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“Senility and Death of Tissues Are Not a Necessary Phenomenon”
: Alexis Carrel and the Origins of Gerontology*

PARK Hyung Wook**

1. Introduction

The life and work of the French surgeon Alexis Carrel (1873-1944) has been a controversial subject among historians and scientists. On the one hand, it is well acknowledged that he made highly important contributions to the development of medicine and science. In addition to his novel way of vascular surgery that earned him the Nobel Prize in Physiology or Medicine in 1912, he played a key role in developing tissue culture as a vital technique in medical research and laboratory examination. On the other hand, however, his political philosophy and eugenic ideas led him to be called a Nazi sympathizer, even though recent historians are

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exploring more complex dimensions of his thoughts. (Reggiani, 2002: 331-56; Reggiani, 2007; 박지현, 2007: 131-63) Moreover, after the 1960s, scientists criticized his claim that he prolonged the lifespan of chicken heart tissues so considerably that they became almost “immortal.”\(^1\) Since it was observed that normal somatic cells had a definite lifespan, later scholars, such as J. A. Witkowski, argued that Carrel’s work must be a scientific fraud which was not detected during his lifetime. (Witkowski, 1980: 129-42)

This paper illuminates an aspect of Carrel’s work and influence which has hardly been discussed by historians. I argue that he contributed to the making of gerontology, the science of aging, through his tissue culture and popular representation. Even if it might be true that his “immortal” chicken heart cells resulted from fraudulent research, his works prompted a number of scientists to think that aging was a contingent phenomenon that could be experimentally controlled rather than an inevitable unidirectional process. His “immortal” chicken heart cells created a new hope for experimental manipulation of senile processes to the scholars who would establish gerontology as a scientific field during and after the 1930s. Furthermore, his claim that different tissues should be cultured in distinct media became a basis of later scholars’ idea that aging occurred at a distinct rate and in a different mode in each part of the body. I will show that this view encouraged scientists of aging to challenge the traditional perspective, according to which aging occurred concurrently through the whole body due to the “decay” or “decline” of a single mysterious factor such as “internal heat” or “vital power.” With their new idea, gerontologists were able to focus on the distinct features of aging observed in each

specific body part, which had a broad range of implications regarding the continued employment of aged laborers as well as gathering the multidisciplinary group of gerontologists. This article also reveals how Carrel’s public speeches and popular representations contributed to the creation of gerontology as a scientific field. The birth of the science of senescence was indebted to his call for systematic study of aging as well as a number of newspaper articles that interpreted his research as evidence for humans’ potential immortal life. Even though Carrel himself never joined the organization of gerontology, his impact upon later students of aging is obvious.

2. Alexis Carrel in Historical Context

Carrel was born in Lyon, France in 1873, and finished his scientific and medical training at the University of Lyon. Failing to gain a hospital appointment there, he went to Canada in 1904 with a hope for a new career in the foreign country. Fortunately, his presentation on the new blood vessel surgery techniques that he had been developing impressed many attendees at a medical meeting held at Montreal. Consequently, he was invited first to the University of Illinois and then to the University of Chicago, where he began to practice tissue and organ transplantation. Yet a still better job offer was awaiting him. With Simon Flexner’s invitation in 1906, he went to the Rockefeller Institute for Medical Research, one of the most prestigious medical research centers in the world. There he developed the new tissue culture techniques and the ways of storing tissues in a low temperature. In 1912, he was appointed a full member of the Institute, which was equivalent to a tenured professor post in regular universities,
The year of 1912 was important for him for another reason. In that year, he was awarded the Nobel Prize in Physiology or Medicine for his innovation in blood vessel suture techniques and transplantation research. ²)

As Hannah Landecker has pointed out, Carrel’s tissue culture originated from his medical and surgical research that he had begun in Lyon and continued at Chicago and the Rockefeller Institute. (Landecker, 2004: 151-74) For Carrel, tissue culture was a means to study the process of healing at the cell level after the surgical reorganization of tissues and organs. In effect, the American embryologist Ross Harrison was earlier than Carrel in performing tissue culture. ³) But while Harrison was interested merely in observing cells survive and differentiate outside of the body, Carrel wanted to make cells not only survive but also proliferate in vitro. This experiment was expected to illuminate how the healing process of reconnected blood vessels and transplanted organs after surgery could proceed within the body. In pursuing this research, Carrel maintained the procedures and practices that he had used for his former surgical operations, such as strict asepsis, artificial circulation of body fluids, and the careful regulation of temperature and humidity.

