DOI: 10.21273/HORTSCI14301-19)
- (82) Takema Sasaki, Motosuke Tsutsumi, Kohei Otomo, Takashi Murata, Noriyoshi Yagi, Masayoshi Nakamura, Tomomi Nemoto, Mitsuyasu Hasebe and Yoshihisa Oda, *Curr. Biol.* 2019, 29, 4060-4070.e3.

- "A Novel Katanin-Tethering Machinery Accelerates Cytokinesis" (DOI: 10.1016/j.cub.2019.09.049)
- (83) Tetsuo Ebihara, Takuya Matsuda, Chieko Sugita, Mizuho Ichinose, Hiroshi Yamamoto, Toshiharu Shikanai and Mamoru Sugita, *Plant J.* 2019, 97, 1120-1131. "The P - class pentatricopeptide repeat protein PppPR_21 is needed for accumulation of the psbI - ycf12 dicistronic mRNA in *Physcomitrella* chloroplasts" (DOI: 10.1111/tbj.14187)
- (84) Takafumi Suzuki, Aki Muramatsu, Ryota Saito, Tatsuro Iso, Takahiro Shibata, Keiko Kuwata, Shin-ichi Kawaguchi, Takao Iwawaki, Saki Adachi, Hiromi Suda, Masanobu Morita, Koji Uchida, Liam Baird and Masayuki Yamamoto, *ChemBioChem*, 2019, 20, 900-905. "A Covalent Inhibitor for Glutathione S - Transferase Pi (GSTP1 - 1) in Human Cells" (DOI: 10.1002/cbic.201800671)
- (85) Yuki Harada, Yuh Hijikata, Shinpei Kusaka, Akihiro Hori, Yunsheng Maac and Ryotaro Matsuda, *Dalton Trans.* 2019, 48, 2545-2548. "Creation of MOFs with open metal sites by partial replacement of metal ions with different coordination numbers" (DOI: 10.1039/c8dt04218g)
- (86) Ryuto Kimura, Yuh Hijikata, Clothilde A. Eveleens, Alister J. Page and Stephan Irle, *J. Comput. Chem.* 2019, 40, 375-380. "Chiral-selective etching effects on carbon nanotube growth at edge carbon atoms" (DOI: 10.1002/jcc.25610)
- (87) Christopher Kesten, Francisco M. Gamez-Arjona, Alexandra Menna, Stefan Scholl, Susanne Dora, Apolonio Ignacio Huerta, Hsin-Yao Huang, Nico Tintor, Toshinori Kinoshita, Martijn Rep, Melanie Krebs, Karin Schumacher and Clara Sanchez-Rodriguez, *Embo J.* 2019, 38, e101822. "Pathogen - induced pH changes regulate the growth - defense balance in plants" (DOI: 10.15252/embj.2019101822)
- (88) Hsing-An Lin, Kenta Kato, Yasutomo Segawa, Lawrence T. Scott and Kenichiro Itami, *Chem. Sci.* 2019, 10, 2326-2330. "Synthesis and structural features of thiophene-fused analogues of warped nanographene and quintuple helicene" (DOI: 10.1039/c8sc04470h)
- (89) Ryo Ohtani, Riho Yamamoto, Hiroyoshi Ohtsu, Masaki Kawano, Jenny Pirillo, Yuh Hijikata, Masaaki Sadakiyo, Leonard F. Lindoye and Shinya Hayami, *Dalton Trans.* 2019, 21, 7198-7202. "Consecutive oxidative additions of iodine on undulating 2D coordination polymers: formation of I-Pt-I chains and inhomogeneous layers" (DOI: 10.1039/c8dt04624g)
- (90) Miki Nakano, Osamu Miyashita and Florence Tama, *Biophysics and Physicobiology*, 2019, 16, 367-376. "Parameter optimization for 3D-reconstruction from XFEL diffraction patterns based on Fourier slice matching" (DOI: 10.2142/biophysico.16.0_367)
- (91) Taishi Nishihara, Akira Takakura, Yuhei Miyauchi and Kenichiro Itami, *Technical Information Institute Magazine*, 2019, 361-369. "A unique ultra-narrow-band thermal exciton radiation phenomena of carbon nanotubes"
- (92) Taishi Nishihara, Akira Takakura, Kenichiro Itami and Yuhei Miyauchi, *Clean Energy*, 2019, 28, 7-14. "Ultra-narrow-band thermal exciton radiation phenomena of carbon nanotubes"
- (93) Tetsuya Higashiyama, *Agribio*, 2019, Feb. "Innovation of fluorescence molecules and cell-visualization technology"
- (94) Koji Takahashi, Shinya Hagihara, Keiko U. Torii and Naoyuki Uchida, *Kagakutoseibutsu*, 2019, 57, 80-87. "Synthetic Pair of Modified Auxin and Its Receptor for Freehand Manipulation of Auxin Responses: New Approach for Freehand Manipulation of Plant Hormone Responses" (DOI: 10.1271/kagakutoseibutsu.57.80)
- (95) Masayasu Taki and Yoshikatsu Sato, *Agribio*, 2019, 3, 8-12. "Chemistry, latest agricultural biofluorescence molecules group developed by a biological fusion study"
- (96) Sahoko Otsuka, Yoshikatsu Sato and Yuji Hiwatashi, *Agribio*, 2019, 3, 81-85. "Cytoskeletal regulation of the plant tip growth explored by the live-imaging technique"
- (97) Okura F, Noshita K, Kinoshita T, and Toda Y. *BSJ-Review*, 2019, 10:99-107. "Perspectives of Plant Phenotypic Analysis Utilizing Deep Learning"

2. Review Articles

- (1) Masato Hirai, Naoki Tanaka, Mika Sakai and Shigehiro Yamaguchi, *Chem. Rev.*, 2019, 119, 8291-8331. "Structurally Constrained Boron-, Nitrogen-, Silicon-, and Phosphorus-Centered Polycyclic π -Conjugated

Systems" (DOI: 10.1021/acs.chemrev.8b00637) Hot Paper.

- (2) Christene A. Smith, Mina R. Narouz, Paul A. Lummis, Ishwar Singh, Ali Nazemi, Chien-Hung Li and Cathleen M. Crudden, *Chem. Rev.* 2019, 119, 4986-5056. "N-Heterocyclic Carbenes in Materials Chemistry" (DOI: 10.1021/acs.chemrev.8b00514) Highly Cited Paper.
- (3) Akiko Yagi, Yasutomo Segawa and Kenichiro Itami, *Chem* 2019, 5, 746-748. "Armchair and Chiral Carbon Nanobelts: Scholl Reaction in Strained Nanorings" (DOI: 10.1016/j.chempr.2019.03.013)
- (4) Hitoshi Endo and Keiko U. Torii, *Cold Spring Harbor Perspect. Biol.* 2019, 11, a034660. "Stomatal Development and Perspectives toward Agricultural Improvement" (DOI: 10.1101/cshperspect.a034660)
- (5) Soon-Ki Han and Keiko U. Torii, *Curr. Opin. Plant Biol.* 2019, 51, 66-73. "Linking cell cycle to stomatal differentiation" (DOI: 10.1016/j.pbi.2019.03.010)
- (6) Ying-Jey GUH, Takako K TAMAI and Takashi YOSHIMURA, *Proc. Jpn. Acad. Ser. B*, 2019, 95, 343-357. "The underlying mechanisms of vertebrate seasonal reproduction" (DOI: 10.2183/pjab.95.025)
- (7) Keisuke Ikegami, Samuel Refetoff, Eve Van Cauter and Takashi Yoshimura, *Nat. Rev. Endocrinol.*, 2019, 15, 590-600. "Interconnection between circadian clocks and thyroid function" (DOI: 10.1038/s41574-019-0237-z)
- (8) Yasutomo Segawa, David R. Levine and Kenichiro Itami, *Accounts Chem. Res.*, 2019, 52, 2760-2767. "Topologically Unique Molecular Nanocarbons" (DOI: 10.1021/acs.accounts.9b00402)
- (9) Shinya Hagihara, Ryotaro Yamada, Kenichiro Itami and Keiko U Torii, *Curr. Opin. Plant Biol.* 2019, 47, 32-39. "Dissecting plant hormone signaling with synthetic molecules: perspective from the chemists" (DOI: 10.1016/j.pbi.2018.09.002)
- (10) Kohsuke Ohmatsu and Takashi Ooi, *Top. Curr. Chem.* 2019, 377, 31. "Cationic Organic Catalysts or Ligands in Concert with Metal Catalysts" (DOI: 10.1007/s41061-019-0256-1)
- (11) Hideto Ito, Yasutomo Segawa, Kei Murakami and Kenichiro Itami, *J. Am. Chem. Soc.* 2019, 141, 3-10. "Polycyclic Arene Synthesis by Annulative n -Extension" (DOI: 10.1021/jacs.8b09232) Highly Cited Paper.
- (12) Naoyuki Uchida and Keiko U. Torii, *Cell. Mol. Life Sci.* 2019, 76, 1067-1080. "Stem cells within the shoot apical meristem: identity, arrangement and communication" (DOI: 10.1007/s00018-018-2980-z)

3. Proceedings

N/A

4. Other English Articles

- (1) Hiroki Tsutsui, Yoshikatsu Sato, Daichi Susaki and Tetsuya Higashiyama, *Mol. Reprod. Dev.* 2019, 86, 925-925. "Microtubule depletion domain 1 localizes at the boundary between female gametes in *Arabidopsis thaliana*" (DOI: 10.1002/mrd.23175)
- (2) Florence Tama, *Biophys. J.* 2019, 116, 331a. "Hybrid Modeling Approaches to Study Structures and Dynamics of Biological Systems" (DOI: 10.1016/j.bpj.2018.11.1799)
- (3) Daisuke Uruguchi, Kohsuke Ohmatsu, and Takashi Ooi, "Molecular Technology: Synthesis Innovation, Volume 4" H. Yamamoto and T. Kato Eds. Wiley-VCH; 2019, 163-197. "Organic Molecular Catalysts in Radical Chemistry: Challenges Toward Selective Transformations"
- (4) Yusuke Nakane and Takashi Yoshimura, *Annu Rev Anim Biosci* 2019, 7, 173-194. "Photoperiodic Regulation of Reproduction in Vertebrates" (DOI: 10.1146/annurev-animal-020518-115216)
- (5) Osamu Miyashita and Florence Tama, *Integrative Structural Biology with Hybrid Methods*, 2019, 199-217. "Hybrid Methods for Macromolecular Modeling by Molecular Mechanics Simulations with Experimental Data" (DOI: 10.1007/978-981-13-2200-6_13)
- (6) Yoshinari A., Moe-Lange J., Kleist T., Cartwright H., Quint D.A., Ehrhardt D.W., Frommer W.B. & Nakamura M. , *Arabidopsis Protocols*, 2019, " Using genetically encoded fluorescent biosensors for quantitative in vivo imaging"

