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Genetic Capitalism: The Anthropological Evolution of Antibiotic Resistant Bacteria

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Genetic Capitalism: The Anthropological Evolution of Antibiotic Resistant Bacteria

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Abstract

This thesis titled "Genetic Capitalism: The Anthropological Evolution of Antibiotic Resistant Bacteria" explores the evolution of antimicrobial resistance (AMR) genotypes in bacteria and its impact on our destruction of a once symbiotic relationship with bacterial species. By taking an anthropological approach, I investigate how material relations, social institutions, cultural meanings, and political relations within and beyond the microcosm of bacteria have led to mass bacterial resistance. In the course of my research, I examine the cultures of bacterial cultures and their interactions, as well as the language of bacteria and their social intelligence, in order to anthropomorphize bacterial species that are well understated in their similarity to human cultures, languages, and economics. I also analyze the concept of bacterial capital and class struggle and the paradox of capitalist medicine as it exists in the 21st century, through the lens of political movements, activism, and critical pedagogy. Finally, I explore the legacy of historical events, such as Franco's dictatorship in Spain, on antibiotic resistance, once again drawing stark comparisons between human political resistance and bacterial antibiotic resistance. Through this research, I argue that incorporating soci-anthropological analyses into the design and interpretation of studies of human microbial biology can provide crucial insights into the specific individual, social, and political-economic factors that shape microbial relationships. As a future medical professional, I believe that understanding the historical, political, and anthropological dimensions of the problem is essential to developing effective solutions to the issue of mass bacterial resistance.

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Introduction

As this is a widely interdisciplinary investigation, it is important to explain the term "antimicrobial resistance" in layman's terms. Put simply, antimicrobial resistance occurs when germs like bacteria and fungi develop the ability to defeat the drugs designed to kill them. That means the germs are not killed and continue to grow. Interestingly enough, antibiotic compounds occur naturally in bacteria and have been used by bacterial populations to fight against other taxa for territory and resources for millenia. These interactions among bacteria evolved long before humans started to produce antibiotics on an industrial scale. However, bacterial genomes collected prior to antibiotic industrialization are either devoid of, or lack many of the antimicrobial resistance (AMR) genotypes we see today.

These observations support the hypothesis of *genetic capitalism*, positing that AMR genotypes are *hoarded* in bacteria and rarely lost, much like wealth and power is hoarder in the truest definition of capitalism. If we zoom out, we see that there has never been a precedent for this type of gene hoarding in bacterial species – that is, not until humans enter the scene. If human interference were to not be a factor, bacterial lineages that are resistant to antibiotics would experience AMR genotype loss after the selective pressure for resistance is released. Currently, not only do we experience genotypes for antibiotic resistance becoming *fixed* along bacterial lineages, but we also find bacterial lineages that emerge with *multiple* genotypes that confer drug resistance, and subsequent untreatable infections. As a future medical professional, I do not believe in stalling global public health issues by temporarily mitigating them, yet this is what we witness with the continuous development of antibiotics to mitigate the rapid rate of resistance across bacterial species. Instead, I want to provide a historical and anthropological lens to analyze the material relations, social institutions, and cultural meanings within the

microcosm of bacteria in order to understand how we have arrived at the point of mass bacterial resistance today.

Anthropology attempts to make up a holistic science of humanity by studying the material history of humans and our biological diversity, combined with analyses of the variability of cultures and cultural practices. Fundamental questions of relatedness, selfhood, and social transformation have long been, and still remain, central to anthropological study. Incorporating anthropological analyses into the design and interpretation of studies of the microbial world can provide scientists with crucial information about the specific individual, social, and political–economic factors that the microbiological field, on its own, often misses. I hope that investigating microbes from an ethnographic perspective can provide anthropologists and scientists alike with new perspectives about how microbiology and socio-cultural paradigms are fundamentally inextricable.

Chapter 1:
Cultures of Bacterial Cultures

To conduct an anthropology of microbiology generally means to make visible the knowledge produced by microbiologists in human terms: to follow the humans that build the field, conduct experiments, make discoveries, apply for grants, engage in scientific questions. It means to show that microbiology is a human practice, fundamentally linked to cultural forms and dependent on the social circumstances in which it is carried out. The actual *microbial worlds* explored by microbiologists rarely come into life, as this would imply shifting our focus on another species, losing sight of its contingency on *the human*. The flipside of anthropology's humanism, which is a reflection of the modern figure of the human as "Man" that emerged in seventeenth- and eighteenth-century Europe, is that it amounts to an unfortunate and unnecessary epistemic poverty: all that the human sciences ever make visible is – the human. In this thesis, I want to attempt something very unorthodox — to use anthropology to enter the space for microbes. How can anthropology, the science of humans, escape humans? And how can they do so without abandoning anthropology and simply replacing it with microbiology? Even more provocatively, hasn't the world outgrown the concept of the human on which anthropology remains founded upon? Isn't "the human" by now an unfortunate, destructive antiquation?

