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## 論 文 内 容 の 要 旨

氏 名 ( 鈴木 和歌奈 )	
論文題名	<b>Towards an Ecology of Cells: An Ethnography of iPS Cell Research and Regenerative Medicine</b> (細胞のエコロジー ; iPS細胞研究と再生医療の民族誌)
論文内容の要旨	
<p>In the 21<sup>st</sup> century, due to the rapid progress of the life sciences, new medical techniques and biotechnologies have burgeoned. This dissertation asks about how new biotechnologies emerge in life science laboratories. What kinds of care are required to manipulate and control “living technologies,” such as cells and laboratory animals? How do these technologies spread, influence, affect, and transform society, including its institutions, markets, policies, and laws? How are those societal transformations influenced by changing understandings of cells, genomes, and organisms in laboratories of life science? To tackle those questions, I rely upon ethnographic fieldwork conducted in a laboratory, here called the Murakami laboratory (a pseudonym), that specializes in medical and industrial applications of iPS (induced pluripotent stem) cell technologies in Japan. As a “translational research” laboratory, the members have been trying to build bridges connecting the science of iPS cells with the fields of medicine and industry.</p> <p>In STS and the anthropology of science, there are two research trends that help to illuminate the significance of emerging biotechnologies in the neoliberal era. The first are “laboratory studies,” while the other body of literature focuses on the concept of “biocapital.” Both of these bodies of literature provide useful methods and perspectives to understand the production of knowledge, as well as broader social transformations resulting from the connections between the market and the life sciences. However, the laboratory practices that I observed during my fieldwork differ from those discussed in these two fields of research. First, since the Murakami laboratory aims at medical and industrial applications, its researchers and staff collaborate with fundamental biology laboratories, hospitals, pharmaceutical companies, and the government. As a result, their knowledge and technologies move between and across different contexts. Hence, I need perspectives from within and outside of the laboratory to understand the production of knowledge in this case. Second, the Murakami laboratory puts in considerable effort taking care of cells and arranging suitable environments for their thriving, which involves equipment, facilities, staff, and the organization as a whole, which goes against the notion that laboratories are solely focused on accumulating scientific knowledge and claiming future profits. I ask, what does it mean to arrange and intervene in cells through environments, in order to actualize the potentiality of cells for medical and industrial use?</p> <p>To understand these specificities of translational research, inspired by feminist STS scholars, care studies, and the concept of the “experimental system” elaborated by Hans Jörg Rheinberger, I propose the concept of an “ecology of cells.” In the laboratory, cells are not just tools for scientific experiments or medical technology. They are “living technologies”: living beings who require care, and, at the same time, are instruments used for science. Through the development of this concept of the ecology of cells, I shed light on how cells oscillate, between living beings and instruments, in the process of translational research. Here, the “ecology” refers to the world in which the cells are kept alive as a living technology. It includes</p>	

scientific, medical, economic and political environments that are created or managed for cells. More concretely, the ecology of cells includes tools, equipment, the broader environment, systems of organization, funding schemes, institutions, policies, and regulations that are connected with the laboratory. I look closely at how these heterogeneous elements are configured and managed, and how cells both transform and are transformed in the process. Importantly, what iPS cells are and what iPS cells can do is being gradually defined through the continual rearrangement of these elements. My concept of the ecology of cells sheds light on this ongoing, reciprocal relationship between the cells and their environments.

In each chapter, I discuss the ecology of cells, from within the laboratory to the broader societal context in Japan and globally. Chapter Two provides necessary context for understanding iPS cell research and the Murakami laboratory. After the Yamanaka research group reported that they had successfully created iPS cells, these stem cells rapidly spread into various fields. From scientists and clinicians, to patients, the mass media, and administrators, high expectations emerged for what these cells would be able to do. Inspired by the concept of a “future generating device,” I argue that the elusive and uncertain materiality of iPS cells evoked heterogeneous practices, imaginations, and promises. At the same time, the flexibility and plasticity of iPS cells enabled them to be diffused into various scientific fields, by transforming their morphology and character. In the end, however, governmental funding and support became concentrated on medical applications – and, in particular, on the use of the cells for regenerative medicine. Drawing on the discussion of the “sociology of expectation,” I delineate how various visions and promises directed the emerging biotechnology in this particular direction. I also show how the Murakami laboratory, in particular, started to play an important role among these heterogeneous actors.

Chapter Three provides an ethnographic portrayal of how people care for the iPS cells in the Murakami laboratory. Culturing “good” and “healthy” cells is especially important for the laboratory, because cells are transplanted into patients’ bodies, where they will need to be able to survive for a long time. However, iPS cells are difficult to care for; they are particularly sensitive and can easily lose their pluripotency. Drawing on discussions of care, embodiment, and the emerging field of affect studies, I depict how scientists and technicians who are called “iPS sommeliers” learn “how to see” cells, improving their handling of cells and developing affective relations with them. In particular, I focus here on the prevalence of Japanese onomatopoeia in the laboratory, which plays an important role in how iPS sommeliers accumulate tacit knowledge and form affective relations. By affecting and being affected, iPS sommeliers and cells come to be cultivated by each other.

Chapter Four looks at how laboratory members care for and also kill laboratory animals. Inspired by the concept of the “choreography of care,” I look at the broader context of what it means to care for – but also use and exploit – animals. As I discuss, Japanese life scientists are known for holding annual ceremonies for the animals they have “sacrificed” in the name of science; however, the historical, regulatory, ethical, and cultural contexts of animal experiments vary widely from place to place. I consider how the Murakami laboratory members appreciate, apologize to, and sometimes detach from animals in the process of their experiments. By doing so, I insist that caring for experimental animals is not only about the relationships between humans (scientists, technicians, or caregivers) who directly tend to the animals’ needs; rather, these relationships are influenced heavily by experimental settings, laboratory settings, institutional and regulatory systems, and other factors.