B. WPI-related papers (Jan 1, 2019 –Dec 31, 2019)1. Original Articles

- (1) J. Steen Hoyer, Jose L. Pruneda-Paz, Ghislain Breton, Mariah A. Hassert, Emily E. Holcomb, Halley Fowler, Kaylyn M. Bauer, Jacob Mreen, Steve A. Kay and James C. Carrington, *Plant Direct*, 2019, 3, e00102. "Functional dissection of the ARGONAUTE7 promoter" (DOI: 10.1002/pld3.102)
- (2) Milica Feldt, Quan Manh Phung, Kristine Pierloot, Ricardo A. Mata and Jeremy N. Harvey, *J. Chem. Theory Comput.* 2019, 15, 922-937. "Limits of Coupled-Cluster Calculations for Non-Heme Iron Complexes" (DOI: 10.1021/acs.jctc.8b00963)
- (3) Michael U. Luescher and Jeffrey W. Bode, *Synlett* 2019, 30, 464-470. "Evidence for a Radical Mechanism in Cu(II)-Promoted SnAP Reactions" (DOI: 10.1055/s-0037-1611670)
- (4) Fumito Saito, Nils Trapp and Jeffrey W. Bode, *J. Am. Chem. Soc.* 2019, 141, 5544-5554. "Iterative Assembly of Polycyclic Saturated Heterocycles from Monomeric Building Blocks" (DOI: 10.1021/jacs.9b01537)
- (5) Akira Yoshinari, Takuya Hosokawa, Taro Amano, Marcel Pascal Beier, Tadashi Kunieda, Tomoo Shimada, Ikuko Hara-Nishimura, Satoshi Naito and Junpei Takano, *Plant Physiol.* 2019, 179, 1569-1580. "Polar localization of the borate exporter BOR1 requires AP2-dependent endocytosis." (DOI: 10.1104/pp.18.01017)
- (6) Minh-Hai Nguyen, Thi-Thuy-Ha Khuat, Hung-Huy Nguyen, Quan-Manh Phung and Thi-Hien Dinh, *Inorg. Chem. Commun.* 2019, 102, 120-125. "Emissive Pd(II) thiosemicarbazones bearing anthracene: New complexes with unusual coordination mode" (DOI: 10.1016/j.inoche.2019.02.028)
- (7) Dino Wu, Nicole A. Fohn and Jeffrey W. Bode, *Angew. Chem.-Int. Edit.* 2019. 58, 1-6. "Catalytic Synthesis of Potassium Acyltrifluoroborates (KATs) through Chemoselective Cross - Coupling with a Bifunctional Reagent" (DOI: 10.1002/anie.201904576)
- (8) Katsuhiko Shiratake, Michitaka Notaguchi, Haruko Makino, Yu Sawai and Lorenzo Borghi, *Plant Cell Physiol.* 2019, 60, 1722–1733. "Petunia PLEIOTROPIC DRUG RESISTANCE 1 Is a Strigolactone Short-Distance Transporter with Long-Distance Outcomes" (DOI: 10.1093/pcp/pcz081)
- (9) Maria A. Nohales, Wanlu Liu, Tomas Duffy, Kazunari Nozue, Mariko Sawa, Jose L. Pruneda-Paz, Julin N. Maloof, Steven E. Jacobsen and Steve A. Kay, *Dev. Cell* 2019, 49, 840-851.e8. "Multi-level Modulation of Light Signaling by GIGANTEA Regulates Both the Output and Pace of the Circadian Clock" (DOI: 10.1016/j.devcel.2019.04.030)
- (10) Alberto Osuna Galvez and Jeffrey W. Bode, *J. Am. Chem. Soc.* 2019, 141, 8721-8726. "Traceless Templated Amide-Forming Ligations" (DOI: 10.1021/jacs.9b03597)
- (11) Ya-Yi Wang and Jeffrey W. Bode, *J. Am. Chem. Soc.* 2019, 141, 9739-9745. "Olefin Amine (OLA) Reagents for the Synthesis of Bridged Bicyclic and Spirocyclic Saturated N-Heterocycles by Catalytic Hydrogen Atom Transfer (HAT) Reactions" (DOI: 10.1021/jacs.9b05074)
- (12) Dong-Mei Yan, Cathleen M. Crudden, Jia-Rong Chen and Wen-Jing Xiao, *ACS Catal.* 2019, 9, 6467-6483. "A Career in Catalysis: Howard Alper" (DOI: 10.1021/acscatal.9b01789)
- (13) Quan Manh Phung, Carlos Martín-Fernández, Jeremy N. Harvey and Milica Feldt, *J. Chem. Theory Comput.* 2019, 15, 4297-4304. "Ab Initio Calculations for Spin-Gaps of Non-Heme Iron Complexes" (DOI: 10.1021/acs.jctc.9b00370)
- (14) Kazuki Kurita, Yuki Sakamoto, Sota Naruse, Tomoko M. Matsunaga, Hideyuki Arata, Tetsuya Higashiyama, Yoshiki Habu, Yoshinori Utsumi, Chikako Utsumi, Maho Tanaka, Satoshi Takahashi, Jong-Myong Kim, Motoaki Seki, Takuya Sakamoto and Sachihiro Matsunaga, *J. Plant Res.*, 2019, 132, 629–640. "Intracellular localization of histone deacetylase HDA6 in plants" (DOI: 10.1007/s10265-019-01124-8)
- (15) Olga Lidia Torres-Rocha, Xiaowei Wu, Chunyang Zhu, Cathleen M Crudden and Michael F. Cunningham, *Macromol. Rapid Commun.* 2019, 40, 1800326. "Polymerization-Induced Self-Assembly (PISA) of 1,5-Cyclooctadiene Using Ring Opening Metathesis Polymerization" (DOI: 10.1002/marc.201800326) Highly Cited Paper.

- (16) Zhen Dong, Guoxin Zhang, Meng Qu, Ryan C Gimple, Qiulian Wu, Zhixin Qiu, Briana C Prager, Xiuxing Wang, Leo J.Y Kim, Andrew R Morton, Deobrat Dixit, Wenchao Zhou, Haidong Huang, Bin Li, Zhe Zhu, Shideng Bao, Stephen C. Mack, Lukas Chavez, Steve A. Kay and Jeremy N. Rich, *Cancer Discov.* 2019, 9, 1556-1573. "Targeting Glioblastoma Stem Cells through Disruption of the Circadian Clock" (DOI: 10.1158/2159-8290.CD-19-0215)
- (17) Somsakul Pop Wongpalee, Shiheng Liu, Javier Gallego-Bartolome, Alexander Leitner, Ruedi Aebersold, Wanlu Liu, Linda Yen, Maria A. Nohales, Peggy Hsuanyu Kuo, Ajay A. Vashisht, James A. Wohlschlegel, Suhua Feng, Steve A. Kay, Z. Hong Zhou and Steven E. Jacobsen, *Nat. Commun.* 2019, 10, 3916. "CryoEM structures of Arabidopsis DDR complexes involved in RNA-directed DNA methylation" (DOI: 10.1038/s41467-019-11759-9)
- (18) Fdez. Galván, I., et al [including Q. M. Phung], *J. Chem. Theory Comput.* 2019, 15, 5925-5964. "OpenMolcas: From Source Code to Insight" (DOI: 10.1021/acs.jctc.9b00532)
- (19) Maria A. Nohales and Steve A. Kay, *PNAS* 2019, 116, 21893-21899. "GIGANTEA gates gibberellin signaling through stabilization of the DELLA proteins in Arabidopsis" (DOI: 10.1073/pnas.1913532116)
- (20) Hao Chen, John E. Saunders, Sogol Borjian, Xiaowei Wu, Cathleen M. Crudden, Dan-Xia Xu and Hans-Peter Looock, *Adv. Sustain. Syst.* 2019, 3, 1800084. "Tetrasulfide - Functionalized Mesoporous Silica on Nanowire Ring Resonators for Detection of Aqueous Lead, Pb(II)" (DOI: 10.1002/adsu.201800084)
- (21) Hsi-Ching Tseng, Chao-Tang Shen, Matsumoto Kentaro, Ding-Nan Shih, Yi-Hung Liu, Shie-Ming Peng, Shigehiro Yamaguchi, Ya-Fan Lin and Ching-Wen Chiu, *Organometallics*, 2019, 38, 4516-4521. "[η^5 -Cp*B-Mes]⁺: A Masked Potent Boron Lewis Acid" (DOI: 10.1021/acs.organomet.9b00671)
- (22) Hirokazu Toju, Koji Okayasu and Michitaka Notaguchi, *Sci Rep*, 2019, 9, 1787. "Leaf-associated microbiomes of grafted tomato plants" (DOI: 10.1038/s41598-018-38344-2)

2. Review Articles

- (1) Vijaya R. Pattabiraman, Ayodele O. Ogunkoya and Jeffrey W. Bode, *Organic Reactions*, John Wiley & Sons, Inc, 2019, 201. "Amide - Forming Ligation Reactions" (DOI: 10.1002/0471264180.or097.02)

3. Proceedings

N/A

4. Other English Articles

- (1) Alán Aspuru-Guzik, Mu-Hyun Baik, Shankar Balasubramanian, Rahul Banerjee, Suzanne Bart, Nadine Borduas-Dedekind, Sukbok Chang, Peng Chen, Clemence Corminboeuf, François-Xavier Coudert, Leroy Cronin, Cathleen Crudden, Tanja Cuk, Abigail G. Doyle, Chunhai Fan, Xinliang Feng, Danna Freedman, Shuhei Furukawa, Suhrit Ghosh, Frank Glorius, Malika Jeffries-EL, Nathalie Katsonis, Ang Li, Sara Snogerup Linse, Silvia Marchesan, Nuno Maulide, Anat Milo, Alison R. H. Narayan, Panče Naumov, Cristina Nevado, Tebello Nyokong, Rosa Palacin, Marc Reid, Carol Robinson, Gregory Robinson, Richmond Sarpong, Corinna Schindler, Gabriela S. Schlau-Cohen, Timothy W. Schmidt, Roberta Sessoli, Yang Shao-Horn, Hanadi Sleiman, John Sutherland, Annette Taylor, Akif Tezcan, Mariola Tortosa, Aron Walsh, Allan J. B. Watson, Bert M. Weckhuysen, Emily Weiss, Daniela Wilson, Vivian W.-W. Yam, Xueming Yang, Jackie Y. Ying, Tehshik Yoon, Shu-Li You, Aldo J. G. Zarbin and Hua Zhang, *Nat. Chem.* 2019, 11, 286-294. "Charting a course for chemistry" (DOI: 10.1038/s41557-019-0236-7)
- (2) Koji Okayasu and Michitaka Notaguchi, *Phloem: Methods and Protocols*. Springer, 2019, 411-420. "Efficient Establishment of Interfamily Heterograft of *Nicotiana benthamiana* and *Arabidopsis thaliana*" (DOI: 10.1007/978-1-4939-9562-2_31)
- (3) Mika Oki, Baptiste Bourreau, Issey Takahashi and Kenji Suzuki, 2019 IEEE International Conference on Systems, Man and Cybernetics (SMC), 2019, 2639-2644, "CANVAS: A Drawing Tool for AR-aided Special Needs Education using Interactive Floor Projection" (DOI: 10.1109/SMC.2019.8914003)

2. Invited Lectures, Plenary Addresses (etc.) at International Conferences and International Research Meetings

- List up to 10 main presentations during FY 2019 in order from most recent.
- For each, write the date(s), lecturer/presenter's name, presentation title, and conference name.