Earth is a microbial planet, formed and shaped by microbes over long stretches of time. The first microorganisms, single-cell prokaryotes known as cyanobacteria, emerged about 3.5 billion years ago, and for the next 2.5 billion years, they were the only life form on Earth and they gradually, haphazardly produced the biosphere on which all life is contingent (Henke, 2004). Then as now, bacteria produce the oxygen we breathe, as well as running the

biogeochemical cycle on which all life on Earth depends. Every multicellular form of life emerged from microbes and evolved in conversation with microbes and the molecules they produce. The unusual status of Earth in our solar system, with respect to billions of other solar systems, as far as we can tell—is due to microbial life. The paramount role that microbes play in our universe puts into question whether humans are *truly* at the apex of our ecological hierarchy. If looked at in terms of our microbial planet, humans are late, accidental descendants of microbial evolution, adapted to and deeply dependent on a microbial world, inseparably interwoven with the microbial environment. From our brains to our circadian rhythm, from our metabolism to our immune system, from embryogenesis to heart rate, insulin level, or the clotting of our blood— there appears to be no aspect of our physiology that doesn't rely on the microbes that live in and on us. Following the perspective of microbiology, the figure of the human as an ecological apex—that figure on which all of the human sciences are contingent up—does not actually exist. It is at best a supremacist and speciesist abstraction. We think about ourselves as having microbes, but really, it is much more realistic to believe that microbes invented us as a habitat in which they cannot only survive but flourish.

Nutrient Sharing

Microbes often live in symbiosis with higher organisms, but they also cooperate with each other in order to optimally utilize the resources that are available to them. Within a bacterial community, cells of different bacterial species are not homogeneously distributed, they are instead patterned by their interactions with neighboring cells and the abiotic environment according to their metabolic and physiological needs. Bacterial growth rate is shaped by natural selection in response to resource and nutrient conditions over their ancestor's history (Henke 2004). In the natural world, bacteria live in communities where individuals rely on one another.

The vast majority of bacteria cannot produce all of the nutrients they require, and instead depend on other bacteria to produce nutrients such as amino acids and vitamins. Until now, it was unclear whether bacteria exchange metabolites exclusively by releasing them into the surrounding environment, or whether they also use direct connections between cells for this purpose, but recent findings show that some bacteria can form nanotubular structures between single cells that enable a direct exchange of nutrients. Especially remarkable, however, was the fact that only the gut microbe Escherichia coli was capable of forming these structures and connecting to another bacterial species, Acinetobacter baylyi, as well as other E. coli cells (Lee 2020). The ability to directly connect to neighboring bacterial cells with the purpose of sharing nutrients that ultimately benefit the entire span of the bacterial culture is particularly interesting, as such tubular connections can also pose a potential risk, because the partner on the other side of the tube could also provide harmful substances. This type of microbial interaction of nutrient sharing is a major driver of microbial community assembly and function. The details of how microbes depend on one another nutritionally remains enigmatic, and we have yet to understand the metabolic cost of producing a shared metabolite, as well as how nutritional interdependence shapes the evolutionary trajectory of bacteria.

The evolution of any characteristic behavior, regardless of the species, presents itself because it serves for some greater survival need, and this is also true for metabolite sharing in E. coli. The division of labor is found to be more efficient and more fit for survival than an isolated and individual struggle through life, and this philosophy is also adopted by bacteria. Researchers from Research Group Experimental Ecology and Evolution at the Max Planck Institute for Chemical Ecology and their colleagues at the Friedrich Schiller University in Jena, Germany came to this conclusion when they performed experiments with microbes. The scientists worked

with bacteria that were deficient in the production of a certain amino acid, and therefore depended on a partner to provide the missing nutrient. Bacterial strains that complemented each other's need by providing the required amino acid showed a fitness increase of about 20% relative to a non-deficient strain without a partner (Lee 2020). This result helps to explain why cooperation is such a widespread model of success in nature.

