ORIGINAL ARTICLE

A Filipino Doctor at the Birth of Immunology and National Revolution: The Career of Francisco Tongio Liongson, MD

Abstract

This paper reviews the scientific and political career of Francisco Tongio Liongson, MD (1869-1919), the first Filipino scientist to defend a doctoral thesis in immunology. Liongson, an Ilustrado, was the first Filipino physician to do research on immunology. We review the development of immunological paradigms in the last 30 years of the 19th century and how these influenced Liongson's scientific and clinical approaches to medicine as narrated in his doctoral thesis. We explore how Metchnikoff's phagocytic and evolutionary theory of the immune system influenced Liongson's clinical and diagnostic approaches. We contextualize Liongson's medical training with the evolving political consciousness of the Ilustrados in Madrid, who initially campaigned for political reforms in the Philippine colony. Liongson, like many of the Ilustrados, realized that Spanish liberal support for reforms was not possible, and the political solution was independence from the Metropolitan power. The revolutionary career of Liongson reached its highlight with his becoming a medical officer of the Filipino Army of Liberation and as a Professor of Medicine in the Filipino Republic's national university. With the defeat of the Filipino Republic by the Americans in 1902, Liongson opted for a parliamentary struggle for independence. In 1916, he was elected as the first Senator from Pampanga province and advocated for improving health services until he died in 1919.

Key words: Philippines, Immune Systems, History, Medicine, Philippine Revolution

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Introduction

The training of physicians and chemists was a policy priority for the Spanish colonial government in the Philippines during the late 19th century. In the 1860s, under the provisions of the Moret Decree, the Spanish government authorized the University of Santo Tomas (UST) to establish faculties of medicine, surgery, and pharmacy in 1871, granting it the authority to confer licentiates in these fields. These became the first science faculties in the Philippines. Within two decades of the Moret Decree, UST had produced distinguished chemists, such as Anacleto del Rosario. However, the university was only permitted to award licentiate degrees, not doctorates, in medicine and pharmacy. As a result, students like Antonio Luna—some of whom held scholarships—had to pursue advanced studies in Europe, particularly in Madrid.

Luna earned his doctorate in 1893, becoming the first Filipino scientist to receive a doctorate on a government scholarship. He was followed by Francisco Tongio Liongson and Mariano Vivencio del Rosario, who completed their doctorates in medicine and pharmacy, respectively. These scientists belonged to the *Ilustrados*—a class of wealthy, educated elites in the Spanish Philippines who were fluent in Spanish and often came from merchant or landowning families (Thomas, 2012). Their work coincided with major advancements in immunology and microbiology. Antonio Luna specialized in malarial transmission and diagnosis, bridging the methodologies of the Paris and Roman schools of malariology (Vallejo, 2017). Del Rosario, who earned his doctorate a year after Luna, researched bacterial toxins produced during cadaver decay (Santiago, 1994b). Meanwhile, Liongson, awarded his medical doctorate in 1895, investigated cellular responses to pathogens and their toxins.

The three Filipino medical-scientists worked under the newly established and accepted Koch and Pasteur paradigms while elucidating the organismal, organ-tissue, and cellular responses to pathogens. In this essay, we focus on the work of Francisco Tongio Liongson, the first professor of medicine in the Universidad Literaria Cientifica de Filipinas, the chief medical doctor to the Filipino Army of Liberation, and later the senator from Pampanga province. It also explored the scientific and socio-political context of a Filipino scientist's developing political consciousness in a time when Filipinos were developing a national consciousness.