Date(s)	Lecturer/Presenter's name	Presentation title	Conference name
Oct. 11-13, 2019	Takashi Ooi	Molecular Design and Asymmetric Catalysis of Weakly-Coordinating Chiral Anions.	The First International Symposium on Molecular Recognition and Synthesis, Fudan University, Shanghai, China
Aug. 28 2019	Kenichiro Itami	Combatting Striga: Return the pink field back to green by molecules and solve the food crisis in Africa.	Africa-Japan Ministerial Dialogue Meeting on STI for SDGs, PACIFICO Yokohama, Yokohama, Japan
Aug. 26, 2019	Takashi Yoshimura	Molecular basis of seasonal changes in behavior.	<i>XVI Congress of the European Biological Rhythms Society</i> , Lyon, France
Jul. 15 2019	Kenichiro Itami	Making new forms of nanocarbons.	The 20th European Symposium in Organic Chemistry (ESOC), Vienna, Austria
Jul. 9, 2019	Yoshinori Kinoshita	Regulation of light-induced stomatal opening and plasma membrane H ⁺ -ATPase.	The 18th International Workshop on Plant Membrane Biology, University of Glasgow, UK
Jun. 2-7, 2019.	Shigehiro Yamaguchi	Main Group-Containing pi-Electron Materials with Structural Constraint.	14th International Symposium on Functional pi-Electron Systems (Fpi14), Invited Lecture, Berlin, Germany
Mar. 21 2019	Jeffrey W. Bode	Predictable and Programmable Organic Synthesis.	Basel Chemical Society, Basel, Switzerland
Mar. 21-22, 2019	Keiko Torii	Cellular decision making during stomatal patterning and differentiation.	Max Planck Institute for Molecular Plant Physiology Symposium, Golm, Germany
Apr. 19, 2019	Wolf Frommer	Engineering pathogen resistance faster than bacteria evolve new virulence mechanisms.	Tri-National Arabidopsis Meeting, Zurich. Zurich, Switzerland
Apr. 10-12, 2019	Tetsuya Higashiyama	Live-Cell Analysis of Multi-Step Signaling in Pollen Tube Guidance.	The 11th Tri-National Arabidopsis Meeting (TNAM 2019) Zurich, Switzerland

3. Major Awards

- List up to 10 main awards received during FY 2019 in order from the most recent.
- For each, write the date issued, the recipient's name, and the name of award.
- In case of multiple recipients, underline those affiliated with the center.

Date	Recipient's name	Name of award
Jan. 01, 2020	Tetsuya Higashiyama	Asahi award
Nov. 19, 2019 (Announcement)	Kenichiro Itami, Wolf Frommer, Tetsuya Higashiyama	2019 Highly Cited Researchers
Nov. 6, 2019	Shigehiro Yamaguchi	Russel Lecture, Queen's University
Sep. 16, 2019	Live Imaging Center (Yoshikatsu Sato)	16 th the Botanical Society Japan Special Prize
Aug. 26, 2019	Takashi Yoshimura	Axelrod lectureship award (European Biological Rhythms Society)
May 6, 2019	Keiko Torii	Walter E and Helen Parke Loomis Lecture, Iowa State University
Apr. 16, 2019	Steve Kay	Fellow of the Royal Society (2019)
Apr. 16, 2019	Jeffrey W. Bode	Nankai Lecture in Organic Chemistry
Apr. 2, 2019	Cathleen Crudden	2019 Arthur C. Cope Scholar Award, American Chemical Society
Mar. 26, 2019	Shigehiro Yamaguchi	Humboldt Research Award

Appendix 2 FY 2019 List of Principal Investigators

NOTE:

*Underline names of principal investigators who belong to an overseas research institution.

*In the case of researcher(s) not listed in the latest report or, for centers selected in FY2012 in the progress report for Extension application screening, attach a "Biographical Sketch of a New Principal Investigator"(Appendix 2a).

		<Results at the end of FY2019>				Principal Investigators Total: 13	
Name	Age	Affiliation (Position title, department, organization)	Academic degree, specialty	Effort (%)*	Starting date of project participation	Status of project participation (Describe in concrete terms)	Contributions by PIs from overseas research institutions
Kenichiro ITAMI*	48	Director, Professor Institute of Transformative Bio- Molecules, Nagoya University	Dr.Eng Specialties: Organic Synthesis, Catalysis, Pharmaceuti-cal Science, Nanocarbon Chemistry	80	from the beginning	usually stays at the center	
Tetsuya HIGASHIYAMA*	48	Vice-Director, Professor Institute of Transformative Bio- Molecules, Nagoya University	Dr.Sci Specialties: Live Cell Biology, Plant Reproduction, Bio-active molecules, Peptides	90	from the beginning	usually stays at the center	
<u>Jeffrey W. BODE*</u>	46	Professor of Organic Chemistry Department of Chemistry and Applied Biosciences, ETH Zürich, Switzerland	Doctoral of Natural Science Specialties: Organic Synthesis, Peptide and Protein Chemistry, Catalysis, Ligation and Bioconjugati-on reactions	21	from the beginning	Stayed at the center for one week in FY2019. Connected 24 hours through iPad to the center. Holds on-line group meeting once a week. Joins PI meeting online.	
<u>Cathleen M. CRUDDEN*</u>	53	Professor Department of Chemistry, Queen's University, Canada	Ph.D Specialties: Catalysis, Organic Synthesis, Materials Chemistry, Chirality	21	from the beginning	Stayed at the center for two weeks in FY2019. Holds Skype group meeting once a week. Joins PI meeting online.	
Toshinori KINOSHITA*	51	Professor Institute of Transformative Bio- Molecules, Nagoya University	Dr.Sci Specialties: Plant Molecular Physiology	90	from the beginning	usually stays at the center	
Takashi OOI*	54	Professor Institute of Transformative Bio- Molecules, Nagoya University	Dr. Engineering Specialties: Organic Synthesis, Catalysis, Molecular Recognition	90	from the beginning	usually stays at the center	

<u>Keiko TORII*</u>	54	Professor College of Natural Sciences The University of Texas at Austin Investigator Howard Hughes Medical Institute	Ph.D. Specialties: Plant Development, Signal Transduction, Stem Cell Maintenance/Differentiation in Plants	21	from the beginning	Stayed at the center for one month in FY2019. Holds on-line plant biology meeting "Mixplant meeting" once a week. Joins PI meeting online.	
Shigehiro YAMAGUCHI*	51	Vice-Director, Professor Institute of Transformative Bio- Molecules, Nagoya University	Dr. Engineering Specialties: Main Group Chemistry, Physical Organic Chemistry	90	from the beginning	usually stays at the center	
Takashi YOSHIMURA*	50	Professor Institute of Transformative Bio- Molecules, Nagoya University	Dr. Agriculture Specialties: Animal Physiology, Systems Biology, Neuroendoc- rinology	70	from the beginning	usually stays at the center	
<u>Steve A. Kay*</u>	60	Director of Convergent Biosciences Provost Professor of Neurology, Biomedical Engineering and Biological Sciences, University of Southern California	Ph.D. Specialties: Chronobiology, Genetics, Biochemistry, Systems Biology	21	from April 1st 2014	Holds on-line meeting on an as- needed basis. Joins PI meeting online.	
Florence Tama*	45	Professor Institute of Transformative Bio- Molecules / Department of Physics, Graduate School of Science, Nagoya University	Ph.D Specialties: computational biophysics	50	from April 1st 2016	usually stays at the center	
<u>Wolf B. Frommer*</u>	62	Professor, Heinrich Heine University Düsseldorf and Max Planck Institute for Breeding Research	Dr. rer. nat. Specialties: Biology	21	from October 16th 2016	Stayed at the center for one week in FY2018. Holds on-line group meeting once a week. Joins PI meeting online.	
Takeshi Yanai*	45	Professor Institute of Transformative Bio- Molecules, Nagoya University	"Dr.Eng Specialties: Theoretical chemistry, computatoinal quantum chemistry"	90	from April 1st 2018	usually stays at the center	

*Percentage of time that the principal investigator devotes to working for the center vis-à-vis his/her total working hours.

Principal investigators unable to participate in project in FY 2019

Name	Affiliation (Position title, department, organization)	Starting date of project participation	Reasons	Measures taken
N/A				

Appendix 2a Biographical Sketch of a New Principal Investigator

(within 3 pages per person)

Name (Age)

N/A

Affiliation and position (Position title, department, organization, etc.)

Academic degree and specialty

Effort

%

* Percentage of time that the principal investigator devote to working for the center vis-à-vis his/her total working hours.

Research and education history

Achievements and highlights of past research activities

Achievements

(1) International influence * Describe the kind of attributes listed below.

- a) Recipient of international awards
- b) Member of a scholarly academy in a major country
- c) Guest speaker or chair of related international conference and/or director or honorary member of a major international academic society in the subject field
- d) Editor of an international academic journal
- e) Peer reviewer for an overseas competitive research program (etc.)

(2) Receipt of major large-scale competitive funds (over the past 5 years)

(3) Major publications (Titles of major publications, year of publication, journal name, number of citations)

(4) Others (Other achievements indicative of the PI's qualification as a top-world researcher, if any.)

Appendix 3-1 FY 2019 Records of Center Activities

1. Researchers and center staff, satellites, partner institutions

1-1. Number of researchers in the "core" established within the host institution

- Regarding the number of researchers at the Center, fill in the table in Appendix 3-1a.

Special mention

- Enter matters warranting special mention, such as concrete plans for achieving the Center's goals, established schedules for employing main researchers, particularly principal investigators.

- As background to how the Center is working on the global circulation of world's best brains, give good examples, if any, of how career paths are being established for the Center's researchers; that is, from which top-world research institutions do researchers come to the Center and to which research institutions do the Center's researchers go, and how long are their stays at those institutions.