Though, it is critical to mention that the result of the cooperation is a risky dependency: If one partner is lost, the other dies as well. The observation of cooperative behavior puts many widely accepted scientific theories into question: Can such a dependency on a partner cell in fact be a trait that is selected for and is maintained for a longer period in a bacterial lineage? If this trait is indeed selected for over the course of the evolution of bacteria, then it fundamentally disputes Darwin's theory of the "survival of the fittest", as cooperating partners' survival and fitness rates are just as high, if not higher than microbes without a partner.

Darwin uses the phrase "survival of the fittest" in chapter four of On the Origin of Species to describe the process of natural selection, but he was not the one to originally coin the phrase, as it was borrowed from the English philosopher Herbert Spencer who first talked about survival of the fittest in his Principles of Sociology. The term " 'natural selection,' " wrote Darwin in The Origin, "is in some respects a bad one, as it seems to imply conscious choice." Referring to the process as "survival of the fittest," Darwin thought, helped clarify things (Sloan, 2015). But the famous naturalist's appropriated turn of phrase has been widely used by eugenicists to justify racism, classism, and ableism within a colonial, post-capitalist world. Princeton's biological anthropologist Alan Mann states that in most cases, "survival of the fittest" is now being replaced by the term "reproduction of the fittest," or "differential selection" (Henke, 2004). There are two major reasons for this change in verbiage. The first is that the

survival aspect is important in evolution, not necessarily in the sense of eliminating competition for resources or evading predators, but rather for living long enough that an organism is able to reproduce. Secondly, the phrase “survival of the fittest” paints a very isolating and violent mental image of nature being inherently competitive, and bloody, as though every organism in a particular ecosystem is perpetually fighting for the ability to survive. This presumption leads to the misinterpretation of what an ideal evolutionary goal actually is. Evolution acts to produce function, not perfection, and this said function determines “fitness” purely based on the organism’s ability to produce offspring — not so much to characteristics like strength, greed, or speed. As seen in bacterial species, often the ability to survive long enough to reproduce requires relying on not only intra-species, but also inter-species cooperation and community building.

The act of sharing food, regardless of the scale of species can indicate a lot about the cooperative nature of a community. Many cultural anthropologists have argued that sharing food is, and has always found to be, in some way or another, the sharing of that which will cause and maintain a common substance among those who commune together.

In every social context, eating together is a powerful and fundamental expression of personal intimacy and a strive towards cooperation and coexisting, whether that is with your own community or a foe. The evolution of bacteria to not only disseminate metabolites into their surrounding environment, but to create mechanisms to directly discharge nutrients into another cell — even with the risk of a parasitic interaction — is the hallmark of how nature has favored and specifically selected for this fundamentally cooperative attribute.

Surface Motility

Even more notable than inter-species interactions is bacteria’s ability to cooperate with other bacterial species, specifically to promote surface motility or movement. This is

characterized as a “social trait”, and is seen upon analyzing interaction between the distantly related soil bacteria Pseudomonas *fluorescens* Pf0-1 and Pedobacter sp. strain V48. When a co-culture including both strains is placed on hard agar (which is not permissive for motility of the monoculture of either species), what is revealed is an emergent phenotype that is termed “interspecies social spreading,” where the mixed colony spreads across the hard surface (Lee, 2020). The initiation of social spreading requires close association between the two species of bacteria, and both species remain associated throughout the spreading colony, with reproducible and inhomogeneous patterns of distribution. Even more fascinatingly, some bacteria can exhibit new emergent behaviors when presented with other species, likely the result of induction of genes that are not expressed in a pure monoculture culture. For instance, some Pseudomonas *fluorescens* strains produce an antifungal compound during interactions with other species; the coculture of different actinomycete species results in the production of secondary metabolites, changes in pigment, and sporulation; the presence of Escherichia coli or Pseudomonas species affects sporulation and biofilm formation in Bacillus subtilis. These are characteristics of bacteria that microbiologists would simply not be able to observe if bacterial species were analyzed individually, a testament to the greater social complex that bacteria rely on to not only survive, but to flourish.

Chapter 2

The Language of Bacteria

How do bacteria know when they have company? Studies over the past centuries have revealed that bacteria can also communicate among themselves to carry out a wide range of complex social behaviors, including cooperation. Specifically, bacterial communication involves releasing, detecting, and responding to the accumulation of molecules called autoinducers. Such social behaviors are widespread in bacteria, and it has recently become clear that social behaviors have important consequences in shaping the behavior and structure of polymicrobial communities. The developing interest in understanding bacterial social behaviors has led to innovative approaches for studying dynamic, mixed microbial communities. Detection of these autoinducers allows bacteria to distinguish between low and high cell population density, and to control gene expression in response to changes in cell number. This process, termed "quorum sensing", allows a population of bacteria to coordinately control the gene expression of the entire community. Quorum sensing is a type of population density-dependent cell-cell signaling that can trigger changes in bacterial behavior when the population reaches a critical density. Every bacterium senses changes in the concentration of these autoinducers in their surroundings (Jacob, 2004). Sensing a sudden increase in autoinducer concentration will change a bacterium's gene expression, protein synthesis, and consequently, behavior. If high concentrations of autoinducers are detected, then the bacterium will adapt to group behavior, while a bacterium that senses a drop in autoinducers will adapt to individual behavior.