Dr. Francisco Tongio Liongson

Francisco Tongio Liongson was born on December three, 1869 in Bacolor, Pampanga, Philippines, to a wealthy family whose wealth lay in the sugar industry. He studied in the town's elementary school and then proceeded to San Juan de Letran in Intramuros for the Bachelor of Arts in 1887. He then received his teaching and surveying diplomas in the following two years from the UST. On August 24, 1889, he arrived in Barcelona to take the medical course at the Universidad Central in Madrid. In 1894, he received his licentiate to practice medicine and in 1895, his doctorate upon presentation and examination of his thesis "La Celula ante Microbio" on October 19, 1895. He, then, proceeded to the Institut Pasteur for his further research training, and like his predecessor, Antonio Luna, he worked in the laboratory of Emile Roux. Roux's laboratory specialized in developing sera for anthrax and diphtheria vaccines, and when Liongson trained in this laboratory, research in these vaccines was the focus (Pièrre Paul Émile Roux 1853-1933, 1934). In Spain, he was an Ilustrado active in the Propaganda movement for reforms in Spanish administration in the Philippines. He wrote for the journal La Solidaridad, which was the political mouthpiece of the Filipino community. He worked with Jose Rizal and Antonio Luna, who later became martyrs for Filipino nationhood. In the same year, he married Maria Dolores Alonso y Castro and returned to the Philippines in November 1895. It was during this era of rising nationalism, revolutionary movements, and scientific advancement that Liongson completed his training as a physician.

Immunology at a Time of Paradigm Shifts: Liongson's Doctoral Thesis, The framework of cellular division and differentiation

Liongson's doctoral thesis was grounded in the revolutionary Darwin-Wallace theory of evolution by natural selection, which provided a framework for understanding cellular differentiation and its role in immunity. At the time, immunology was dominated by Pasteur's humoral theory, but Metchnikoff's discovery of phagocytosis (1893) in marine invertebrates (*Daphnia* and starfish) challenged this paradigm. His observations suggested that immune defense mechanisms—like phagocytosis—had deep evolutionary roots, emerging as homologous traits across species (Gould, 2002). Liongson's work contributed to the growing recognition that cellular immunity (mediated by phagocytes) was as critical as humoral immunity (Cooper, Kauschke, and Cossarizza, 2002, p. 320). This shift aligned with broader debates in evolutionary developmental biology, where phenomena, such as tadpole tail regression and bacterial clearance by immune cells, were seen as parallel processes—both representing programmed biological "loss" events shaped by evolutionary pressures (Tauber, 2003). By framing phagocyte evolution within Darwinian theory, Liongson's research bridged immunology, phylogeny, and developmental biology, reinforcing the idea that immune mechanisms were not static but products of deep evolutionary history.

This was the starting theoretical framework of Liongson's doctoral thesis at the Universidad Central de Madrid. The doctoral thesis entitled "La Celula ante Microbio" reviewed the theory in cell biology and immunology of the last decade of the 19th century. It is not an experimental thesis but an extended "reseña" or review. Liongson's review starts with Leeuwenhoek, as cited by Marie François Xavier Bichat. While Bichat made seminal contributions to anatomy by identifying 21 distinct tissue types, his work—conducted without microscopic examination—remained limited to gross anatomical analysis. Hence, Bichat's analyses did not include differentiation of cellular types in tissues but provided a theoretical bridge between organ function theory and the cellular theories of Rudolf Virchow. This is the cell theory which posits that cells come from preexisting cells *Omnis cellula in cellula*.

The principle of *omnis cellula in cellula* (all cells from cells) necessitated an explanatory mechanism for cellular reproduction - a gap filled by the emerging understanding of mitotic and meiotic division. Fifty-nine pages of Liongson's thesis examine cellular biological theory as of 1895, covering cell structure and newly proposed functional hypotheses. For example, Liongson described the hypothesis that the nucleus contains the "organic molecules" (Chromatin) necessary for the ontological development of the organism and its immune system.

Liongson began his explanation of the immunological cellular response by first characterizing phagocyte movement. He correctly theorized that Brownian motion was a physical, rather than biological, process—a concept later fully explained by Albert Einstein in his 1905 doctoral thesis. Liongson focused specifically on leukocytes, investigating whether their movements were attributable to Brownian motion. He also detailed clinical observations in which phagocytic activity ceased at 0°F and resumed at 70°F.