Examples of researchers involved in the global brain circulation:

Position at ITbM	Period of project participation	Previous Affiliation (Position title, organization, *country)	Next Affiliation (Position title, organization, *country)
Designated Associate Professor	4/1/2013-3/31/2020	Assistant Professor, Nara Institute of Science and Technology, Japan	Professor, Nagoya University, Japan
Designated Assistant Professor	4/1/2015-3/31/2020	Student, Nagoya University, Japan	Research Fellow, Kyushu University, Japan
Research Fellow	11/1/2015-9/30/2019	Student, The University of Hong Kong, Hong Kong	Assistant professor, Shanghai Jiao Tong University, China
Research Fellow	1/1/2017-10/31/2019	Project Officer, Indian Institute of Technology Tirupati, India	Research Associate, Cambridge University, UK
Research Fellow	7/1/2017-3/31/2020	Student, University of Münster, Germany	Research Fellow, Nagoya University, Japan
Research Fellow	10/15/2017-10/14/2019	Assistant, Polish Academy of Science, Poland	Post-doc, Polish Academy of Science, Poland
Research Fellow	10/1/2018-8/31/2019	Student, National University of Singapore, Singapore	Lecturer, Yulin University, China
Designated Lecturer	4/1/2019-Present	Research Fellow, Nagoya University, Japan	
Designated Assistant Professor	4/1/2019-Present	PRESTO Researcher, Japan Science and Technology Agency, Japan	
Designated Assistant Professor	4/1/2019-Present	Student, Tokushima University, Japan	
Research Fellow	4/1/2019-2019.4.30	Designated Assistant, National Institute for Basic Biology, Japan	Designated Assistant, National Institute for Basic Biology, Japan
Research Fellow	4/1/2019-6/30/2019	Technical Assistant, Nagoya University, Japan	Research Fellow, Nagoya University, Japan
Research Fellow	4/1/2019-Present	Research Fellow, Nagoya University, Japan	
Research Fellow	4/1/2019-12/31/2019	Student, Nagoya University, Japan	Postdoctoral Research Scholar, Emory University, USA
Research Fellow	4/1/2019-Present	Postdoctoral Fellow, Queen's University, Canada	
Research Fellow	4/1/2019-Present	Student, Nagoya University, Japan	
Research Fellow	4/12/2019-Present	Student, Gyeongsang National University, Republic of Korea	
Designated Professor	5/14/2019-6/1/2019	Professor, Wuhan University, China	Professor, Wuhan University, China

Research Fellow	8/1/2019-Present	Student, University of Madras, India	
Research Fellow	8/1/2019-Present	Research Fellow, Hokkaido University, Japan	
Designated Professor	9/23/2019-12/22/2019	Professor, University of Zürich, Switzerland	Professor, University of Zürich, Switzerland
Research Fellow	10/1/2019-Present	Student, Beijing Institute of Technology, China	
Research Fellow	10/1/2019-Present	Student, University of Pennsylvania, USA	
Research Fellow	10/23/2019-Present	Postdoctoral Researcher, Uppsala University, China	
Research Fellow	11/25/2019-Present	Student, ETH Zürich, Switzerland	
Research Fellow	12/1/2019-Present	Research Fellow, TU Berlin, Germany	
Research Fellow	1/16/2020-Present	Student, University of Sheffield, UK	
Research Fellow	1/16/2020-Present	Humboldt Research Fellowship, TU Berlin, Germany	
Designated Associate Professor	2/1/2020-Present	Senior Associate, NU Tech Inc., USA	

1-2. Satellites and partner institutions

- List the satellite and partner institutions in the table below.
- Indicate newly added and deleted institutions in the "Notes" column.
- If satellite institutions have been established overseas, describe by satellite the Center's achievements in coauthored papers and researcher exchanges in Appendix 4.

<Satellite institutions>

Institution name	Principal Investigator(s), if any	Notes
N/A		

< Partner institutions >

Institution name	Principal Investigator(s), if any	Notes
ETH Zurich	Jeffrey W. BODE	
Queen's University	Cathleen M. CRUDDEN	
University of Texas at Austin	Keiko TORII	New (University of Washington deleted due to the transfer of Torii)
University of Southern California	Steve A. KAY	
Heinrich Heine University Düsseldorf	Wolf B. FROMMER	
NSF Center for Selective C-H Functionalization	N/A	
University of Freiburg	N/A	
RIKEN Center for Sustainable Resource Science (CSRS)	N/A	
Institute of Chemistry (IoC), Academia Sinica	N/A	

2. Holding international research meetings

- Indicate the number of international research conferences or symposiums held in FY2019 and give up to three examples of the most representative ones using the table below.

FY 2019: 5 meetings	
Major examples (meeting titles and places held)	Number of participants
The 7th International Symposium of Transformative Bio-Molecules (ISTbM-7), 15th Hirata Award, 5th Okazaki Award Sakata and Hirata Hall, Nagoya University December 13, 2019	From domestic institutions: 275 From overseas institutions: 30
EMBO Practical Course "Functional live imaging of plants" ITbM, Nagoya University May 21-30, 2019	From domestic institutions: 57 From overseas institutions: 51
ITbM-GTR Pre-ISNA Symposium "Toward advanced functions from new pi-skeletons" Noyori Conference Hall, Nagoya University July 20, 2019	From domestic institutions: 220 From overseas institutions: 30

3. Diagram of management system

- Diagram the center's management system and its position within the host institution in an easily understood manner.
- If any new changes have been made in the management system from that in the latest "center project" last year, describe them. Especially describe any important changes made in such as the center director, administrative director, head of host institution, and officer(s) in charge at the host institution (e.g., executive vice president for research).

ITbM's organizational diagram

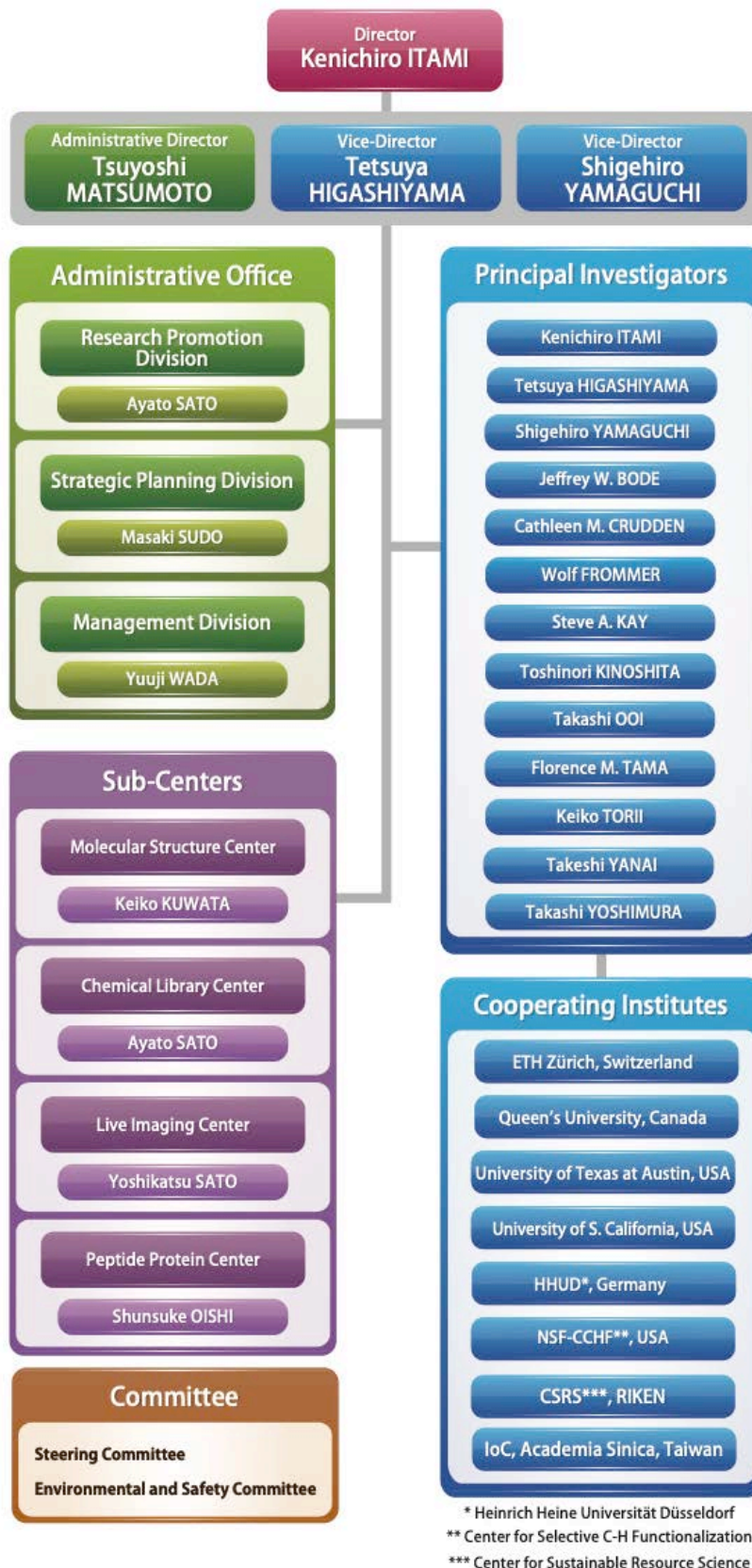
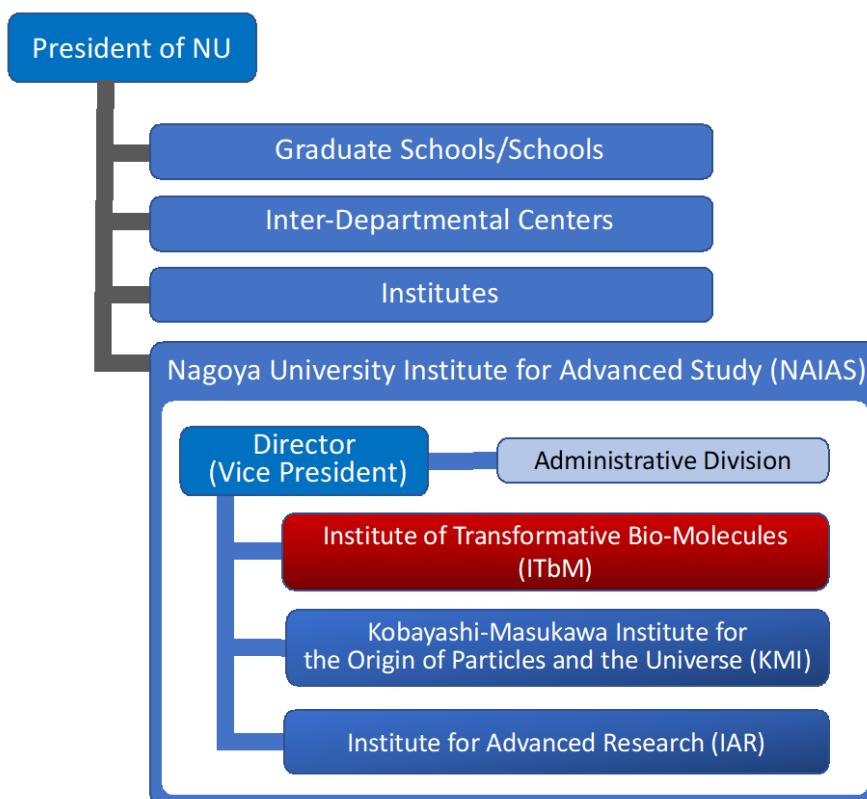