What's in a Language?

Organisms cannot simply feed on energy as man-made machines do, instead they must feed upon 'negative entropy' – absorb lower entropy organic substances produced by lower organisms and exude high entropy waste products (Jacob, 2004). Bacteria, being the first form of life on Earth, had to devise ways to convert inorganic substance into living matter. This is not a solitary endeavor for the bacteria; under natural conditions, they use chemical communication to form hierarchically structured colonies. By acting in community, they can make use of any available source of energy and imbalances in the environment to reverse the spontaneous course of entropy production and synthesize life-sustaining organic molecules for themselves and in the service of all other organisms. Bacterial communication is far more advanced than it may seem, as they have developed linguistic mechanisms to interpret the information received in a "meaningful" way — developing common knowledge and learning from past experience. The colony behaves much like a multicellular organism or a social community with elevated complexity and plasticity that afford better adaptability to whatever growth conditions might be encountered.

The two discoveries in the 1950s, including the universal grammar and the structural code of DNA, later led to the linkage of linguistics and genetics (Jacob, 2004). The first discovery suggested universal structural motifs and combinatorial principles (syntactic rules) at the core of all natural languages, and the second provided analogous universals for the genetic code of all living organisms. Chomsky's meaning-independent syntactic grammar approach, along with computational linguistic methods, is widely used now in biology, especially in bioinformatics and structural biology, but increasingly also in microbiology and ecology. The focus has been mainly on the structural aspects used to exchange information, or the two levels

of formal linguistics: lexical – formation of words from their components (e.g. characters and phonemes) and syntactic – organization of phrases and sentences in accordance with well-defined grammar rules. I propose that bacterial signaling also involves linguistic communication in the way that we understand human anthropological linguistic communication, primarily in regards to the meaning-exchange function of language. This includes the semantic aspects of linguistics that are associated with the assignment of context-dependent meaning to words, sentences and paragraphs, as well as meaning extraction.

For instance, when reading a text, one has the semantic freedom to assign to it different meanings. Each reader has individual mental flexibility to assign their own meanings to the text, according to previous personal knowledge and specific expectations, or purpose in reading the text. The meaning of a text is often captured only after reading it multiple times. At each such iteration, words, sentences, and paragraphs can assume different meanings in the reader's mind. Iterative reading is necessary because there is a hierarchical organization of contextual extraction of meaning. Essentially, each word contributes in the reader’s mind to the interpretation of the entire sentence that the word is part of. Though, at the same time, the generated whole meaning of the sentence can change the meaning assigned to each of the words that the sentence is composed of. Beyond the individual semantic level of linguistics, some linguists identify a dialogue among conversers (discourse or goal-driven conversation), using shared semantic meanings as the pragmatic level of linguistics, which bacteria have been doing eons before the evolution of the human species. This higher level of linguistic communication requires the conversers to have a common goal in sharing the dialogue, mutual knowledge and mutual concepts and expectations (presupposition, implicature, and attribution). As a result, the group usage of a dialogue can vary from activity coordination through collective decision-making to

the emergence of a *group self-identity*. Using these advanced linguistic capabilities, bacteria can lead rich social lives for the group benefit. They can develop collective memory, use and generate common knowledge, develop group identity, recognize the identity of other colonies, learn from experience to improve themselves, and engage in group decision-making, an additional surprising social conduct that amounts to what should most appropriately be explained as social intelligence.

Bacterial Social Intelligence

The term "social intelligence", originally coined to describe special mental skills that only humans use to conduct successful social lives, has been used more recently to describe linguistic, communication-based group behavior of other organisms, including microbes. The term social intelligence refers to human mental skills beyond the mathematical and academic ones connected with analytical intelligence that are required to conduct a successful social life. Therefore, it is generally associated with special cognitive capacities of humans, such as perceiving self and group identity, perceiving self and group goals, engaging in adaptive social interactions, and acting together for personal and group benefit.