Liongson was much familiar with the differences between cell mitosis and meiosis, as he wrote:

> "*We can assign two general ways by which nature works to construct cells, and they are: division and conjugation, or, in other words, cell formation by excision of a pre-existing cell and by conjunction and fusion of two previous elements. The latter is the exclusive heritage of ovular cells of the animal kingdom, but the former is general to all anatomical elements*."

He noted the changes in the nucleus at prometaphase and anaphase:

> "*Cell division is subdivided into two main ways: direct segmentation and indirect segmentation or Kariokinetics. It is called direct or simple when the division is neither preceded nor accompanied by modifications in the texture of the nucleus, and indirect or Kariokinetic when the cell division is preceded by curious structural alterations of the nucleus, such as glomerulus segmentation, polestar formation, etc.*"

Mitosis is an example of cellular protoplasmic movement which interested Metchnikoff. Elié Metchnikoff was a passionate experimentalist who conducted studies on embryo ontology and the role of phagocytosis in the immune response. He was the first to systematically investigate phagocytic cells, macrophages and microphages in tissue repair and infection. He is considered to be one of the founding fathers of immunology.

German biologist Walther Flemming became the first scientist to observe mitotic cell division in 1882, meticulously documenting the process—including changes in cell substance, nucleus behavior, and cytoplasmic division—in salamander cells. He was able to visualize chromosomes by using aniline dyes, which bind to chromosomes. Flemming intuitively knew that chromosomes carry genetic material because of the higher density of chromatin. However, it was Heinrich Waldemeyer who coined the term "chromosome". Theodor Boveri described meiosis and the process of reduction division. Walter Sutton was the first to connect the biological process of meiosis with Gregor Mendel's statistical laws of inheritance (Yanagida, 2014).

Liongson's interest in theories of inheritance—particularly their relation to cellular organelles and the morphological changes during mitotic protoplasm division—was sparked by his reading of Flemming's 1879 work, *Beiträge zur Kenntniss der Zelle und ihrer Lebenserscheinungen* (which he mistakenly cited as 1877). He was also interested in the forces of attraction and repulsion of the cellular components and organelles in their movement during cell division. Liongson hypothesized this as a result of Brownian motion for most organelles, while he had no theory for the nucleus. Although he did not specifically cite it, Liongson was also able to consult Flemming's 1882 work, in which he describes in great detail the formation of chromosomes. We know this since he uses near-verbatim adoption of Flemming's terminology, including the chromosome description. Flemming did not use the word, which was coined later. Liongson uses "nuclear en vias de segmentacion se transforma en cordon" or "when the nucleus begins to divide, it begins to transform itself into a cord", paraphrasing Flemming's original German description. However, Liongson was unable to connect the mitotic structures he observed (such as polar formations and asters) to chromosomal movement within the protoplasm, leaving this mechanistic relationship unresolved.

Reviewing the theories available to him (e.g., Bechamp, Altmann, Haeckel, and Schieffer) and using the now archaic term "bioblast" as a noun for what we know now as organelles, Liongson tried to find the simplest hypothesis to explain movements in protoplasm, especially of the nucleus in cell division. But at this stage of cellular biology's paradigm development (1860s to mid-1880s), none of the competing hypotheses had been experimentally verified, except for Brownian motion. At the time, Brownian motion remained the only testable and falsifiable framework capable of explaining such phenomena until a more accurate theory could replace it.

In this context, Liongson describes "bioblasts" as autonomous units within the cell that could generate new cells through division. This alludes to Darwin's theory of how inheritance was transmitted to cells as units called "gemmules" in sexual reproduction. These gemmules eventually reside in the gonads.