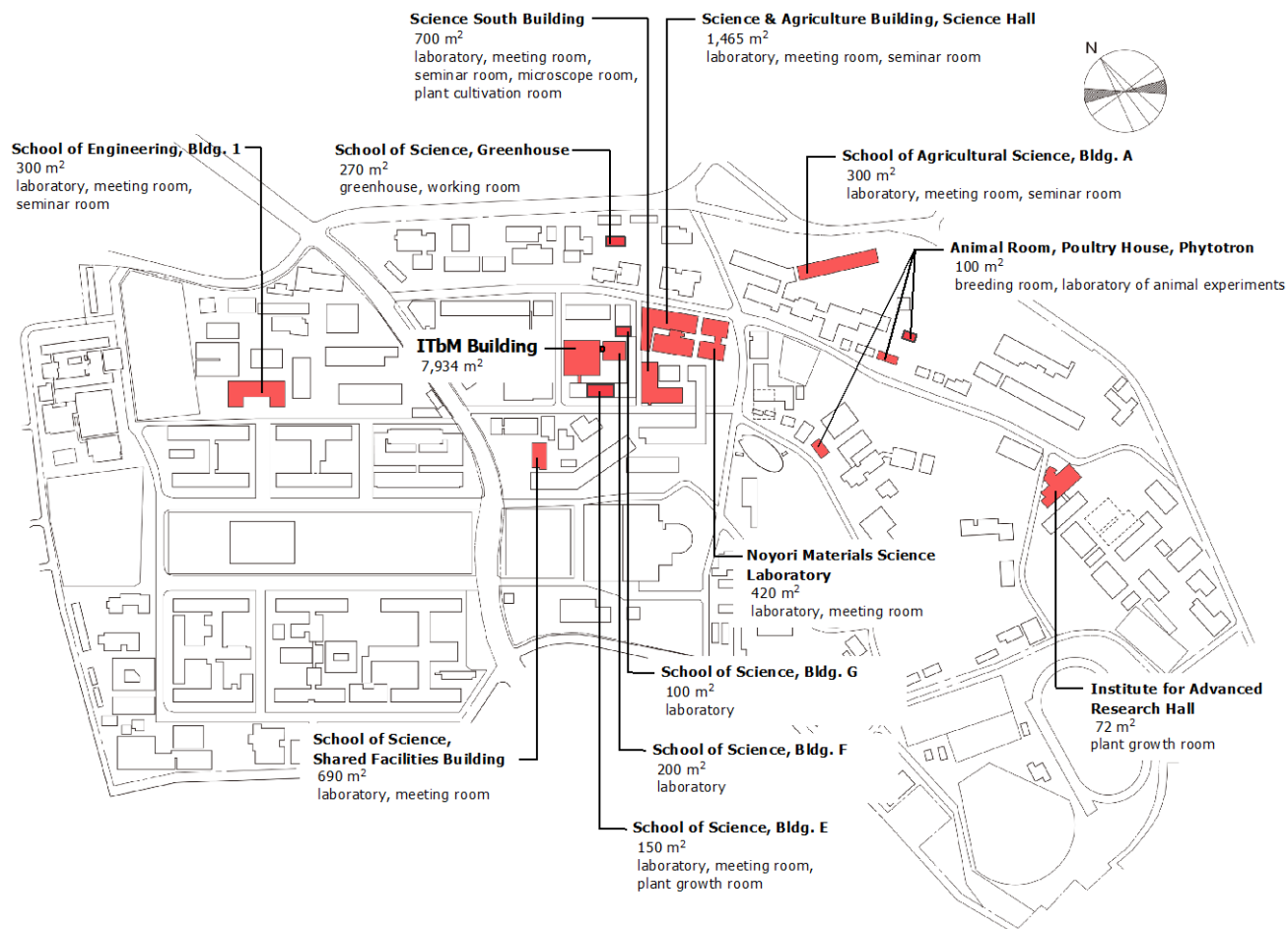
Diagram to show the ITbM's position within Nagoya University

"Nagoya University Institute for Advanced Study (NAIAS)" was established in October 2019, and ITbM was positioned under the umbrella. Irrespective of this organizational change, Director of ITbM retains the authority to make decisions on ITbM.



4. Campus Map

- Draw a simple map of the campus showing where the main office and principal investigator(s) are located.



The offices of the Center Director, All the PIs, and Administrative Department are located in the "ITbM Building"

5. Securing external research funding*

External research funding secured in FY2019

Total: 972,770,271 yen

- Describe external funding warranting special mention. Include the name and total amount of each grant.

* External research funding includes "KAKENHI," funding for "commissioned research projects," "joint research projects," and for others. (donations, etc.)

The followings are the selected external funds continued in FY2019. Each total amount shows the sum total of the fund from the year of adoption to FY2019.

- Name: Strategic Basic Research Programs (ERATO), JST
Total Amount: 2,219,639,000 JPY (acquired by Kenichiro Itami)
- Name: Grant-in-Aid for Specially Promoted Research, JSPS
Total Amount: 109,850,000 JPY (acquired by Kenichiro Itami)
- Name: Grant-in-Aid for Scientific Research on Innovative Areas (Research in a proposed research area), JSPS
Total Amount: 410,150,000 JPY (acquired by Tetsuya Higashiyama)
- Name: Grant-in-Aid for Scientific Research on Innovative Areas (Research in a proposed research area), JSPS
Total Amount: 480,480,000 JPY (acquired by Toshinori Kinoshita)
- Name: Grant-in-Aid for Scientific Research on Innovative Areas (Research in a proposed research area), JSPS
Total Amount: 86,450,000 JPY (acquired by Takashi Ooi)

Appendix 3-1a FY 2019 Records of Center Activities

Researchers and other center staff

Number of researchers and other center staff

* Fill in the number of researchers and other center staff in the table below.

* Describe the final goals for achieving these numbers and dates when they will be achieved described in the last "center project."

a) Principal Investigators

(full professors, associate professors or other researchers of comparable standing)

(number of persons)

	At the beginning of project	At the end of FY 2019	Final goal (Date: March, 2020)
Researchers from within the host institution	7	8	8
Researchers invited from overseas	3	5	5
Researchers invited from other Japanese institutions	0	0	0
Total principal investigators	10	13	13

b) Total members

	At the beginning of project		At the end of FY2019		Final goal (Date: March, 2022)	
	Number of persons	%	Number of persons	%	Number of persons	%
Researchers	20	/	80	/	80	/
Overseas researchers	5	25	28	35	27	34
Female researchers	4	20	19	24	11	14
Principal investigators	10	/	13	/	13	/
Overseas PIs	3	30	5	38	6	46
Female PIs	2	20	3	23	3	23
Other researchers	8	/	36	/	35	/
Overseas researchers	0	0	1	3	1	3
Female researchers	1	13	9	25	9	26
Postdocs	2	/	31	/	32	/
Overseas postdocs	2	100	22	71	20	63
Female postdocs	1	50	7	23	8	25
Research support staffs	10	/	59	/	50	/
Administrative staffs	10	/	12	/	12	/
Total number of people who form the "core" of the research center	40	/	151	/	142	/

Appendix 3-2 Project Expenditures

1) Overall project funding

* In the "Total costs" column, enter the total amount of funding required to implement the project, without dividing it into funding sources.

* In the "Amount covered by WPI funding" column, enter the amount covered by WPI within the total amount.

* In the "Personnel," "Project activities," "Travel," and "Equipment" blocks, the items of the "Details" column may be changed to coincide with the project's actual content.

(Million yens)				Costs (Million yens)	
Cost items	Details (For Personnel - Equipment please fill in the breakdown of fiscal expenditure, and the income breakdown for Research projects.)	Total costs	Amount covered by WPI funding		
Personnel	Center director and administrative director	33	18	WPI grant in FY 2019	665
	Principal investigators (no. of persons):12	105	18	Costs of establishing and maintaining	0
	Other researchers (no. of persons):52	279	221	Costs of equipment procured	67
	Research support staff (no. of persons):28	58	58	GC/MSD system	15
	Administrative staff (no. of persons):23	90	63	High-end electric inverted microscope	13
	Subtotal	565	378	Wavelength-tunable pulse light source system	13
Project activities	Cost of dispatching scientists (no. of persons):2	11	11	Other equipment	26
	Research startup cost (no. of persons):5	6	6		
	Cost of international symposiums (no. of symposiums):4	1	0		
	Rental fees for facilities	25	3		
	Cost of consumables	25	25		
	Cost of utilities	56	56		
	Other costs	111	98		
Subtotal	235	199			
Travel	Domestic travel costs	3	3		
	Overseas travel costs	14	14		
	Travel and accommodations cost for invited scientists (no. of domestic scientists):3 (no. of overseas scientists):5	3	1		
	Travel cost for scientists on transfer (no. of domestic scientists):1 (no. of overseas scientists):7	3	3		
	Subtotal	23	21		
Equipment	Depreciation of buildings	36	7		
	Depreciation of equipment	91	46		
	Subtotal	127	53		
Research projects (Detail items must be fixed)	Project supported by other government subsidies, etc. ^{*1}	210			
	KAKENHI	426			
	Commissioned research projects, etc.	161			
	Joint research projects	46			
	Others (donations, etc.)	26			
	Subtotal	869	0		
Total		1819	651		

*1. Management Expenses Grants (including Management Enhancements Promotion Expenses (機能強化経費)), subsidies including National university reform reinforcement promotion subsidy (国立大学改革強化推進補助金) etc., indirect funding, and allocations from the university's own resources.
*2 When personnel, travel, equipment (etc.) expenses are covered by KAKENHI or under commissioned research projects or joint research projects, the amounts should be entered in the "Research projects" block.

*1 運営費交付金(機能強化経費を含む)、国立大学改革強化推進補助金等の補助金、間接経費、その他大学独自の取組による学内リソースの配分等による財源
*2 科研費、受託研究費、共同研究費等によって人件費、旅費、設備備品等費を支出している場合も、その額は「研究プロジェクト費」として計上すること

Appendix 4 FY 2019 Status of Collaboration with Overseas Satellites

1. Coauthored Papers

- List the refereed papers published in FY 2019 that were coauthored between the center's researcher(s) in domestic institution(s) (include satellite institutions) and overseas satellite institution(s). List them by overseas satellite institution in the below blocks.
- Transcribe data in same format as in Appendix 1. Italicize the names of authors affiliated with overseas satellite institutions.
- For reference write the Appendix 1 item number in parentheses after the item number in the blocks below. Let it free, if the paper is published in between Jan.-Mar. 2020 and not described in Appendix 1.

Overseas Satellite 1 Name (Total: OO papers)

- 1) N/A
- 2)
- 3)
- 4)

Overseas Satellite 2 Name (Total: OO papers)

- 1)
- 2)
- 3)
- 4)

2. Status of Researcher Exchanges

- Using the below tables, indicate the number and length of researcher exchanges in FY 2019. Enter by institution and length of exchange.
- Write the number of principal investigator visits in the top of each space and the number of other researchers in the bottom.

Overseas Satellite 1:

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2019					

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2019					

Overseas Satellite 2:

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2019					

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2019					

Appendix 5 FY 2019 Visit Records of Researchers from Abroad

* If researchers have visited/ stayed at the Center, provide information on them in the below table.