Tissue culture techniques came to be used for basic biological as well as medical investigations, which included research on the mechanisms of senescence. Indeed, the significance of Carrel’s tissue culture for the aging process was observed at the very moment when the technique was devised. In 1911, in one of his earliest papers on tissue culture, he wrote “it may easily be supposed that senility and death of tissues are not

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²) On Carrel’s early career, blood vessel surgery, and winning of the Nobel Prize, see McKellar, 2004: 135-50.
³) After Harrison, Margaret Reed and Rhoda Erdman started tissue culture. They, too, were slight earlier than Carrel. See Reggiani, 2007: 36-7.
a necessary phenomenon and that they result merely from accidental causes, such as accumulation of catabolic substances and exhaustion of the medium.”\(^4\) In fact, he thought that his success in the continuous culture of the chicken’s tissue outside of the body was dependent upon his control of such “accidental causes.” When the symptoms of “senility” began to appear among the cells, namely, when “the rate of growth decreased or when large granulations appeared in the cytoplasm of the cells,” he extirpated “with a cataract knife the fragment of coagulated plasma containing the original piece of tissue and the surrounding new cells, which [were] washed for several minutes in normal or slightly hypotonic Ringer’s solution.”\(^5\) The washed cells were then replanted into a fresh and nutritious medium that could bring about “rejuvenation” of the cultured cells. Since this process could be repeated indefinitely, he thought that senescence, at least at the cell level, could be postponed permanently. Indeed, he and his colleagues during the 1940s argued that they kept culturing the cells derived from a chicken’s heart for more than thirty years, which was much longer than most chickens’ maximum lifespan.

But this “immortal” tissue of Carrel’s, whose reality was hardly doubted until the early 1960s, became a significant problem thereafter. In fact, based on their own tissue culture experiments, Leonard Hayflick and Paul Moorhead at the Wistar Institute in Philadelphia argued in 1961 that normal human diploid fibroblasts could not proliferate indefinitely.\(^6\) Since this seemed to be true of other types of cells, it was claimed that normal somatic animal cells except for tumor tissues should die after a certain

\(^5\) Ibid.
number of divisions, which was later called the “Hayflick limit.” With this idea in mind, Witkowski has claimed that Carrel’s culture of “immortal” cells probably resulted from fraudulent experiment, especially considering Carrel’s secretive attitude toward his own work. (Witkowski, 1980: 129-42) To Witkowski, Carrel manipulated the result of his experiments to argue for the immortal life of his somatic cells that actually should have shown only limited longevity. In a recent monograph, however, Landecker has tried to offer a more historical interpretation on the problem. She has pointed out that understanding the historical reason why Carrel’s immortality argument was not seriously challenged until the early 1960s is more important than trying to explain, with meager evidence available, why his chicken heart cells did not seem to die for more than thirty years. (Landecker, 2007: 91) In quite a different context, biologists have recently begun to question the existence of the Hayflick limit, since not every non-tumor cell should die after a certain number of divisions. It has recently been found that human embryonic stem cells may be perpetually cultured outside of the body. 7)

The current paper does not attempt to suggest any new interpretation on this problematic issue. Rather, following Landecker, I try to place Carrel and his research in a historical context. This paper asks what the meaning of his works was with respect to the new conception of aging that arose during the early twentieth century and how influential his research was upon the scientists who constructed gerontology as a research field. The answers to these questions should begin with Carrel’s actual experiments for understanding senescence.

3. Aging as a Scientific Problem

With tissue culture techniques, Carrel and his assistants tackled various issues related to aging. Initially, he found that blood plasma was not an effective medium for the proliferation of cultured cells. It seemed that each type of cell had its own most effective medium for growth, and blood plasma was not optimal for any kind of cells. Moreover, its meager usefulness further decreased with the aging of the individual organism that provided the plasma. What, then, was the best medium for tissue culture in general? Carrel found such a medium from a material that he acquired from the youngest body, the ground embryonic tissue extracts which he called the “embryonic juices.” The embryonic juices, whose precise biochemical composition was not known, were highly effective in stimulating the growth of cultured tissues when mixed with normal blood plasma.