Microbial ethics

By using linguistic communication, bacteria very apparently show patterns of collective behavior that might reflect some fundamental aspects of social intelligence. A case study that supports this includes the variety of strategies Myxobacteria can use when their social intelligence is challenged by "cheaters" – opportunistic bacteria who take advantage of the group's cooperative effort. For example, they can single out defectors by collective alteration of their own identity into a new gene expression state. By doing so, the cooperators can generate a

new ‘dialect’ that is hard for the defectors to imitate. This ongoing intelligence clash with defectors is beneficial to the group, as it helps the bacteria to improve their social skills for better cooperation (Jacob, 2004). Furthermore, bacteria can use the aforementioned intraspecies quorum sensing in ways that demonstrate social intelligence: in multi-colonial communities (ex: subgingival plaque) each colony develops its own expertise in performing specific tasks for the benefit of the entire community and they all coordinate the work.

Some bacteria undertake the task of keeping valuable information that is costly to maintain and can be hazardous for the bacteria to store. Frequently, such information is directly transferred by conjugation following chemical courtship that is played by the potential partners; bacteria resistant to antibiotics emit chemical signals to announce this fact. Bacteria in need of that information, upon receiving the signal, emit pheromone-like peptides to declare their willingness to mate. Sometimes, the decision to mate is followed by exchange of competence factors (peptides) to detect compatibility between cells. This pre-conjugation communication modifies the membrane of the partner cell into the penetrable state needed for conjugation, or “mating”.

Bacterial democracies

Another example of the advantage of bacterial discourse is the starvation response of many species. When growth conditions become too stressful, bacteria can transform themselves into inert enduring spores. Sporulation is a process executed collectively and beginning only after ‘consultation’ and assessment of the colonial stress as a whole by the individual bacteria. Simply put, starved cells emit chemical messages to convey their stress. Each of the other bacteria uses the information for contextual interpretation of the state of the colony relative to its own situation. Accordingly, each of the cells decides to send a message for or against

sporulation. Once all of the colony members have sent out their decisions and read all other messages, sporulation occurs if the ‘majority vote’ is in favor.

Some bacterial strains organize their colonies by generating backbone modules, each containing many bacteria, which are used as the building blocks for the colony (Figure 1). This behavior is observed in, for example, Paenibacillus *vortex* which form the bacterial vortices shown in Figure 1, and in other strains, such as Bacillus *circulans* and Paenibacillus *alvi* (Renfrew, 2009). Maintenance of the central integrity of the vortex while serving as a higher-order building block of the colony requires advanced communication. Each cell in the vortex needs to be informed that its role is now more complex, being a member of both the specific vortex and the whole colony, so it can adjust its activities accordingly. This ongoing communication is particularly apparent when it comes to the birth of new vortices (Figure 1). New vortices emerge in the trail behind a vortex as a result of initiation signals that cause the bacteria within the trail to increase the production of lubricating fluid and to move rapidly as a turbulent ‘biofluid’ until the backbone is formed, and subsequently turns into a new vortex. The entire process appears to proceed as a continuous dialogue; a vortex grows and moves, producing a trail of bacteria, and is pushed forward by the very same bacteria left behind. At some point the process stalls, and this is the signal for the generation of a new vortex behind the original one, which then leaves home (the trail) as a new entity toward the colonization of new territory.