Total: 48

	Name	Age	Affiliation		Academic degree, specialty	Record of research activities (Awards record, etc.)	Time, duration	Summary of activities during stay at center (e.g., participation as principal investigator; short-term stay for joint research; participation in symposium)
			Position title, department, organization	Country				
1	Cathleen Crudden	53	Principal Investigator, ITbM / Professor, Department of Chemistry, Queens University	Canada	Ph.D. Chemistry	<ul style="list-style-type: none"> Arthur C. Cope Scholar Award (2019) IPMI Carol Tyler Award (2018) The Aldrich Lecture Award (2014) Clara Benson Award, CSC (2011) Catalysis Lectureship Award, Catalysis Society (2010) 	2 weeks	• participation as principal investigator
2	Keiko Torii	54	Principal Investigator, ITbM / Professor, College of Natural Sciences, The University of Texas at Austin, Investigator, Howard Hughes Medical Institute	USA	Ph.D. Biochemistry	<ul style="list-style-type: none"> Clayton Person Lecture (Department of Botany, University of British Columbia, Canada) (2018) Distinguished Lecture, Institute of Plant Molecular Biology, Academia Sinica, Taipei (2016) 35th Saruhashi Award (2015) 2015 ASPB Fellow Award, American Society of Plant Biologists (2015) Fellow, AAAS (2012) JSPS Prize (2008) SJWS Award (2006) 	1 month	• participation as principal investigator
3	Jeffrey W. Bode	46	Principal Investigator, ITbM / Professor, Department of Chemistry and Applied Bioscience, ETH Zurich	Switzerland	Dok. Nat. Sci.	<ul style="list-style-type: none"> Mukaiyama Award (2018) E.J. Corey Award (2011) Novartis Lectureship (2010) 6th Yoshimasa Hirata Memorial Lecture (2010) 	1 week	• participation as principal investigator
4	Wolf B. Frommer	62	Principal Investigator, ITbM / Professor, Heinrich Heine University Düsseldorf and Max Planck Institute for Breeding Research	Germany	Dr. rer. Nat	<ul style="list-style-type: none"> Tsungming Tu Award (2018) Clarivate-Web of Science Highly Cited (2018) Clarivate Analytics Highly Cited Researcher (2017) Alexander von Humboldt Professorship - International Prize for Research in Germany (2016) Member, German Academy of Sciences, Leopoldina (2015) Laurence Bogorad Award for Excellence in Plant Biology Research, American Society of Plant Biology (2012) Fellow, American Association for the Advancement of Science (2003) European Science Award, Körber Foundation (2001) Gottfried-Wilhelm-Leibniz Preis, German Research Foundation (DFG) (1998) Young investigator Award, German Federal Ministry for Science and Technology (1992) 	1 week	• participation as principal investigator
5	Tristan Lambert	N/A	Professor, Cornell University	USA	Ph.D., Organic Chemistry	<ul style="list-style-type: none"> Swiss Chemical Society Lecturer (2015) Visiting Professorship, Phillips-University Marburg (2014) Eli Lilly Grantee Award (2011) Thieme Synthesis/Synlett Journal Award (2010) NSF CAREER (2010) Alfred P. Sloan Research Fellowship (2010) Amgen Young Investigator Award (2010) American Chemical Society Young Investigators Symposium (2010) Abbott Young Investigator Award (2009) NIH Postdoctoral Fellowship (2004-2006) Klaus and Mary Saegabarth Fellowship, UC-Berkeley (1998-1999) 	3 days	• lecture @ ITbM seminar • research discussion
6	Ari Pekka Mahonen	N/A	Professor, University of Helsinki	Finland	Ph.D., Plant Molecular Genetics, Developmental Biology	<ul style="list-style-type: none"> Scandinavian Plant Physiology Society (SPPS) Early Career Award (2015) The Finnish Academy of Science Award for outstanding doctoral dissertation (2006) University of Helsinki Award for outstanding doctoral thesis (2006) 	2 days	• research discussion
7	Lei Aiwen	46	Professor, Wuhan University	China	Ph.D., Organic Chemistry	<ul style="list-style-type: none"> The Third Batch of National Million Plan Leader (2017) First-Class Science Research Famous Achievement Award (2017) Overseas Chinese (Innovative Talents) Contribution Award (2016) The National Youth Science and Technology Innovation Talents (2015) The Roche Chinese Young Investigator Award (2015) 	2 weeks	• JSPS invitation fellowship
8	Masamitsu Kanada	N/A	Assistant Professor, Michigan State University	USA	Ph.D., Cell Biology	<ul style="list-style-type: none"> Best Presentation Award, 7th Annual Meeting of Japanese Society for Molecular Imaging, Hamamatsu, Japan (2012) Best Poster Award, the 2011 World Molecular Imaging Congress, San Diego, CA (2011) Provost's Award, Graduate School of Life and Environmental Sciences, University of Tsukuba (2008) Chair's Award, Doctoral Program in Structural Biosciences, University of Tsukuba (2008) 	1 day	• research discussion
9	Bin Liu	46	Professor, National University of Singapore	Singapore	Ph.D., Chemistry	<ul style="list-style-type: none"> Micro-Nano Letters Researcher Award (2018) Asian Scientist 100 list (2017) President's Science and Technology Awards (2016) Singapore National Institute of Chemistry (SNIC)-BASF Materials Award (2014) Singapore National Science and Technology Young Scientist Award (2008) 	2 weeks	• JSPS invitation fellowship
10	Eliud Kiplimo Kireger	59	Director General, Kenya Agriculture and Livestock Research Organization (KALRO)	Kenya	Ph.D., Plant Eco-physiology	<ul style="list-style-type: none"> Australian International Development Agency Award (2007) Doctoral Research Fellowship, University of Wales (UK) (1999) International Centre for Research in Agroforestry Award (1995) 	1 week	• research discussion • press release

11	Carry L. Partch	N/A	Associate Professor, University of California Santa Cruz	USA	Ph.D., Biochemistry and Biophysics	<ul style="list-style-type: none"> •Margaret Oakley Dayhoff Award, Biophysical Society (2018) •Junior Faculty Research Award, Society for Research on Biological Rhythms (2016) •EMBO Symposium on Molecular Machines: Integrative Structural and Molecular Biology, first place research prize (2016) •Dean's Award for Excellence in Postdoctoral Research, UTSW (2010) 	2 days	<ul style="list-style-type: none"> •lecture @ ITbM seminar •research discussion
12	Ulrich Grossniklaus	56	Professor/Head, Department of Plant and Microbial Biology, University of Zurich	Switzerland	Ph.D., Plant Biology	<ul style="list-style-type: none"> •Thomson Reuters Highly Cited Researcher in Plant and Animal Science (2014) •Elected as Member of Leopoldina, the German National Academy of Sciences (2011) •Awardee of an Advanced Grant from the European Research Council (ERC) (2009) •Elected as Member of the European Molecular Biology Organization (EMBO) (2007) 	3 months	<ul style="list-style-type: none"> •designated professor
13	Kay Maxine Tye	38	Professor, Salk Institute	USA	Ph.D., Neuroscience	<ul style="list-style-type: none"> •Tsuneko & Reiji Okazaki Award (2019) •SFN Young Investigator Award (2016) •Daniel X. Freedman Award (2016) •Presidential Early Career Award for Scientists and Engineers (2016) •McKnight Neuroscience Scholar Award (2015-18) •Award for Outstanding Undergraduate Research (UROP) Faculty Mentor (2015) •Harold E. Edgerton Faculty Achievement Award (2015) •Klingenstein Fellowship Award (2012-2015) •Whitehall Foundation Research Award (2012-2015) 	5 days	<ul style="list-style-type: none"> •invited lecture @ 7th International Symposium on Transformative Bio-Molecules (ISTbM-7)
14	Vy Maria Dong	44	Professor, University of California at Irvine	USA	Ph.D., Chemistry	<ul style="list-style-type: none"> •ACS Elias J. Corey Award, Outstanding Original Contribution in Organic Synthesis by a Young Investigator (2019) •Agnes Fay Morgan Research Award, Iota Sigma PI (2016) •The Society of Synthetic Organic Chemistry, Lectureship, Japan (2013) •Novartis Chemistry Lecturer (2012-2013) •Eli Lilly Grantee Award (2011-2012) •Roche Excellence Award in Chemistry (2011) •Adrian Brook Distinguished Professor (2011) 	3 days	<ul style="list-style-type: none"> •invited lecture @ 7th International Symposium on Transformative Bio-Molecules (ISTbM-7)
15	Gong Chen	42	Professor, Nankai University	China	Ph.D., Organic Chemistry	<ul style="list-style-type: none"> •ACP lectureship awards in Japan and Malaysia (2018) •National Natural Science Fund for Distinguished Young Scholars of China (2017) •WuXi AppTec Scholar Award in Life Science and Chemistry (2016) •Distinguished Junior Faculty Award by Chinese-American Chemistry & Chemical Biology Professor Association (CAPA) (2014) •Amgen Young Investigator Award (2013) •Thieme Chemistry Journal Award (2011) •National Science Foundation (NSF) CAREER Award (2011) 	4 days	<ul style="list-style-type: none"> •invited lecture @ 7th International Symposium on Transformative Bio-Molecules (ISTbM-7)
16	Abigail Doyle	39	Professor, Princeton University	USA	Ph.D. Chemistry	<ul style="list-style-type: none"> • RSC Fluorine Award (2019) • 15th Hirata Award (2019) • BMS Unrestricted Grant in Synthetic Organic Chemistry (2016) • Phi Lambda Upsilon National Fresenius Award (2014) • Presidential Early Career Award for Scientists and Engineers (2014) • Novartis Chemistry Lectureship (2014/2015) • Bayer Excellence in Science Award (2013) • Arthur C. Cope Scholar Award (2013) • Camille-Dreyfus Teacher Scholar Award (2013) • Thieme Chemistry Journals Award (2013) • Amgen Young Investigator Award (2012) • Alfred P. Sloan Foundation Fellowship (2012) • NSF CAREER Award (2012-2017) • Roche Early Excellence in Chemistry Award (2012) • Eli Lilly Grantee Award (2012-2014) • Boehringer Ingelheim New Investigator Award (2012) • Merck Award for Selective Fluorination (2010-2012) 	4 days	<ul style="list-style-type: none"> •invited lecture @ 7th International Symposium on Transformative Bio-Molecules (ISTbM-7)
17	Kwan Yin Cheung	29	Research Assistant, Chinese University of Hong Kong	China	Ph.D. Chemistry	<ul style="list-style-type: none"> •Lau Oi Wah Memorial Award for Scholastic Excellence (2012) •Chung Chi Scholarships for Excellence (2012) •Dr. Wong Kam Han Memorial Prizes (2011) 	1 year	<ul style="list-style-type: none"> •collaborative research
18	Haidong Ding	40	Associate Professor, College of Bioscience and Biotechnology, Yangzhou University	China	Ph.D. Botany	N/A	8 months	<ul style="list-style-type: none"> •collaborative research
19	Silvia Manrique Uрпи	39	Postdoctoral researcher, Università degli Studi di Milano	Italy	Ph.D., Plant Molecular Biology	<ul style="list-style-type: none"> •Post-doctoral fellowship awarded by Fundación Alfonso Martín Escudero (2015) •EMBO short-term fellowship (2015) 	3 months	<ul style="list-style-type: none"> •collaborative research
20	Marshall Brennan	N/A	Publishing manager, ChemRxiv American Chemical Society	USA	Ph.D. Chemistry	<ul style="list-style-type: none"> •Forbes "30 Under 30" 2018 Nominee (2018) •ACS Catalyst Award - Recognizing the successful launch and increasing community uptake of ChemRxiv (2018) •C&EN's "Top 20 Chemists Worth Following On Twitter" (2014) 	1 day	<ul style="list-style-type: none"> •lecture @ ITbM seminar •research discussion
21	Sarah M. (Sally) Assmann	N/A	Waller Professor of Biology, Pennsylvania State University	USA	Ph.D., Plant Physiology	<ul style="list-style-type: none"> •Elected American Association for the Advancement of Science (AAAS) Member-At-Large, Biological Sciences Section (2015) •Elected Member, North American Arabidopsis Steering Committee (NAASC) (2013-2018) •Elected Fellow, AAAS (2009) •President, American Society of Plant Biologists (ASPB) (2008-2009) •ASPB Fellow (2007) •Penn State Faculty Scholars Medal in Life and Health Sciences (2001) •NSF POWRE Award (1999-2000) •NSF Pre-doctoral Fellowship (1981-1983) 	5 days	<ul style="list-style-type: none"> •invited lecture @ International Symposium "Frontiers in plant environmental response research" •research discussion