There is no evidence that Liongson was familiar with Mendel's theories. His work aligned with the scientific paradigms of the researchers he cited, which were heavily influenced by Darwinian thought. Mendel's findings (1865) had been published in an obscure journal by Brünn's Natural History Society and remained largely unknown until their rediscovery in 1900 by Hugo de Vries, Carl Correns, and Erich von Tschermak. Nevertheless, Liongson proposed a hypothetical role for nuclein (first identified by Friedrich Miescher in 1869) as the substance carrying genetic material capable of generating new cells and their organelles. He suggested that bioblasts containing nuclein within chromatin could produce new cells through mitosis. However, Liongson argued that nuclein—whether in chromatin or the chromatin "cordon"—was not inherently alive and required the activity of living protoplasm to function.

This aligns with the biochemical theories of the 1880s that Liongson reviewed. The nucleus was hypothesized to contain the information that gives rise to new cells, but it is not inherently alive and is at the simplest level of chemical complexity. This was followed by the substances forming the more complex protoplasm and then the cell as a whole, which is the most complex. At all these levels of cellular organization, there are the abstract concepts of bioblasts, which transmit genetic information.

Liongson had support for this hypothesis from Haeckel, who posited that the plastidula (what is now known as a plasmid) in prokaryotes, contains genetic information which Haeckel called memory ("memoria" in Liongson's reading). Liongson writes it as:

> "*Esta memoria inconsciente explicaría, según él, la herencia, el hábito, la reproducción, etc. Reconoce, además, otra muy importante también, la evolutiulidad ó variabilidad, por la cual las moléculas orgánicas se adaptan á nuevas condiciones, modificando sus propiedades originarias y contrariando las tendencias de la herencia.*"
>
> *According to Haeckel, this unconscious memory would explain inheritance, the habits, and the reproduction of cells. This recognizes another very important fact, the evolution or variability of expression as a result of organic molecules adapting to new conditions, modifying their original properties, and contradicting their original tendencies of heredity.* (Translation by R. Addun)

Liongson understood that the genetic material in plasmids contains information about heredity and all organismal traits associated with it, such as reproduction, habits, etc. This is a hypothesis within Darwin's theory of natural selection, in which organic molecules can adapt to changes in the environment that may modify their heredity and genetic characteristics.

Liongson concludes this part of the review and moves on to the basic anatomical description of the cell and the specific functions of each organelle in the maintenance of homeostasis, described as "al perfecto equilibrio" or in "perfect balance." It should be noted that "homeostasis" was the guiding paradigm for Metchnikoff's immunology research, and by using "al perfecto equilibrio" especially in the cell's response to a pathogen, he is echoing Metchnikoff. To better explain his understanding of homeostasis, Liongson focused on cellular nutrition, metabolic products, and the chemistry of the cell when confronted with a pathogen, and how these impact the human body. But first, he needed to define the scope of his investigation in microbiology and how that would define the scope of his understanding of immunology.

Defining microbiology

Before the theories of Robert Koch were first proposed, physicians were more interested in bacteria and defined a science, "bacteriology," which largely focused on pathogens, even if its roots were in botany. Ferdinand Cohn first described cyanobacteria and laid the basis for the taxonomy of the prokaryotes in Breslau. After 1870, Cohn decided to focus on bacteria, defining them as non-photosynthetic. "spherical, oblong, or cylindrical, sometimes twisted or bent, which multiply exclusively by transverse division and occur either isolated or in cell families and thereby separating bacteriology from botany. (Cohn, 1939)" Cohn divided bacteria into four groups based on their morphology: i. Sphaerobacteria (spherical), ii. Microbacteria (short rods or cylinders), iii. Desmobacteria (longer rods or threads) and iv. Spirobacteria (screws or spirals) (Cohn, 1875).

Since Cohn had previously studied cyanobacteria, he initially classified bacteria within the plant kingdom. Liongson, reviewing bacterial taxonomy within Cohn's framework, cites his work on *Bacillus subtilis*—particularly experiments involving the arrest of bacterial cell division. These studies held significant clinical and diagnostic value, especially in advancing antiseptic techniques, which later became standard medical practice. Notably, Liongson himself did not consider bacteria to be plants; a perspective reflected in his adoption of the term "microbiology" to describe his field of study.