During the late 1910s and the 1920s, Carrel further studied the factors involved in aging at the level of both the whole organism and the cell. While working at a hospital in France during World War I, he examined with his mathematically trained colleague Pierre LeComte du Noüy the decline of the wound healing rate in accordance with the age of patients. (Landecker, 2007: 81) With this experience, Carrel started studying cellular senescence in a more quantitative manner after returning to the Rockefeller Institute by the end of the War. Through his series of experiments using pure culture of fibroblasts, Carrel found that “the rate of cell multiplication [varied] in

inverse ratio to the age” of the organism that offered blood plasma as culture media.\(^{10}\) Since the relationship between age and cell division rate seemed to be quite precise, he even argued that the rate could be used in measuring the degree of changes occurring in the blood with senescence. He also studied the character of the factors that were primarily responsible for age-related alterations in the blood. Through his experiments on the changes in the proliferating capacity of blood serum after heating and CO\(_2\) precipitation, he argued that there were both “growth-activating” and “growth-inhibiting” substances in the serum, and that the former’s function decreased while that of the latter increased with aging.\(^{11}\) This difference explained why blood plasma from very old animals could not support the growth of cultured cells any more.

Carrel pursued little research on aging after 1930. Although he then started his final scientific project which had some implication for senescence, namely, the culturing of organs using a perfusion pump designed by him and the renowned pilot Charles Lindbergh, it had little direct relevance to aging process. (Friedman, 2008: 25-85) It is difficult to know all the reasons why he virtually ceased his study of senescence in the 1930s. As historian Andrés Reggiani has mentioned, the retirement of Simon Flexner—who had been his mentor at the Rockefeller Institute—along with his changing interest, may have contributed to lessening of his scientific productivity. (Reggiani, 2007: 32, 85) It was equally significant that his major methodologies, most of which came from his surgical training, were not adequate for any further elucidation of the subjects he


was interested in, including the biochemical or molecular properties of the factors involved in the aging of the cell in relation to its media. Admittedly, he did publish a paper in which he argued that the serum lipoid, lecithin, cholesterol, and some sorts of proteins were growth-inhibiting factors whose concentration in the blood increased with senescence.\(^{12}\) However, he did not have expertise in biochemistry to make a further analysis of the properties and functions of these molecules with respect to aging. In the 1930s, the number of his scientific publications in general began to decline, while he started to spend longer hours in writing theoretical or popular works and delivering public lectures.

But Carrel’s nonexperimental works were another important part of his career, since they played a significant role in forging new discourses on aging. In 1931, for instance, he stated how “physiological time” differed from “physical time.” While physical time should proceed irreversibly and inexorably at a uniform rate, physiological time—which was “recorded by a cell community only when the metabolic products are allowed to remain around the tissue”—did not.\(^{13}\) Its course could be modified and controlled by experimental means, just as his tissue culture showed. Moreover, it was significant that “each type of tissue appears to record time in its own way.”\(^{14}\) As his tissue culture revealed, this feature of physiological time was probably due to the fact that each group of cells in the body required distinct media for survival, whose constitution was in turn created partially by the cells themselves.\(^{15}\) This phenomenon implied that aging could

\(^{13}\) Alexis Carrel, “Physiological Time,” *Science* 74, 1931, p.621.
\(^{14}\) Ibid., p.619.
\(^{15}\) Alexis Carrel, “Tissue Culture and Cell Physiology,” *Physiological Reviews* 4, 1924, pp.7-9
proceed in a distinct mode and manner in each part of the body. As we will see, this idea, together with similar thoughts of other scholars, influenced the direction of early gerontologists’ research.

