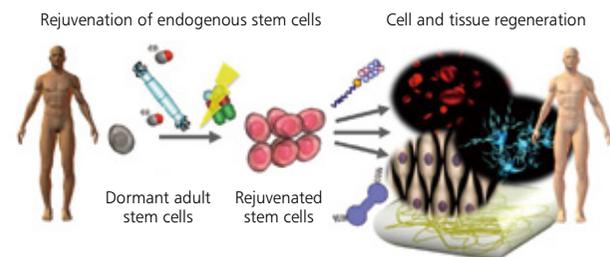


# iCeMS Vision

## Rejuvenation of Adult Stem Cells for Tissue Regeneration

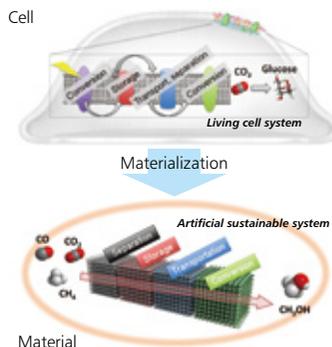
Embryonic tissue stem cells actively proliferate and give rise to various mature cells, while adult stem cells are mainly dormant. We plan to revert these dormant adult stem cells into an embryonic-like state using seed technologies that can spatiotemporally regulate gene expression. iCeMS will boldly create chemically defined, effective methods to activate dormant adult stem cells and regenerate functional cells, such as germ cells, cardiomyocytes, pancreatic  $\beta$ -cells, and neurons. iCeMS will also pursue the 3-dimensional reconstitution of tissues and organs of desired shape and size by developing novel synthetic assemblies. Our approaches may prove useful for regenerating damaged tissues and treating diseases.



## Cell-Inspired Materials for Energy Storage

A sustainable future for mankind depends on the discovery of new materials that capture, store, and transform gas molecules intertwined with human life. Powerful lessons in creating such smart materials can be obtained from the biological design of living organisms. For instance, membrane compartments in living cells simultaneously "select" and "condense" molecules.

iCeMS will attempt to develop new materials that sort and store gas molecules abundant in the air to invent a new energy storage system. Such cell-inspired materials would contribute to solving environmental and energy problems.



iCeMS in numbers

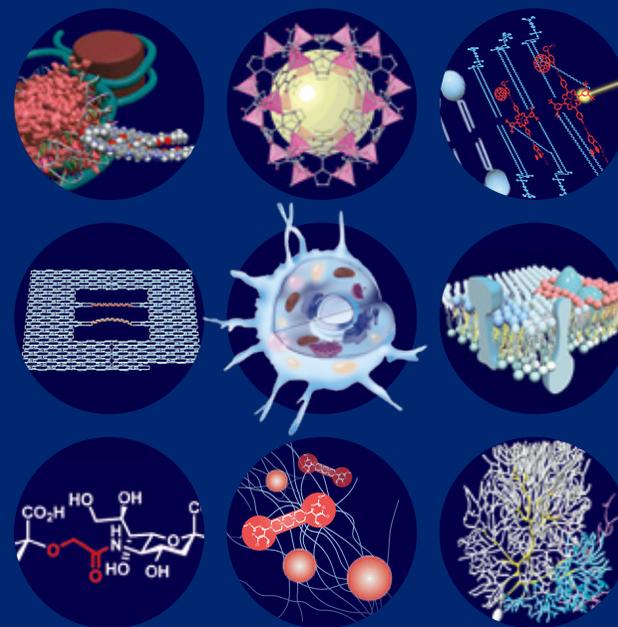
- Founded in **2007**
- **186** researchers, **32** % from overseas
- **29** research Groups
- **11,000** m<sup>2</sup> of open laboratory and office space
- A chemical library consisting of **70,000** compounds
- Over **1,500** materials synthesized to date
- **982** peer-reviewed papers (articles, reviews, and letters) published to date, **22** % in journals with IF **10** or more
- **160** seminars, **87** % featured speakers from overseas (representing **22** countries)
- **15** partner institutions around the world
- **71** early-career scientists sent overseas for short stays to increase job opportunities and boost foreign collaborations
- **161** collaborative projects with industry
- **3.3** billion Japanese yen budget including **1.3** billion from the Japanese government and **2** billion from external sources