In recognizing the diversity of microbial species in concert with recognition of the diversity of blood cell types, Liongson uses the word "microbiologia" to describe the science he will use in medical diagnosis and clinical practice. Notably, the Filipino scientist who preceded him in the doctorate (1893), Antonio Luna, used the older and more specific term "bacteriology" as the diversity of microbes was not yet appreciated as much when Liongson did his research just two years later. Luna, at the start of this doctoral research, hypothesized that the proximal cause of malaria was due to a bacterium (Vallejo, 2017).

> *These small organisms, called microbial pathogens, whose actions or functions are incompatible with the cellular functions in our body, are the object of these studies. These have given rise to that new science called Microbiology.* (Translation by R. Addun)

Three Immunological Paradigms

Liongson begins this part of the review on fermentation of yeasts because clinicians understood infectious diseases as fermentation in vivo at the beginning of the 19^{th} century. This idea, according to Liongson, persisted until mid-century. Without empirical evidence that such a process is responsible for the immunological response, Liongson called this "imaginación" or fantasy of the doctors. Liongson's thesis was to establish the scientific basis of the cellular immunological response, necessitating a thorough examination of available experimental and clinical evidence. The review aimed to bridge existing medical and pathological practices with emerging biological insights, particularly by analyzing the effects of bacterial metabolites on cells and the chemical reactions triggered by pathogenic infection. The two important experimental approaches were inoculation and vaccination.

At the end of the 19^{th} century, three paradigms of the immune response were established that would shape immunology in the 20th century. These were Koch and Pasteur's germ theory, Von Behring and Kitasato's serum theory, and Metchnikoff's phagocytic theory. All of these theories directly influenced Liongson's medical practice. Pasteur's work on microbial attenuation—initially challenged by Toussaint but later supported by Auguste Chauveau—became central to humoral theory. This framework was further confirmed by Von Behring and Kitasato's groundbreaking experiments on diphtheria and tetanus toxins (Berliner medicinische Gesellschaft, 2009). As Liongson notes,

> *This natural immunity depended on inhibitory substances, capable of opposing the proliferation of bacteria, substances that, by nature, could not be of microbial origin, and that, in these cases, could only be manufactured by animal cells. But three weeks after this (July 19, 1880), Chauveau applies his idea of inhibitory substances to acquired immunity, which, similarly, will no longer be manufactured by the animal organism, but by the microbe pathogen.*

The use of serums can attenuate the virulence of the pathogen, which is now known to physicians as antitoxin but which Liongson called a "toxin destroying" substance. Liongson observed this in his clinical training.

However, Liongson, who was familiar with the then-current paradigms of the immune response, critically evaluated Pasteur's theory with respect to the culture methods and the methods of attenuation of microbes in vaccination. Pasteur's attenuation theory logically extends from his microbiological culture experiments. Pasteur's central idea was that the pathogenic microbe depleted the host of its essential nutrients and so loses its virulence, conferring host immunity (Smith, 2012). On the other hand, Toussaint, a veterinarian, who first isolated chicken cholera in 1879, used dead anthrax pathogens and, on inoculation, elicited an immune response in dogs and sheep, thereby conferring immunity (Chevallier-Jussiau, 2010).

Liongson also cites Chaveau, a veterinarian like Toussaint, who, to some historians of medicine, should be considered the father of microbiology (Lahaie, and Watier, 2017), and agrees with his theory of humoral immunity. Whereas Pasteur proposed the "exhaustion of essential nutrients" in the host as the cause of in vitro reduction in virulence, Chaveau hypothesized that microorganisms produce substances in the host that are detrimental to themselves, thus reducing their virulence. This formulation of humoral immunity is exactly the reverse of the modern understanding, in which it is the host that produces the substances (antigen-antibodies) that reduce virulence. Chaveau tested this with anthrax by heating large volumes of anthrax-infected sheep blood and transfusing this to uninfected sheep hosts. The experiment failed but was repeated successfully by Toussaint.