The creation of new discourses on aging was indebted to the consistent popular representation of Carrel’s works as well. In the Progressive Era of the United States—including the early twentieth century—which highly valued the advancement of human life through scientific innovations, Carrel’s research on tissue culture and organ transplantation was enthusiastically welcomed by the general public as well as scientists. For example, a popular article in 1912 praised the potential usefulness of Carrel’s research for rehabilitation medicine. He was described as a scholar who enabled one to offer “new organs for old ones.” In a language analogous to the modern discourse on stem cells, the reporter wrote, “If the heart is not performing its proper function, what is easier than to throw it away and secure a new one from cold storage”? Carrel’s research would eventually make this possible, perhaps in the future. His tissue culture research also became the source of imagination and enthusiasm about immortal life without old age and death. Indeed, an article in the Examiner claimed that “A GREAT scientist, Dr. Alexis Carrel has shown … that permanent life is not impossible.” Another writer in the same year even argued that “a revolt against old age and death” was proceeding primarily due to Carrel’s research. His public lecture on his tissue culture delivered at the

17) “New Organs for Old Ones,” The Wilkes-Barre Record (8 June 1912).
18) Ibid.
19) “Why We Ought to Live 100 Years,” The Examiner (23 June 1912).
20) “May We Live 200 Years?” The Kansas City Star (30 June 1912).
third “Race Betterment Conference” held at Battle Creek, Michigan in 1928 intensified this popular enthusiasm and hope. An article in New York Sun summarized this lecture by writing that “given proper environment, proper feeding and care, unicellular organisms … can be maintained in a stage of eternal youth,”21) A reporter of Brooklyn Eagle also described Carrel’s study of potential immortality at the cell level in detail, while admitting that the whole organism had to die eventually.22) Through these popular articles, Carrel promoted the discourse on the possibility of immortality and the deferment of aging by means of science.

His best-selling yet controversial book, Man the Unknown (1935), communicated Carrel’s idea on aging directly to general readers rather than through journalists’ writings. As has been well known, this book highlighted an impending “crisis” of Western civilization—which might be characterized by racial strife, economic depression, spiritual emptiness, and the negligence of individual distinctiveness amid material growth—and promulgated his technocratic, racist, and elitist prescriptions which included eugenic measures and massive euthanasia of criminals and social deviants.23) Yet few historians have noticed that as a part of the widespread social crisis Carrel pointed to problems regarding aging as well. To him, modern medicine failed to tackle chronic illness and degeneration occurring in older individuals, even though it was quite successful in dealing with infectious diseases and acute conditions. Strangely, however, “we enjoy youth, or its appearance, for a much longer time than our fathers did.”24)

22) Zoe Beckley, “There is No Eternal Youth, But We Can Curb Old Age, Woman Researcher Says,” Brooklyn Eagle (19 January 1928).
23) Carrel, Man, the Unknown, p.318.
24) Ibid., p.178.
Indeed, “hygiene, athletics, alimentary restrictions, beauty parlors,” and other amenities available in modern cities created people who looked younger than their age. Nevertheless, “worries, lack of economic security, overwork, absence of moral discipline, and excesses of all sorts” could actually hasten aging and cause sudden and untimely death. 25) The absence of work after retirement was engendering another severe problem. He stated that “leisure is even more dangerous for the old than for the young.” 26) Hence, “to those whose forces are declining, appropriate work should be given.” But a more fundamental solution to the problems of aging could be found in a thorough scientific understanding of the mechanisms of longevity and senescence. While “the science of man is still too rudimentary to be useful” and some people’s dream of rejuvenation could not be easily realized, scientific research on “physiological time” and the senile processes would be a critically important subject in the scientific endeavor of the future. 27)

Carrel explicitly advocated the establishment of a research institute for this subject, while his book was garnering both enthusiastic praise and bitter criticism among a variety of readers, including those who were seriously interested in aging as a scientific subject. 28) With an invitation by the Association of Life Insurance Presidents, Carrel delivered a lecture on human lifespan at their annual meeting in 1937, and during this lecture he claimed that a research institute for the scientific study of aging should be

25) Ibid., p.179.
26) Ibid., p.186.
27) Ibid., p.179.
28) Alfred Cohn’s positive comments on Man, the Unknown may show how scientists of aging read the book. See Cohn to Carrel, 15 October 1935, Box 41, Folder 22, AC. As a cardiologist and a member of the Rockefeller Institute, Cohn was Carrel’s colleague and one of the early contributors to American gerontology.
According to Carrel, the lengthening of the human’s lifespan would not necessarily be beneficial, since “the importance of human life depends on its quality, not on its length.” Therefore, it was important to “find the means of improving its quality,” and aging research would certainly provide such a means. Based on a proper understanding of senile processes, it could let us know the ways of enhancing the quality of life in old age. Hence, Carrel argued, “there should be somewhere in the civilized world an institute dedicated to the study of the process of aging.” The scientists in this institute would study “the chemical, physical, and physiological changes that manifest the progress of age in tissues” using dogs, monkeys, mice, and rats. This research was necessary, because “the problem of the prolongation of life has extended beyond the frontiers of hygiene and medicine into an uncharted country,” the exploration of which required a new research institute studying novel problems. This institute would certainly improve humans’ life, since “there is no example of a scientific search for truth which has not been rewarded.”