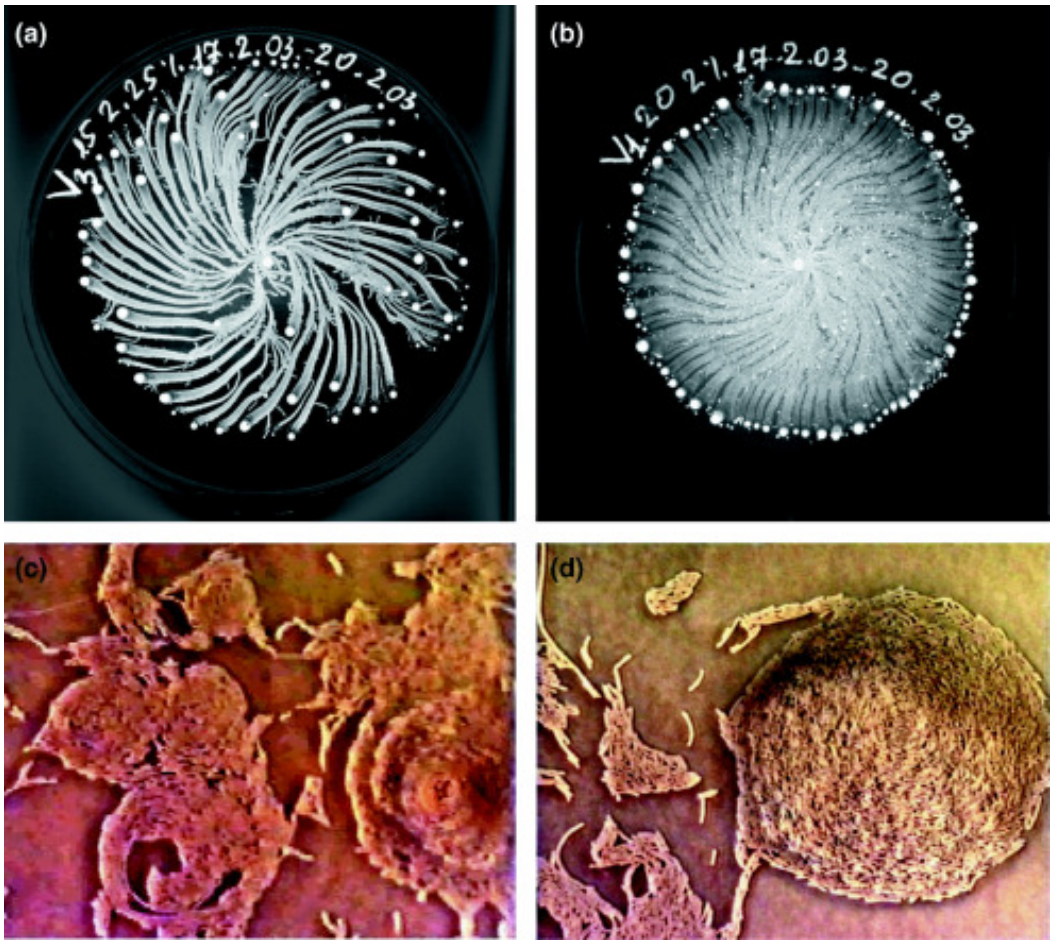

Figure 1. Cooperative hierarchical organization. Complex patterns developed after three-day growth of the Paenibacillus *vortex* bacteria (taken from the same culture) on 8.8 cm diameter plates (Jacob 2004).

Within the field of anthropology, we have long understood social groups through factors that unify them – a shared language, culture, beliefs, a shared social and emotional intelligence that allow the members of a given community to strive for common goals. But we cannot omit that, unfortunately, anthropology has also become the Western technical-scientific vehicle for the development of separation, whether that is between races, classes, and in our case — species. There does not exist a field that merges the socio-cultural lens utilized to understand the human species to analyze dynamics amongst other organisms, including microbes, not in a way that

doesn't center microbes in relation to human health and society, anyway. We understand microbes and specifically bacteria only insofar as they are relevant to humans – microorganisms' role in human metabolic function, the political implications of seeing microbes as enemies, neutral parties, or allies, and how we can suppress, and control them. The reality we often choose to ignore is that the biological and ecological landscape that surrounds us is the direct product of socio-cultural relations that long precede the evolution of human beings: we, to the demise of many speciesist evolutionary biologists, are not the originators nor the initiators of social and cultural intelligence. As a result, the question that forms is, how does this understanding of complex microbial relations change the way we understand antibiotic resistance? So far, our approach has been an attempt to outsmart these microorganisms, but what we refuse to admit is that in the cat and mouse chase that is antibiotic resistance, we are seemingly not doing the chasing.

Chapter 3

Bacterial Capital and Class Struggle

To think of ourselves as a living system, we must see ourselves in community with all other organisms at a microscopic, national and global level. While this may seem superficially easy, it is actually not. Western culture, now globally dominant, has systematically trained us to think and act as though we are separate individuals, often in competition with each other for scarce resources of one sort or another, primarily money, which has become the perceived means to all we want and need in life. Many problems that challenge us today can be traced back to a profound tension between what is good and desirable for society as a whole and what is good and desirable for an individual. That conflict can be found in global problems such as climate change, pollution, resource depletion, poverty, hunger, overpopulation, as well as antibiotic resistance. The careless production and consumption of antibiotics, advertisements for domestic hygiene products, and the general phobia of bacteria usually follow the same simple yet powerful structure: the threat of bacterial contamination looms large, but antibiotics, anti-bacterial gels, soaps, fluids, powders or foams can offer protection against it. We are encouraged to think of bacteria as entities that threaten our secluded, sovereign cleanliness. This has led us to a very limiting, and dangerous relationship with bacteria.