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 606-8501, Japan

## Institute for Integrated Cell-Material Sciences

# iCeMS



# Manipulating Cells with Materials

## iCeMS Research

Our institute seeks to illuminate a chemical basis of cells, creating compounds to control processes in cells such as stem cells (materials for cell control), and further down the road spark cellular processes to create chemical materials (cell-inspired materials).

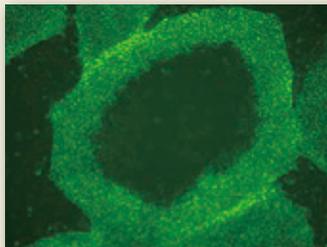
A study of the melded boundary between cells and materials based on a fusion of cell biology, chemistry, and physics is our goal.

We seek to be the best in the world, with the fruits of our international, interdisciplinary labors bringing nourishment and fresh ideas to research in industries as diverse as medicine and the environment.



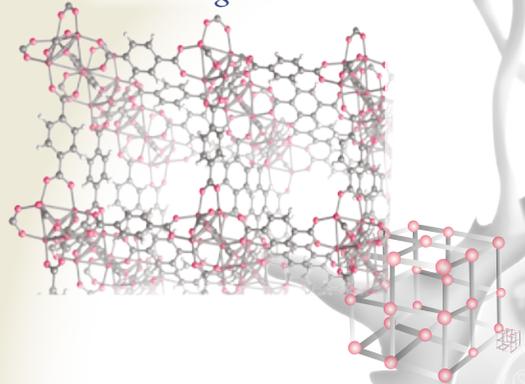
## Manipulation of Nucleus Information

The nucleus memorizes and processes centralized information in the cell. We strive to elucidate the dynamics and mechanisms of chromatin organization and transcription regulation during cell differentiation as well as reprogramming. By doing so, we can develop synthetic functional molecules, including those with photoinducible properties, to visualize and manipulate nuclear information processing.



Chemical compounds retained in human iPS cells emit a fluorescent green glow

## Functional Porous Materials Controlling Bioactive Gases



## Extracellular Environment

## Synthesized Cell Adhesion Substrates

## Light-Induced Materials to Control Membrane Functions

## Chromatin

## Membrane

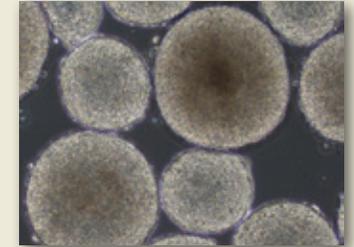
## Specific Gene Activation by DNA-Targeting Molecules

## Cell

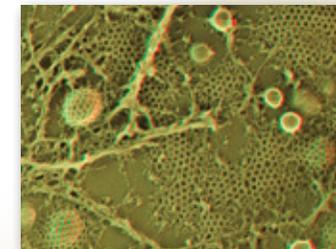


## Manipulation of Cell Communication

Differentiation of stem cells into multicellular tissues is regulated by the communication between cells alone and cells with materials. We seek to uncover underlying mechanisms and develop scaffolds by molecular scale design for the reconstruction of functional cell architectures such as brain, muscle and germline tissues.



Three-dimensional culture of human iPS Cells using soluble polymers



Electron microscope image of clathrin-coated pits on the plasma membrane



## Manipulation of Membrane Compartments

Cellular membrane compartments mediate selection and condensation: inward and outward signaling cascades, energy conversion, and exchange of matter. We seek to understand the molecular mechanisms of these meso-domain reactions to develop molecular technologies for manipulating membrane functions by external stimuli such as light, magnetic field and heat.