Carrel’s advocacy for an institute for aging research highly impressed both journalists and scientists. Most notably, New York Times described his lecture in detail in an article titled, “CARREL URGES FUND FOR STUDY OF AGING,” and New Health also summarized Carrel’s argument for building an institute for the study of senescence. His lecture elicited responses from

29) Vincent P. Whitsitt to Carrel, 30 October 1937, Box 65, Folder 23, AC.
30) Alexis Carrel, “The Problem of the Prolongation of Life,” 3 December 1937, Box 23, Folder 15, AC.
31) Ibid.
32) Ibid.
33) Ibid.
34) Ibid.
scientists as well, including Clive McCay at Cornell University who had just found that restricted dietary caloric intake increased longevity. In his letter to Carrel, McCay wrote that Carrel had recently “[deplored] the neglect of problems of old age by the research laboratory.” McCay added, “you are stimulating interest and the future will be brighter.”

McCay then described his own work on aging in detail, which, surprisingly for him, Carrel already knew well.

McCay’s career shows both direct and indirect influences from Carrel. Although McCay began his professional life as a scholar in animal husbandry, his research eventually became focused on the study of the impact of caloric intake upon longevity and aging. From the early 1920s, as a national research fellow at Yale university and a junior faculty member in the animal husbandry department at Cornell, he studied the effect of different nutritional factors on various animals’ growth and lifespan. In 1934, during this work, he found that rats with reduced-calorie diet underwent slower aging and thus lived longer than those with a normal number of calories in food. Indeed, this study of McCay’s was similar to what Carrel did at the cell level, namely, the manipulation of the process and rate of senescence. While Carrel argued that he could change the course of cellular aging by controlling the culture media supplied to cells, McCay claimed that he could alter the rate of rats’ senile changes by decreasing the number of calories in the rats’ food. In the above letter McCay wrote to Carrel, we can understand how pleased he was through his discovery which corresponded to the investigation of one of the most

37) McCay to Carrel, 6 December 1937, Box 64, Folder 9, AC.
38) Ibid.
influential biomedical scientists of his time. McCay soon became an active member of the emerging field of the science of aging. (Park, 2010a: 79-124)

In fact, Carrel interacted with and influenced many scientists who would build gerontology after the 1930s. He was a close colleague of cytologist Edmund Vincent Cowdry (1888-1975) and cardiologist Alfred Cohn (1879-1957) in the Rockefeller Institute. Carrel also knew well Ludwig Kast and Lawrence Frank of the Josiah Macy, Jr. Foundation, \(^{40}\) and corresponded with Edward Stieglitz, the first head of the Gerontology Unit at the National Institute of Health (NIH), as well as William MacNider, the first president of the Gerontological Society. \(^{41}\) As I discussed elsewhere, Cowdry, with a small fund from the Macy Foundation, edited the first comprehensive handbook on senescence, *Problems of Ageing* (1939), to which a large number of eminent scholars contributed, including McCay, Cohn, William MacNider, and Walter Miles. (Park, 2008: 529-72) These authors constituted the Club for Research on Ageing in 1940 as the earliest American research group for studying and discussing aging as a scientific problem. In 1945, they formed the Gerontological Society as their official organization and launched the *Journal of Gerontology* as the first academic periodical in aging research. The U.S. federal government also began to fund gerontology systematically after 1940 when the Unit on Gerontology was established within the NIH. \(^{42}\) This intramural gerontology research program kept growing thereafter until it became the National Institute on Aging in 1974.