The caricatured sketch below (Figure 2) depicts a woman in a fashionable dress looking into a microscope to observe little monsters swimming about in a drop of London Thames water. In the 1820s much of the drinking water of Londoners came from the Thames, and much of the sewers of London simultaneously were being emptied into the Thames river (Library of Congress, 1828). A Commission on the London Water Supply was appointed to investigate this dangerous situation, and it was subsequently reported in 1828. After that report, the five water

companies which served the north bank of the river improved their supplies by building reservoirs etc., but the residents on the south bank of the river, who were predominantly lower-class, continued to receive infected water. The problems were not solved until the 1860s when London's present sewerage system was installed by the Metropolitan Board of Works (MBW) (Macpherson, 2018). Between the date of this caricature (1828) and the completion of the MBW sewers, Londoners suffered two cholera epidemics, one in 1832 (part of the world pandemic of cholera) and one in 1854. Looking at bacterial species through a microscope was a popular entertainment provided by traveling showmen, as the cramming full of many life forms into tiny spaces was an uncanny microcosm of the greater imagined, and feared, socioeconomic order in England. This anxiety-ridden combination of overpopulation and bacterial proliferation continues to be provoked in the visualization of contemporary microbes.

Bacteria are known to live in extreme proximity to each other, and this proximity is almost like an insult to the force of Western modernity, repugnant to the grid of Western science and civic control (Inglis 2014). This historical combination of factors means that bacteria became, and continue to be, a channel for fears about overpopulation, immigration, and the corruptive influence of living too closely with millions of others. We can see this when we think about how bacteria are portrayed visually. Although it is possible to take microscopic photographs of bacteria, like in Figure 1 (which I, personally, find to be absolutely fascinating), these images are generally found only in scientific and medical contexts. For the rest of the population, bacteria do not appear in a realistic way. Instead, they come to us through the filter of antibiotic commercialization and advertisements for antibacterial products. What I have come to understand is that this visualization of the ways that bacteria appear in popular culture is also a visualization of ourselves as a society. Bacteria have become a sort of projection for fears of

what we might become as a human species, and of aspects of ourselves and our society that we find it difficult to confront directly.

Disappointingly, this has disastrous consequences for global health, and for the organisms that reside on our planet, which of course includes us and bacteria. The truth is, we are stuck together: there are about five million trillion trillion bacteria on this planet, and counting; they are a complex, ancient entity. But the visual verbiage of fear, disgust and dread that has been so effective at selling antibacterial products and pharmaceuticals for well over a century has brought us to an ecological dead end. Our overuse of antibiotics is the most obvious evidence of the failure of anti-bacterial thinking, leading to a medical and ecological failure that will result in untreatable bacterial infections to supersede the urgency of cancer in the coming decades.

Figure 2. A woman drops her porcelain tea-cup in horror upon discovering the monstrous contents of a magnified drop of Thames water; revealing the impurity of London drinking water. Coloured etching. (W. Heath, Library of Congress, 1828).

Microbial Colonialism

Bacteria, and their ability to communicate are central yet largely under-theorized actants within human history. They are the biosphere's most prevalent and prolific players, and through colonies created by aforementioned quorum sensing, they assemble an infinite array of allies, influencing human life in both symbiotic and parasitic ways. A co-evolutionary approach to colonization considers how the European colonization of the Americas, Africa, and the Antipodes was precipitated through prior bacterial organization, communication and general liveliness: that bacteria colonized at least as much as humans ever did (Smithers, 2014). For instance in the case of Treponema *pallidum*, bacterial trafficking crossed the oceans in the opposite direction, colonizing already so-called "developed" nations, and inciting Europeans to engage in already-enmeshed cultural and social selections: isolating syphilitic patients, killing female sex-workers infected with syphilis, developing medical treatments such as silver nitrate eye drops and so on. Bacteria over the course of history have held up a moral mirror to the development of colonial class stratifications, pointing out the irony in the self-proclaimed "civilized" nations utilizing brutal and violent force to exterminate the most marginalized.

When analyzing the complex role that warfare plays in our collective history, the role of *biological* warfare is often overlooked. Within the overwhelming instances of medical imperialism in human history, the protagonists in social explanations of colonial events are always human (Jansen, 2014). This is not to say that the historical and social analysis of colonialism necessarily ignores disease, agriculture, chemicals, or technology, but that these are

considered as “external” factors — nature, tools, obstacles, resources – whose role is essentially considered to be passive in the greater scheme of geopolitical conflict (Smithers, 2014). Yes, perhaps the Plasmodium *falciparum* that used the bodies of mosquitoes as a vehicle for infection during World War I simply interacted with the activities of their human agents, and nothing more. But they do, indeed, simultaneously make possible a variety of social and historical processes.