Chapter Five investigates how the Murakami laboratory creates and arranges the ecology of cells.

Either in a body or a dish, stem cells interact with broader environments, including other cells surrounding the stem cells, biological agents, and molecules. Because of this permeability, the laboratory members must take care of the environment in order to care for cells properly. To protect the dishes where cells live while in the laboratory, the members run and manage a special facility, where they closely control the cleanliness and temperature of the environment. Furthermore, to run the facility adequately, the laboratory organizes a special team and collaborates with regulatory offices and industrial partners. In order to make sense of these practices, I rely upon and critique recent anthropological discussions about “potentiality.” By analyzing the discourses of scientists and bio-entrepreneurs, anthropologists and STS scholars have argued that potentiality can be harnessed directly from stem cells. However, what the Murakami lab is doing is arranging suitable environments and then intervening in iPS cells through these environments. Using these ethnographic insights, and focusing on the practices of the laboratory, I propose that the potentiality of cells is decided (or not decided) by these environments.

Through this dissertation, I explore the development of the ecology of cells and the transformation of iPS cells in the process of translational research. By focusing on the ongoing relationships between cells and broader environments, I delineate the dynamic and reciprocal interactions between these cells and society. Ultimately, I argue that cells living in a dish in a laboratory have an “ecological” relationship: through complicated interactions with other elements, cells and their environments also transform. This specific ecological relation also requires that particular social aspects, such as organizational management and regulatory systems in Japan, become “ecological” as well. In other words, the translational research process does not only capture the iPS cells’ potentiality; it also contributes to the “ecological” transformation of society more broadly.

## 論文審査の結果の要旨及び担当者

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<p><b>論文審査の結果の要旨</b></p> <p>本論文は、iPS細胞を利用した再生医療研究の現場に関する人類学的な研究である。1970年代末より、ヨーロッパ、アメリカを中心として、実験室における科学者の実践を人類学的に研究する「実験室の民族誌」という研究ジャンルが台頭してきた。それまでの科学論は、合理性についての哲学的考察、科学理論についての哲学・社会学的分析、大学や科学政策に関する制度論的な研究が中心であった。これに対して、実験室の民族誌は、科学の実践における社会的、物質的、記号的要素の複雑な絡み合いを描き出すことで、アクターネットワーク理論をはじめとする新たな研究領域を切り開き、現在に至るまで大きな影響を与えている。</p> <p>本論文は、日本において現在まで行われた数少ない本格的な実験室の民族誌である。これまでの実験室の民族誌の批判的検討に基づく本論文では、主に以下に述べる点に焦点を当てた極めてユニークな分析が行われている。本論文では、まず従来の実験室の民族誌に対して、実験室とその外側の複雑な関係を考慮に入れる必要があることを指摘する。同様の指摘を行ってきたアクターネットワーク理論に従いつつ、著者はiPS細胞研究に固有の基礎科学と再生医療への応用の緊密な関係、それを巡って形成されてきた熱狂的とも言える期待の高まりに注目し、基礎研究と臨床応用をつなぐ、translational researchに焦点を当てる。iPS細胞の培養から患者への移植による臨床試験に至る一連の研究を統一した枠組みの中で行うtranslational researchは、政府の再生医療振興政策の核の一つに位置付けられている。著者は、translational researchの枠組みのもとでiPS細胞を培養する実践とそこに関わる情動的次元を詳細に描き出す。さらにこの実践が、いかに臨床試験、安全基準の審査、医薬品規制などと関わっていくのかを明らかにしている。</p> <p>このようなプロセスを描き出すために、著者はアクターネットワーク理論、生物学史家のRheinbergerによる実験システム論、フェミニズム科学論を批判的に検討し、iPS細胞を用いるtranslational researchの核にある、生きた細胞を培養し、医療テクノロジーとして用いる実践の体系を、細胞のエコロジー (ecology of cells) として概念化する。Rheinbergerが描き出した実験システムが、RNAなど科学的知識の対象となるもの (epistemic things) を生み出すのに対して、細胞のエコロジーは再生医療で用いられる「生きたテクノロジー」を生み出すシステムである。それゆえ、それは人工的な生態系としての性質を帯びている。生きた細胞であるiPS細胞は、常に変化を続け、現時点では標準化も行われておらず、「生きもの」としてコンスタントなケアを必要とする。Multispecies ethnographyに着想を得た著者は、このような生きものと科学者、テクニシャンの関係にある種の人間・動植物関係として捉え、細胞培養を実験室の実践は細胞が生存するための人工的な生態系を作り出し、拡張することであると指摘する。</p> <p>ここで中心になるのは、不安定なiPS細胞を「育てる」テクニシャンと科学者たちのケアの実践である。フェミニズム科学論におけるケアの議論を批判的に取り入れた著者は、このケアが細胞の様子を表すための擬態語 (オノマトペ) の使用を介して、テクニシャンと細胞の間に情動的 (affective) な関係を生み出しているかを明らかにしている。</p> <p>本論文は、長期にわたる綿密なフィールドワークに基づいた優れた民族誌的研究であり、その経験的・記述的な価値は極めて高い。さらに、筆者が、アクターネットワーク理論、実験システム論、フェミニズム科学論における最新の議論を高い水準で消化した上で、それに対する適切な批判と拡張を行っている点も高く評価される。よって本論文は博士 (人間科学) の学位に相応しいものであると判断した。</p>			