These early scholars in American gerontology deeply respected Carrel and

\(^{40}\) See, for example, Kast to Carrel, 18 June 1928, Box 42, Folder 12, AC; Frank to Carrel, 14 May 1938, Box 66, Folder 3, AC Cohn to Carrel, 5 December 1940, Box 41, Folder 22, AC.  
\(^{41}\) See Stieglitz to Carrel, 26 June 1940, Box 69, Folder 27, AC; MacNider to Carrel, 7 April 1931, Box 58, Folder 88, AC.  
\(^{42}\) The Unit was funded by the Josiah Macy Foundation during its first year at the NIH.
followed his ideas in their practice and discourse. A letter from anatomist T. Wingate Todd—a contributor to Cowdry’s Problems of Ageing—written after visiting Carrel’s laboratory exemplifies the feeling of the American scientists of aging toward Carrel’s contributions,

Having now returned home to Cleveland, I have had time to get into perspective the thoughts and hopes which flow from my visit to you last Wednesday. The opportunity to chat with you and to look over those living tissues, especially the conversation, was not merely invigorating, but full of imaginative lighting for my thought and I do not wish to let this immediate period of enthusiasm, while the conversation is still vivid in my mind, pass without again thanking you for this privilege.43)

Gerontologists’ high regard for Carrel’s tissue culture can also be seen during the meeting of the Club for Research on Ageing. In 1943, Ross Harrison, instead of Carrel who was then in France, was invited to the meeting of the Club, and talked about various subjects regarding the features of aging shown through tissue culture. He said, “The strain of fibroblasts first explanted by Carrel in 1912 is now 31 years old,” Hence, their duration of life was “well over the life span of the host.”44) In this state, it was possible to assume that “cells in tissue culture do not become senescent,” because “senescence is ⋯ an accident.”45) Harrison also added that “in tissue cultures we should be able to determine the conditions that control senescence, perhaps by variation in the chemical composition of

43) Todd to Carrel, 4 April 1938, Box 67, Folder 39, AC.
45) Ibid.
Indeed, the most manifest impact of Carrel’s scientific investigation can be found in gerontologists’ use and development of tissue culture as a critical experimental tool for studying and manipulating aging at the cell level. For instance, Henry Simms, an early member of the Gerontological Society, used tissue culture to challenge Carrel’s argument that blood plasma from older animals inhibited the growth of tissue. It is also important that Peter Leslie Krohn, a recipient of the Nuffield Gerontological Research Fellowship, studied aging and immortality of cells using tissue culture. Although scientists in the 1960s such as Hayflick and Moorhead attacked Carrel’s immortality argument, it should be noticed that even they used tissue culture as a major research tool for exploring senescence. By the 1960s, Carrel’s technique of growing cells outside of the body was established as a means of measuring and controlling aging process.

Probably, Peter Brian Medawar (1915-1987), the British zoologist, a Nobel laureate, and a founding member of the British Society for Research on Ageing, was the most prestigious scientist who used tissue culture for studying senescence during the first half of the twentieth century. In effect, he began his career as an experimental scientist with tissue culture, which revealed that even embryonic cells underwent senile changes. By interpreting the decline of the growth rate of cultured embryonic chicken heart cells as a symptom of senescence, he argued that the speed of aging

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46) Ibid.
47) Henry S. Simms, Abstract of Presentation at the Meeting of the Club for Research on Aging, 13 February 1943, Box 30, Folder Club for Aging 1943, Feb, NWS.
48) Peter Leslie Krohn, “The Nuffield Foundation: Nuffield Gerontological Research Fellowship, Proposals for Research,” pp.3-6, Box NF AGE1, Folder Age 18 Nuffield Gerontological Research Fellowship, NF.
was the highest during an animal’s earliest life and was gradually lowered in later phases. Medawar kept studying senescence thereafter, and his evolutionary theory of aging proposed in 1946 exerted a substantial influence upon later scholars interested in approaching the subject from evolutionary and genetic perspectives. As I stated elsewhere, Medawar in this evolutionary research used the ideas and mathematical formulas that had been adopted in his early tissue culture project. (Park, 2009: 151) Even his tissue transplantation experiment on immune tolerance that awarded him the Nobel Prize in Physiology or Medicine in 1960 was guided by his persistent interest in the phenomenon of decline and senescence. Like his embryonic chicken heart cells that showed a decline in their ability to grow, his mice underwent a decline in their capacity to tolerate genetically distinct tissues during their developmental phases.