22	Hannes Kollist	49	Professor of Molecular Plant Biology, Institute of Technology, University of Tartu	Estonia	Ph.D., Plant Physiology	•Estonian Science Prize in the field of geo- and biosciences (2010)	1 week	•invited lecture @ International Symposium "Frontiers in plant environmental response research" •research discussion
23	So Hirata	48	Marvin T. Schmidt Professor & Blue Waters Professor, Department of Chemistry, University of Illinois at Urbana-Champaign	USA	Ph.D.	•2017 SCS Teaching Award, UIUC (2017) •Sciolog Collaborative Innovation Award, Research Corporation for Science Advancement (2012) •National Science Foundation CAREER Award (2009-14) •Hewlett-Packard Outstanding Junior Faculty Award (2008)	3 days	•research discussion
24	Marcus Lundberg	N/A	Associate professor, Theoretical Chemistry Department of Chemistry – Ångström Laboratory Uppsala University	Sweden	Ph.D., Chemical Physics	•QSCP (Quantum Systems in Chemistry and Physics) promising scientist prize (2012) •Arrhenius award, Faculty of Natural Sciences, Stockholm University (2005) •Honorary award, School of Materials Engineering, KTH (1998)	1 day	•lecture @ GTR seminar
25	Thomas Mueller	58	Professor, University of Oldenburg	Germany	Ph.D., Physical Organic Chemistry, Carbocation Chemistry	•DFG Habilitationsstipendium (1997 - 1999)	1 day	•lecture •research discussion
26	Scott J. Miller	N/A	Professor, Yale University	USA	Ph.D. Chemistry	•Fellow of the American Chemical Society(2018) • Max Tishler Prize, Harvard University(2017) • Member, American Academy of Arts and Sciences(2016) • ACS Award for Creative Work in Synthetic Organic Chemistry, American Chemical Society(2016) • Fellow of the American Association for the Advancement of Science(2012)	2 days	•lecture @ ITbM seminar •research discussion
27	Tomislav Friscic	N/A	Associate Professor, McGill University	Canada	Ph.D. Chemistry	•2019 Award for Research Excellence in Materials Chemistry, Canadian Society for Chemistry •2018 National Research Council Steacie Prize for Natural Sciences •2016 McGill University Principal's Award for Outstanding Emerging Researchers •2013 Fellow of the Royal Society of Chemistry • RSC Harrison-Meldola Memorial Award for "developing solid-state methodologies which explore and combine new types of molecular self-assembly"(2011)	1 day	•lecture @ ITbM seminar •research discussion
28	Jérôme Canivet	N/A	Chargé de recherche, CNRS	France	Ph.D. Chemistry	•The Young Investigator Award from the Catalysis Division of the French Chemical Society (2018)	1 day	•lecture @ ITbM seminar •research discussion
29	Tiow-Gan Ong	N/A	Professor, Institute of Chemistry, Academia Sinica	Taiwan	Ph.D. Chemistry	•Award for Outstanding Young Scholar, Shui-Mu Foundation of Chemistry (2014) •Distinguished Lectureship Award from The Chemical Society of Japan Asian International Symposium (2013) •Young Chemists Award of the Chemical Society Located in Taipei (2010)	1 day	•lecture @ ITbM seminar •research discussion
30	Ruediger Simon	57	Professor, Heinrich Heine University	Germany	Ph.D.	•Journal of Experimental Botany, Handling Editor (2016-) •Member of the Plant Sciences Review Panel, German Research Foundation (DFG) (2016-)	12 days	EMBO Workshop "Functional Imaging of Plants"
31	Alexis Maizel	45	Professor, Heidelberg University	Germany	Ph.D.	N/A	12 days	EMBO Workshop "Functional Imaging of Plants"
32	Melanie Krebs	42	Academic senior councillor, Heidelberg University	Germany	Ph.D., Plant Physiology	N/A	12 days	EMBO Workshop "Functional Imaging of Plants"
33	Jazmin Reyes	N/A	Postdoctoral researcher, Heidelberg University	Germany	Ph.D., Biomedical Sciences	N/A	12 days	EMBO Workshop "Functional Imaging of Plants"
34	Maike Breiden	34	Postdoctoral researcher, Heinrich Heine University	Germany	Ph.D.	N/A	12 days	EMBO Workshop "Functional Imaging of Plants"
35	Benjamin Podbilewicz	57	Professor, Department of Biology, Technion.	Israel	Ph.D., Cell Biology	•European Research Council Advanced Grant (ERC) (2011-2016) •Grass Fellow, Radcliffe Institute for Advanced Study, Harvard University (2012-2013)	21 days	•invited lecture @ 71st Japan Society for Cell Biology •ITbM Seminar
36	Gavin James Wright	N/A	Senior Group Leader, Wellcome Trust Sanger Institute	United Kingdom	Ph.D.	N/A	8 days	•invited lecture @ 71st Japan Society for Cell Biology •ITbM Seminar
37	Alexander Jones	37	Research Group Leader, Sainsbury Laboratory, Cambridge University	UK	Ph.D., Plant Biology	•Tansley Medal for Plant Science (2016) •ASPB Western Section – Outstanding Presentation Award (2014) •UC Davis Plant Biology Departmental Citation - Highest Academic Achievement (2004) •University of California Regent's Scholar (2000)	5 days	•invited speaker @ Frontiers in plant environmental response research (Nagoya, Nov 18-19, 2019)
38	So-Yon Park	40	Senior Research Associate, School of Plant and Environmental Sciences, Virginia Tech	USA	Ph.D.	N/A	1 week	•invited speaker @ Frontiers in plant environmental response research (Nagoya, Nov 18-19, 2019)
39	Iva Mozgová	37	Group Leader, Biology Centre of the Czech Academy of Sciences	Czech Republic	Ph.D., Molecular Biology	•Benzelius Award, Royal Society of Sciences, Uppsala, SE (2015) •EMBO Long-term Fellowship (2012 - 2014) •Masaryk University Rector's PhD Thesis-Award (2011)	1 week	•invited speaker @ Frontiers in plant environmental response research (Nagoya, Nov 18-19, 2019)
40	Danhua Jiang	38	Principal Investigator, Institute of Genetics and Developmental Biology, Chinese Academy of Sciences	China	Ph.D.	•EMBO Long-term Fellowship (2014-2016) •International Society for Plant Molecular Biology (ISPMB) gold medal (2012)	5 days	•invited speaker @ Frontiers in plant environmental response research (Nagoya, Nov 18-19, 2019)

41	Stacey Harmer	52	Professor, University of California, Davis	USA	Ph.D., Molecular Biology	<ul style="list-style-type: none"> •Faculty Research Award, College of Biological Sciences, University of California, Davis (2016 – 2017) •Chancellor's Fellow, University of California, Davis (2011 – 2016) •Faculty Development Award, University of California, Davis (2007 – 2008) •New Investigator Award, American Society for Photobiology (2004) •Highest Distinction in General Scholarship, Department of Biochemistry, UC Berkeley (1991) •National Research Service Award, National Institutes of Health (1999 – 2002) •Highest Honors, Department of Biochemistry, UC Berkeley (1991) 	5 days	<ul style="list-style-type: none"> •invited speaker @ Frontiers in plant environmental response research (Nagoya, Nov 18-19, 2019)
42	Gabriel Krouk	40	Group leader, Biochimie et Physiologie Moléculaire des Plantes, Centre National de la Recherche Scientifique	France	Ph.D.	<ul style="list-style-type: none"> •Laureate of the AXA-French Academy of Science price (« les Grandes avancées françaises en biologie ») (2011) 	5 days	<ul style="list-style-type: none"> •invited speaker @ Frontiers in plant environmental response research (Nagoya, Nov 18-19, 2019)
43	Vincent Coeffard	N/A	Group Leader at Laboratory CEISAM, Nantes	France	Ph.D., Organic Chemistry	<ul style="list-style-type: none"> •International Fellowship for Young Researchers from The National Natural Science, Foundation of China (2014) 	1 day	<ul style="list-style-type: none"> •lecture in organic seminar •research discussion
44	Xavier Guinchart	N/A	Researcher CNRS, Institute of Chemistry of Natural Substances	France	Ph.D., Organic Chemistry	<ul style="list-style-type: none"> •Prix Jean-Pierre Sauvage 2017, the Organic Division of the SCF (2017) 	1 day	<ul style="list-style-type: none"> •lecture in organic seminar •research discussion
45	Dean Toste	N/A	Gerald E. K. Branch Distinguished Professor, UC Berkeley	USA	Ph.D., Chemistry	<ul style="list-style-type: none"> •Royal Society of Chemistry, Catalysis in Organic Chemistry Award (2018) •Janssen Prize for Creativity in Organic Synthesis (2018) •Humboldt Research Award, Germany (2016) •American Chemical Society, Creativity in Synthetic Organic Chemistry Award (2015) •Mitsui Catalysis Award (2014) •Society of Synthetic Organic Chemistry Japan, Mukaiyama Award (2011) •Tetrahedron Young Investigator Award (2011) •Royal Society of Chemistry, Merck Award (2010) •Solvias Ligand Prize (2009) •Thieme-IUPAC Prize in Synthetic Organic Chemistry(2008) •American Chemical Society, Elias J. Corey Award (2008) •BASF Catalysis Award (2007) •Organometallic Chemistry Directed •Towards Organic Synthesis (OMCOS) Award (2007) •Novartis Young Investigator Award (2006) •Roche Excellence in Chemistry Award (2006) •American Chemical Society, Cope Scholar Award (2006) •AstraZeneca Excellence in Chemistry Award (2005) •Pfizer Research Laboratories Creativity in Organic Synthesis Award (2005) •Camille and Henry Dreyfus New Faculty Award (2002) •American Chemical Society, Nobel Laureate Signature Award (2002) 	2 days	<ul style="list-style-type: none"> •lecture in organic seminar •research discussion
46	Jeffrey N. Johnston	48	Stevenson Professor of Chemistry, Vanderbilt University & Institute of Chemical Biology	USA	Ph.D., Organic Chemistry	<ul style="list-style-type: none"> •VICB Most Highly Cited Article Award, Vanderbilt University (2015) •Arthur C. Cope Scholar Award in Organic Chemistry, American Chemical Society (2014) •VICB Most Highly Cited Article Award, Vanderbilt University (2013) •Chancellor's Award for Research (2011) •IU Outstanding Junior Faculty Award (2004) •Eli Lilly Grantee Award (2003-2005) •Amgen Young Investigator Award (2003) •Astellas USA Faculty Award (2005-2006) •Yamanouchi USA Faculty Award (2002-2005) •IU Trustees Teaching Award (2001) •Boehringer-Ingelheim Young Investigator Award (2000-2001) 	3 days	<ul style="list-style-type: none"> •lecture in organic seminar •research discussion
47	Valerie Simmoneaux	N/A	Research Director, CNRS	France	Ph.D., Neuroscience	<ul style="list-style-type: none"> •Scientific Excellence Award from CNRS (2017, 2013) 	2 days	<ul style="list-style-type: none"> •lecture @ GTR seminar
48	Carlos A. Molina	N/A	Montclair State University	USA	Ph.D., Molecular Biology	<ul style="list-style-type: none"> •Faculty Service Award, College of Science and Mathematics, MSU (2016) •AACR Minority Scholar Award in Cancer Research (2001, 2002) •The Cancer Institute of New Jersey Gallo Award (2000) 	1 day	<ul style="list-style-type: none"> •research discussion

Appendix 6 FY2019 State of Outreach Activities

* Fill in the numbers of activities and times held during FY2019 by each activity.