Liongson cites Richet and Hericourt (1890) in his experiments on avian tuberculosis and anthrax in inoculating dogs and rabbits, and concludes that this supports Chaveau's idea of humoral immunity (Héricourt, and Richet, 1890). It is in this experiment that Richet and Hericourt were able to demonstrate a transferable immunity in dogs to tuberculosis but using attenuated *Mycobacterium*. But they had three bacterial pathogens to choose from: anthrax, diphtheria,and tuberculosis. Their choice of tuberculosis, driven by its high public health priority at the time, ultimately proved problematic for validating humoral theory. We now know that immunity to tuberculosis is primarily cell-mediated, not antibody-dependent, making it an unsuitable model for demonstrating humoral immunity's clinical applications.

Nonetheless with Behring's clinical demonstration of serotherapy in 1890 (Von Behring, 1890), the German school of immunology became more attractive to physicians and convinced them of the effectiveness of vaccination grounded on their experience in state mandated smallpox vaccination beginning in 1879, and the theory of humoral substances in serum that conferred immunity (Klein, Schöneberg, and Krause, 2012).

The significance of Liongson's Doctoral Thesis

Between 1890 and 1895, the Colonial Government in the Philippines sponsored two doctoral theses: Antonio Novicio Luna's in pharmacy and Francisco Tongio Liongson's in medicine (Vallejo, 2017). While both contributed to medical science, their research focuses differed substantially. Luna, as a Doctor of Pharmacy, focused on malaria—investigating its cause while developing experimental diagnostic methods and preventive measures for clinical use. In contrast, Liongson's medical dissertation systematically examined current immunological theories, critically evaluating them through the perspective of late 19th-century clinical research practices. Because of his medical background, Liongson was especially interested in applying experimental findings to clinical practice, which explains his thorough review of existing medical research.

However, a common theoretical framework is evident in both doctoral theses. The framework was based on Metchnikoff's theories of inflammation and the host's response to the pathogen causing it (Metchnikoff, 1893). Furthermore, Metchnikoff's phylogenetic approach to cellular differentiation was used in framing the questions on the differentiation of merozoites in Luna's thesis and the phagocytes in Liongson's thesis.

Liongson's thesis is within the context of the rising dominance of the humoralists who insisted on the substances in the blood serum, which conferred immunity in contrast to Pasteur's "depletion of essential nutrients" theory. Confronted with this development in 1895, when Liongson defended his thesis, like any clinical scientist faced with convincing experimental data (mostly in veterinary medical contexts) but without much clinical data, he cautioned about generalizing Behring and Kitasato's findings on diphtheria but expressed the hope that this will be applicable in his future medical practice.

The immunological paradigms Liongson learned in medical research and training, Metchnikoff's phagocytosis, Pasteur's attenuated viruses, and Chaveau, Toussaint, Richet, and Hercourt, Behring and Kitasato's humoral immunity were critically reviewed. However, it is notable that Liongson did not cite Paul Ehrlich whose work on standardizing antiserums was noted by physicians of the time (Valent, et al., 2016). Ehrlich, together with Metchnikoff, received the 1908 Nobel Prize in Medicine. Richet received the 1915 Nobel Prize for his work on anaphylaxis. Behring received the first Nobel Prize in Medicine in 1902 for his work on antiserums.

By 1900, the humoral immunity paradigm was dominant, and Liongson's conclusion in his doctoral thesis definitely supports this:

1. Microbes act on animals through substances that they secrete.

2. Among the substances secreted by microbes, there are favorable and unfavorable ones for the microbe that produces them and for other species. There are toxic substances for animals, an action that constitutes the virulence of the bacteria, and there are bacterial products that initiate the immune response..

3. Vaccine substances secreted by microbes do not impede the production of immunity.

4. Vaccine materials impress the animal organism in such a way that, even after it is eliminated, the humors less conducive to the life of the microbe remain permanently, and in their presence, the leukocytes execute diapedesis more profusely and perform their phagocyte function more energetically.