Gerontologists were also inspired by Carrel’s view of the condition of cellular growth and aging. In particular, Cowdry—the editor of *Problems of Ageing* and one of Carrel’s junior colleagues at the Rockefeller Institute—adopted Carrel’s standpoint in the approach to aging at the cell level. It is notable that even after moving to Washington University Cowdry kept corresponding with Carrel over various matters, such as the way


of establishing facilities for tissue culture at his laboratory. From the continued interaction with his senior friend, Cowdry absorbed Carrel’s view, as revealed in his chapter of *Problems of Ageing*. He wrote, “Carrel and Burrows (1911) found that plasma (blood minus corpuscles) is not an optimum medium for the growth of cells planted in it.” As stated above, Carrel claimed that a specific type of cells needed a particular kind of media rather than blood plasma for optimal growth and proliferation. The culture medium was also a major factor determining the mode and rate of cellular aging in them. Following this view, Cowdry thought that the proliferation and aging of each type of cells in the body should be conditioned by their distinct regional environment with a peculiar constitution of the fluid. In a chapter in *Arteriosclerosis* (1933), another multiauthored book edited by Cowdry, he wrote,

> Since their local environments vary as well as their duties, the muscular arteries themselves exhibit peculiar and interesting modifications. The uterine artery is almost made anew with each pregnancy. The umbilical artery is a highly special structure designed to serve a temporary and unique function. The arteries of the placenta become old and senile in less than nine months.

In fact, this statement reveals a departure from the older notion that aging in the whole body simultaneously occurred by the decline of one universal factor. A new way of investigating old age was to follow the senile change

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52) For example, see Cowdry to Carrel, 13 April 1929, Box 159, Folder 5, EVC.
of each body part closely, which might differ from one another significantly in terms of rate, mode, and time of the onset.\footnote{Carrel was not the only scholar who proposed this standpoint, See Charles S, Minot, The Problem of Age, Growth, and Death: A Study of Cytomorphosis (New York: Putnam, 1908), pp.214-6; Alfred E, Cohn and Henry A, Murray, Jr., "Physiological Ontogeny I. The Present Status of the Problem," Quarterly Review of Biology 2, 1927, pp.469-93; Raymond Pearl, The Biology of Death (Philadelphia: Lippincott, 1922), pp.138-49, 225; A. J. Carlstono Cowdry, 28 Jun 1937, Box 10, Folder 397, WDM.}

In many respects, this idea contributed to the new ways of doing and organizing aging research in the twentieth century. First, by postulating the local distinctiveness of senile changes, scientists could gradually give up the old concern on the “internal heat” or “vital power” whose decline had been supposed to affect the whole body’s senescence. This concern, which had a long tradition coming from the ancient and medieval literature by Galen, Aristotle, Roger Bacon, and others, could now be suspected and questioned.\footnote{Among numerous books and papers, see Hippocrates, “Aphorisms,” The Genuine Works of Hippocrates, tr, Francis Adams (Baltimore: Williams and Wilkins, 1939), p. 294; Galen, “The Nature and Sources of Growth and of Disease,” A Translation of Galen’s Hygiene, tr. Robert Montraville Green (Springfield, Illinois: Charles C, Thomas, 1951), pp.6-8; Roger Bacon, The Cure of Old Age and Preservation of Youth (London: Tho. Flesher and Edward Evets, 1683), p.2; Francis Bacon, “The Preface,” History Natural and Experimental of Life and Death or the Prolongation of Life(London: William Lee and Humphrey Moseley, 1658); Christopher William Hufeland, The Art of Prolonging Life(London: J. Bell, 1797), pp.35, 63-4; Marie François Xavier Bichat, Physiological Researches upon Life and Death, tr, Tobias Watkins (Philadelphia: Smith and Maxwell, 1809), pp.1-2; Homer Bostwick, An Inquiry into the Cause of Natural Death or Death from Old Age (New York: Stringer and Townsend, 1851), p.7.} Second, certain later scientists like Nathan W. Shock at the NIH—who led the intramural gerontology program after the resignation of Stieglitz—applied this idea to the industrial issues in the mid-twentieth century. If a body part of an aged laborer did not undergo senescence as opposed to other parts that became more senile, the person could be employed in a position in industry which particularly
needed the use of the relatively younger portion of his body. In this way, older workers could avoid losing jobs and scientists of aging could help their continued employment and welfare. Third, Cowdry’s motivation for creating gerontology as a multidisciplinary scientific field partially came from his thoughts on the local distinctiveness of aging. Gerontology had to include experts across disciplinary domains, because aging might show unique features in different portion of the body which were amenable to investigation by diverse expertise. In this state, it was also necessary to include scholars who were interested in broader subjects regarding aging in social and psychological sciences, who could offer synthetic frames for multidisciplinary research. With this idea in mind, Cowdry invited scholars from a variety of specialties and disciplines, including physiology, cardiology, neurology, ophthalmology, histology, psychology, animal husbandry, anthropology, and statistics for the publication of *Problems of Ageing.* This was the beginning of gerontology as a multidisciplinary scientific field in the United States.