* Describe the outreach activities in the "6. Others" of Progress Report, including those stated below that warrant special mention.

Activities	FY2019 (number of activities, times held)
PR brochure, pamphlet	ITbM A4 Pamphlet, ITbM B4 Pamphlet, NU Topics, TICAD7 Report Africa-Japan Ministerial Dialogue Meeting on STI for SDGs, ITbM Funding Brochure Vol.2
Lectures, seminars for general public	Chunichi Culture Center Lecture (Itami, Torii, Tsuchiya, Higashiyama, Kinoshita, Yoshimura), EMBO imaging Workshop (Higashiyama), Chemical Biology Meeting (Taki, A. Sato), High School Chemistry Grand Prix (A. Sato), Yume-Navi Live (Kinoshita), Tokai Science Festa (A. Sato, Miyake), NU B-Jin Seminar (Takahashi, A. Sato), TICAD7 Africa-Japan Ministerial Dialogue Meeting on STI for SDGs (Itami), Academic Night Lecture (Itami), ICREA 18 th Open Forum "Contribution of science and technology to sustainable development in Africa-Challenge of Nagoya University" (Tsuchiya), 3 rd Research University Consortium Symposium (Matsumoto), NU PI Cultivate Seminar (Miyake, Takahashi), NU Open Lecture (Higashiyama), LINK-J (Higashiyama)
PR brochure, pamphlet	ITbM A4 Pamphlet, ITbM B4 Pamphlet, NU Topics, TICAD7 Report Africa-Japan Ministerial Dialogue Meeting on STI for SDGs, ITbM Funding Brochure Vol.2
Teaching, experiments, training for elementary, secondary and high school students	Lecture : Zuiryo HS science course (Yoshimura / A. Sato / Miyake / Takahashi), Yokkaichi HS (A. Sato), Kariya HS (Itami), Gifu HS (including chemistry experiment course, Itami, A. Sato), Kikuzato HS (Taki, Toda, A. Sato), Ise HS Science olympic measures course (A. Sato) Science experiment course : Chunichi Culture Center Kids Summer School (Miyake) Facility tour: Fujishima HS (Taki, Itami), Hamamatsu City HS, Tajimi Kita HS, Asahioka HS, Handa HS, Mahidol School (Thailand), others (Vietnamese HS students, Univ. Texas, Nagoya City Tenhaku HS, Notre Dame Seishin HS, Ise HS)
Science café	NU School of Science Fresher's Science Café, Joint event with Nu coop for science students
Open houses	NU Festival, NU Homecoming Day, NU Science department alumni meeting, Nu coop meeting
Participating, exhibiting in events	NU Fresher's Training, Super Science High School Event, BioJapan, Science Agora, WPI Science Symposium, 8 th Hyper interdisciplinary conference, 6 th CSRS-ITbM Joint Workshop
Press releases	13 Press releases (Nakamichi, Torii, Ooi, Itami, Y. Sato, Kinoshita, Yamaguchi, Hirota, Nambo, Nakamura) 9 Press conferences (Nakamichi, Ooi, Itami, Y. Sato, Kinoshita, Yamaguchi, Nambo)
Others (Gallery exhibition, Symposium, etc)	ITbM Gallery exhibition (7 th -3 th) ITbM Molecule Gallery exhibition (1 st -3 rd) Symposium: ITbM-GTR ISNA Pre-symposium, CCHF-IBS-ITbM Workshop (Seoul, South Korea), ITbM-NU Medical dep. Joint Symposium, 6 th CSRS-ITbM Joint Workshop, GTR Workshop SSH Teaching Steering committee (Yokkaichi HS, Meijyo HS, A. Sato)

* If there are any rows on activities the center didn't implement, delete that (those) row(s). If you have any activities other than the items stated above, fill in the space between parentheses after "Others" on the bottom with the name of those activities and state the numbers of activities and times held in the space on the right. A row of "Others" can be added, if needed.

Outreach Activities and Their Results

List the Center's outreach activities carried out in FY 2019 that have contributed to enhancing the brand or recognition of your Center and/or the brand of the overall WPI program, if any, and describe its concrete contents and effect in narrative style. (Where possible, indicate the results in concrete numbers.)

Examples:

- As a result of using a new OO press-release method, a OO% increase in media coverage was obtained over the previous year.
- By holding seminars for the public that include people from industry, requests for joint research were received from companies.
- We changed our public relations media. As a result of using OO to disseminate information, a OO% increase in inquiries from researchers was obtained over the previous year.
- As a result of vigorously carrying out OO outreach activity, ¥OO in external funding was acquired.

Appendix 7 FY 2019 List of Project's Media Coverage

* List and describe media coverage (e.g., articles published, programs aired) in FY2019.

	Date	Types of Media (e.g., newspaper, magazine, television)	Description
1	Apr 18-19, 2019	Newspapers	Professor Takashi Yoshimura's research on RNA being involved in medaka behavior, published in Nature Ecology & Evolution. Featured in: Nikkei Shimbun, Kagaku Shimbun.
2	Apr 18, 2019	Newspaper	Graduate Program of Transformative Chem-Bio Research. Featured in: Nikkan Kogyo
3	May 9, 2019	Newspaper	Dr. Minako Ueda and Professor Tetsuya Higashiyama's research on Function of vacuoles in the division of plant fertilized eggs published in Proceedings of the National Academy of Sciences. Featured in: Chunichi Shimbun.
4	May 9, 2019	Newspaper	Professor Keiko Torii 's interview about woman reseachers. Featured in: Mainichi Shimbun
5	May 14, 2019	Newspaper, Websites (Domestic)	Dr. Norihito Nakamichi and Professor Toshinori Kinoshita's research on plant circadian clock, published in Proceeding of the National Academy of Sciences. Featured in: Chunichi Shimbun, Fukui Shimbun Online, Nikkei BioTec Online, CNET Japan, etc.
6	Jun 2, 2019	Newspaper	Dr. Norihito Nakamichi's interview. Featured in: Asahi Shimbun
7	Jun 20, 2019	Newspaper, Websites (Domestic)	Professors Keiko Torii and Kenichiro Itami 's research on plant stomata, published in Nature Plants. Featured in: Mainichi Shimbun, Chunichi Shimbun, Nihon no Kenkyu.com, etc.
8	Jun 21, 2019	Newspaper, Websites (Domestic)	Professor Takashi Ooi's research on A new chemical reaction of enol silyl ethers published in Nature Communications. Featured in: Chunichi Shimbun, Nihon no Kenkyu .com, etc.
10	Jul 9-Jul 25, 2019	Newspapers, Websites (Domestic)	Dr. Yoshikatsu Sato's research on a gene related to leaf cell reprogramming, published in Nature Plants. Featured in: Chunichi Shimbun, Yomiuri Shimbun, Mainichi Shimbun online, Tech ii.com, IT media NEWS, Nikkei BioTec online, etc.
11	Jul 19, 2019	Newspaper, Website (Domestic)	Professor Kenichiro Itami's research on Strength of carbon nanotubes depending on their chemical structures, published in Nature Communications. Featured in: Kagaku Shimbun, Nikkei Shimbun web, Fabcross for engineer web, B to B platform web, University Journal online etc.
12	Jul 20-Aug 2, 2019	Newspapers, Websites (Domestic/International)	Dr. Yasutomo Segawa and Professor Kenichiro Itami's research on Topological molecular nanocarbons:, published in Science. Featured in: Chunichi Shimbun, Kagaku Shimbun, Nikkan Kogyo Shimbun, ScienceDaily, etc.

13	Jul 23-24, 2019	Websites (Domestic)	Professor Toshinori Kinoshita's research on Regulation of stomatal opening and histone modification by photoperiod in plant, published in Scientific Reports. Featured in: Nihon no Kenkyu.com, CNET Japan, OPTRONICS online etc.
14	Aug 16, 2019	Newspaper, Websites (Domestic/International)	Professor Shigehiro Yamaguchi's research on A photostable fluorescent marker for the super-resolution live imaging of the dynamic structure of the mitochondrial cristae, published in Proceeding of the National Academy of Sciences. Featured in: Nikkei Sangyo Shimbun, Nikkei Shimbun web, Nihon no Kenkyu .com, Tech ii.com, etc.
15	Aug 29, 2019	Newspaper	Dr. Yuichiro Tsuchiya's special research review on eradication of African parasitic plants "Striga". Featured in: Yomiuri Shimbun.
16	Aug 29, 2019	Newspaper	Professor Kenichiro Itami's presentation about the research of a molecule to eradicate African parasitic plants "Striga" on TICAD7. Featured in: Yomiuri Shimbun.
17	Oct 10, 2019	Websites (Domestic/International)	Dr. Tsuyoshi Hirota's research on circadian clock published in Journal of the American Chemical Society. Featured in: OPTRONICS online, ScienceDaily, Neuroscience News .com, etc.
18	Oct 14, 2019	Newspaper	Professor Kenichiro Itami's interview. Featured in: Asahi Shimbun.
19	Oct 16, 2019	Newspaper	Conferences for fostering young chemical researchers. Featured in: Chunichi Shimbun.
20	Oct 17, 2019	Website (Domestic)	Dr. Masakazu Nambo and Professor Cathleen Crudden's research on Modular Synthesis of alpha-Fluorinated Arylmethanes via Desulfonylative Cross-Coupling published in Nature Communications. Featured in: Nihon no Kenkyu .com
21	Nov 17, 2019	TV (Domestic)	Dr. Yuichiro Tsuchiya's special research interview on eradication of African parasitic plants "Striga". Featured in: Chukyo TV.
22	Nov 22, 2019	Newspaper, Website, (Domestic)	Dr. Masayoshi Nakamura's research on plant cell division, published in Current Biology. Featured in: Kagaku Shimbun, Izu Shimbun Digital, Nihon no Kenkyu.com, Tech ii.com, etc.
23	Nov 29, 2019	Newspaper	Dr. Tsuyoshi Hirota's presentation on BINDS Symposium. Featured in: Kagaku Shimbun.
24	Dec 4 2019- Jan 9, 2020	Newspapers, Websites (Domestic)	Professor Tetsuya Higashiyama's interview. Featured in: Yamagata Shimbun, Asahi Shimbun, Chubu keizai Simbun, Yamagata News online, etc.
25	Dec 12 2019	Newspaper, Websites (Domestic)	Dr. Yuichiro Tsuchiya's special research review on eradication of African parasitic plants "Striga". Featured in: Mainichi Shimbun, Mainichi Shimbun online.
26	Jan 3, 2020	Newspaper	Professor Tetsuya Higashiyama's special research review of plant fertilization. Featured in: Asahi Shimbun.
27	Jan 1-30, 2020	Newspapers	Professor Tetsuya Higashiyama was awarded the Asahi Award. Featured in: Yamagata Shimbun, Featured in: Asahi Shimbun.
28	Mar 23, 2020	Newspaper	Dr. Yuichiro Tsuchiya's special research review on eradication of African parasitic plants "Striga". Featured in: Asahi Shimbun.