5. Natural immunity exists due to conditions little known of species, race, or individual, and so does artificial immunity that can sometimes be created by vaccination.

6. All forms of immunity have different degrees; therefore, increasing the amount of virus, increasing its intensity, or weakening the organism that has to be vulnerable, may result in infection in organisms otherwise immune.

7. To produce immunity, the following occurs: a) the bactericidal power of the hu-

mors and tissues; b) chemotaxis and vasomotor actions that determine phagocytic; c) modifications in the cellular function that can come from stimulations by toxins, from changes produced by habit, from reactions of a nervous system more or less impressionable etc., changes of cellular function which are the only ones capable of explaining the persistence and inheritance of immunity.

8. Different germs have different pathogenic modes of producing infection; therefore, the organism must also pose different modes of defense for each case, but undoubtedly at the bottom of all resistance, cellular functionalism is what mainly executes it.

We then see the development of Liongson's thinking on immunology in his medical practice. After reviewing the current knowledge in cell biology and cellular immune response, he then accepts the humoral immunity paradigm as promising and more applicable in clinical practice. This paradigm became dominant in the 20th century.

Liongson's Later Career as a Physician in a Revolution and Politics

Liongson returned to the Philippines in 1895 and worked in private medical practice until the outbreak of the Philippine Revolution on 29 August 1896. That same year, he joined the Katipunan revolutionary movement, serving as a military doctor with the rank of captain. Later, under General Antonio Luna's orders, he was assigned to General Mascardo's command and commissioned as a medical officer with the rank of *Comandante*.During the brief existence of the First Philippine Republic, Liongson was appointed professor of medicine at the *Universidad Literaria-Cientifica de Filipinas* in 1898. Although the university operated for only three months, it successfully conferred licentiate degrees in Medicine. Following the defeat of the Philippine Republic by American forces and the surrender of Mascardo's troops on 15 May 1901, Liongson was appointed chief medical officer of Pampanga by the American military government. In this role, he effectively controlled outbreaks of cholera, leprosy, and smallpox in the province. However, in 1902, he was removed from his position, allegedly for incompetence—though political motivations may have played a role.

Liongson was likely exposed to socialist and Krausist thought during his studies in Madrid, possibly through the influence of his professors. In his early immunological hypothesis, Liongson builds upon Metchnikoff's evolutionary theory of cellular differentiation, proposing that distinct cell types exhibit varied responses to stimuli. Strikingly, he employs a sociopolitical metaphor, likening the immune system to class relations in human society—where each specialized cell (or "trade") plays a defined role. He further suggests that immune dysfunction parallels societal disequilibrium, akin to a workers' strike disrupting industrial harmony.

> "*But in the beginning of their life, cells do not have unique functions; all cells have the same or almost the same anatomical characteristics and similar physiological aptitudes. But gradually, as if adapting to new conditions of the organic medium, they vary in shape, size, and even structure, forming themselves into families and professional guilds, each concentrating on developing a specific function. From this viewpoint, our wise and dignified professor Dr. Cajal ingeniously compared a developing organism to a people that differentiates and pro-*

gresses, passing from a wild and vagabond state to a state of social organization; every individual who, when autonomous or leading a wandering life, satisfied all his needs by himself, no matter how indecently, now depends on the production of others once the social professions are established; and in the social life of a people, like the life of the cell, this division of labor marks a notable progress, since what is lost in independence on one hand is gained by individual welfare and improvement of collective work on the other. Extending the analogy, Dr Cajal added that a guild strike creates a significant social disequilibrium because the other members of society do not know how to do the work of the strikers."