4. Conclusion

Despite his considerable influence upon the science of aging, Carrel himself did not join early gerontologists’ gatherings. Carrel did not accept

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58) On the relation of gerontology’s multidisciplinarity to Cowdry’s experience as a cytologist-who was interested in distinct features of different types of cells-and textbook editor, see Park, 2008: 533-44, 554-5.
Cowdry’s invitation to contribute to *Problems of Ageing*. While “this would interest me very much,” Carrel replied to Cowdry, “unfortunately, the nature of my work this winter makes it materially impossible for me to assume any outside activities.”59) Carrel did not participate in any other early projects and meetings concerning the science of aging in America, and died in France in 1944 during his controversial activities under the Vichy government.

However, Carrel made lasting contributions to gerontology. Most of all, by establishing tissue culture as a vital technique for manipulating the process of senescence, he led other scientists to think that aging was a contingent phenomenon that could be experimentally manipulated. Furthermore, his idea that cellular aging was influenced by culture media promoted the view that senescence was a locally distinct phenomenon. This standpoint had broad implications in industrial management of aged labor force as well as the way of organizing gerontology as a scientific field. In addition, his public speeches and media representations encouraged a hope for a new life in old age among many people’s mind, including those who would participate in institutionalizing gerontology. These scientists began to address the subjects that would be increasingly important with the aging population in modern society, such as chronic diseases, adaptation in old age, and the problems of retirement and continued employment.

59) Carrel to Cowdry, 23 October 1936, Box 41, Folder 36, AC.
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   NWS Nathan Shock Papers, Bentley Historical Library, Ann Arbor, Michigan, USA.
   WDM William deB. MacNider Papers, Wilson Library, University of North Carolina,
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PARK Hyung Wook: “Senility and Death of Tissues Are Not a Necessary Phenomenon”


(Secondary Sources)


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-Abstract-

“Senility and Death of Tissues Are Not a Necessary Phenomenon”
: Alexis Carrel and the Origins of Gerontology

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The French surgeon and Nobel laureate Alexis Carrel’s tissue culture has been highly influential in biomedicine. This paper contextualizes Carrel’s works with respect to the birth of gerontology during the first half of the twentieth century. I argue that Carrel contributed to gerontology in several respects. First, using his “immortal” tissues, he asserted that aging was a contingent phenomenon that could be experimentally manipulated. Although this claim was eventually challenged, it prompted many scientists to think that aging was not so much an unavoidable, unidirectional phenomenon as a process amenable to experimental approaches. Second, his research on different culture conditions required by distinct cell types encouraged the idea that the rate and mode of aging differed in distinct parts of the body. This idea became a basis of later gerontologists’ claim that each senior person’s job in industry should be determined according to the degree of senescence shown in his particular body parts. It also helped gerontologists make their field a multidisciplinary arena that could tackle diverse features of senescence occurring in the body. Third, Carrel’s public speeches and appearance in popular media encouraged both scientists and laypeople to think that research on senescence should be pursued more

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systematically in an era of an increasing elderly population. By analyzing the relation of these issues to the efforts to construct gerontology, this paper illustrates tissue culture’s broader meanings with respect to the emerging concerns about the aging population, the need for continued employment of seniors, and scientists’ hopes for controlling senile processes.

**Keywords**: Alexis Carrel, tissue culture, aging, gerontology, seniors