Determining the extent of Liongson's engagement with the political and moral philosophy of Karl Friedrich Christian Krause would require further research. Krause's philosophy, grounded in harmonious rationalism, advocated for progressive social, legal, and educational reforms. His ideas resonated not only with the *Ilustrados*—including figures like Rizal, the Luna brothers (Antonio and Juan), Marcelo H. del Pilar, and Graciano López Jaena—but also with Latin American nationalists in Spain. The *Ilustrados* were likely influenced by Krausist republicanism, particularly through the ideas of the Catalonian statesman and Spanish Prime Minister Francisco Pi y Margall, a key proponent of Spanish Krausism. Pi y Margall's thought gained prominence during the short-lived First Spanish Republic (1873–1874) (Sarkisyanz, and Rizal, 1995). Spanish Krausism, while embracing Darwinian notions of organic societal evolution, diverged from Darwinism by asserting a teleological progression toward human perfection—framing social development as an orderly, rational process aimed at moral and intellectual advancement.

The intellectual environment of students in Madrid's Medical Faculty was heavily influenced by the moralistic socialism of Pi y Margall's moralistic socialism (Sarkisyanz, and Rizal, 1995). This is the socialist thought familiar to the Ilustrados. Pi y Margall's socialism was a Krausist application of justice to the social order, not a socialism based on historical materialism, class struggle, or opposition to strikes if they threaten the social order. Although Pi y Margall never mentioned Marx or Engels in his writings, Engels considered the Spanish republican a socialist (Engels, 1941).

Ironically, Liongson died of anthrax on 20 Feb 1919, at age 49- the very disease that had been the subject of his research at the Institut Pasteur. His untimely death occurred just before he was scheduled to depart as part of the first Philippine Independence Mission to the United States.

Conclusion

Liongson was well-versed in the competing immunological paradigms of the late 19th century. While he acknowledged the empirical strengths of humoral theory given the contemporary evidence, he maintained a critical stance toward critiquing Pasteur's immunological theory. However, he cautioned against generalization of Behring's findings on antisera for medical practice, given that the experimental data came from veterinary practice and contexts. He did not abandon Metchnikoff's theories.

Liongson's political trajectory reflected both his revolutionary ideals and pragmatic accommodations. A committed nationalist, he joined the Katipunan movement immediately upon returning to the Philippines in 1895, demonstrating his support for Philippine independence. His doctoral thesis reveals the influence of contemporary socialist and liberal thought. However, as a member of the landed elite, he ultimately pursued independence through collaboration with the American colonial government, participating in the emerging parliamentary system. This dual position - revolutionary nationalist turned institutional reformer - characterized much of his political career, during which he championed public health initiatives, agricultural credit systems, and vaccination programs. Ironically, it was this latter commitment that led to his untimely death from anthrax.

The scientific pursuits and political consciousness of *ilustrado* scientists during the twilight of Spanish rule in the Philippines remain understudied and merit further scholarly attention. While most *ilustrados* in Spain trained as physicians or lawyers (Santiago, 1994a) and contributed to *La Solidaridad*, only three actively bridged science, propaganda, and revolution. Among them, Antonio Luna's career is the most documented: a scientist who directed Manila's municipal laboratory (Jose, 1999); he later leveraged his study of military tactics to become a revolutionary general and national hero. In contrast, Liongson transitioned from medical science to politics (Santiago, 1994a), while Mariano Vivencio del Rosario sustained his work in chemistry after the revolution, eventually serving as the inaugural Dean of Pharmacy at the University of the Philippines (Santiago, 1994b). If the revolution were triumphant and the independence of the Philippines were secured, Liongson, like his confreres in Madrid, would have retired as academics since they already held appointments at the Universidad Literaria-Cientifica de Filipinas.

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Authors' Contribution

Benjamin Vallejo Jr. wrote on the development of Liongson's theories as evidenced from his only publication, his doctoral thesis. Rodrigo Angelo C. Ong evaluated the clinical practice, vaccination, immunological, and biochemical contexts of Liongson's theories in his doctoral thesis. Raymundo P. Addun translated the thesis from Spanish into English. All authors read and approved the final version of the work.

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Conflict of Interest

None.

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