Furthermore, advances in immunology show that human cells must actually cooperate with the bacteria that enters the body: immunity turns out to be a conversation between bodies and microbes. In this sense, disease becomes a relationship between pathogens and humans, and consequently, the trafficking of bacteria and other pathogens across land and oceans become political players in human history. This requires us to expand our definition of genocide, widening our understanding of the term to a greater interpretation of what harm and violence can look like. To do so, we must understand genocide as a sliding continuum that ranges from everyday practices to organized mass murder. There is a juxtaposition of our understanding of genocides — we often conceptualize them as singular events that are irrefutably intentional and violent (i.e the Holocaust, Armenian genocide, etc.) Though historical analyses of many colonial and imperial wars indicate that a more sinister end of this “sliding spectrum” exists.

Biowarfare

According to Norbert Finzsch, “historical phenomena which are commonly called genocides rest upon invisible everyday practices that do not appear on the radar of transgressions, forming different plateaus of a rhizomatic expansion, called settler imperialism” (Finzsch, 2008). Essentially, he makes a case that “low intensity” war against the indigenous populations through utilizing biological methods to drive away, decimate, or annihilate

indigenous populations is still a form of *organized* method of warfare, but historical narratives tend to ignore or downplay their violence, as the violence can be attributed to "external" factors (i.e. pathogenic infections, environmental factors, innate immunity, etc.). Bio-power, which is a concept developed by Michel Foucault and later redefined by Giorgio Agamben, was first conceived as the type of knowledge that would help the maximization of life. Bio-power, Foucault argued, emerged initially with the movement towards improved health in the course of the eighteenth and nineteenth centuries. Foucault stated, "Death was gradually ceasing to torment life so directly [...]. Western man was gradually learning what it meant to be a living species in a living world, to have a body, conditions of existence, probabilities of life [...]. For the first time in history no doubt, biological existence was reflected in political existence; the fact of living was no longer an inaccessible substrate that only emerged from time to time, amid the randomness of death and its fatality; part of it passed into knowledge's field of control and power's sphere of intervention" (Foucault, 1978). This bio-power is not only exercised over the individual body, but also over the body of groups and larger communities, through the medical control of its vitality (e.g. reproduction, mortality, health, etc.) — that is to say legislative or governmental control, and regulation of populations. Thus, if we take into consideration the time period in which the initiation of bio-power is situated, bio-power simply becomes the continuation of war in relation to race – it includes the possibility of not only destroying a political foe, but also to destroy an adversary race as a whole.

In Jansen's anthropological model of biowarfare, human behavior can affect disease transmission in four areas: (a) exposure to the agent, (b) shedding of the disease agent from an infected human host, (c) creation of man-made habitats in which the transmission cycle can be completed, and (d) diffusion of the transmission system from one place to another. Historical

findings indicate that the infection and the massacre of over 70% of the Native American population was instigated by the intentional weaponization of smallpox by European imperialists (Stearn, 1945). Although modern medicine was still in its infancy in the early 17th century, even with the limited knowledge of the time, it is reasonable to speculate that the European immigrants to the New World, and ultimately the Native Americans, understood that smallpox was a disease that could spread not only as a result of direct person-to-person contact, but also by clothing once worn by persons with smallpox.

The use of biowarfare against indigenous populations is not unique to the colonization of the Americas, but has occurred throughout history in various parts of the world. The deliberate introduction of smallpox by British settlers to the Aboriginal population in Australia is one such example of the devastating impact of biowarfare on indigenous communities. This practice can be seen as an extension of colonialism's violent project to eliminate or subjugate “othered” populations. Such biowarfare can also be seen as a means of reducing the resistance of indigenous populations to other forms of exploitation and control. The use of biowarfare, therefore, can be seen as a deliberate tool of colonialism that reflects a larger system of oppression.

Biopower, as theorized by Foucault and Agamben, operates not only on individual bodies but also on the collective health of populations. In the case of colonialism and biowarfare, this power is exerted to weaken, or eradicate the health and vitality of indigenous communities, making them more vulnerable to other forms of exploitation and control. The regulation and control of indigenous peoples' health is also a way for colonial powers to exert their dominance and reinforce their legitimacy as benevolent caretakers of “inferior” populations. In this sense, biopower can be seen as a means of perpetuating the larger system of oppression that colonialism

represents. In the 21st century, the disproportionate impact of antibiotic resistance on marginalized communities, including indigenous populations, highlights the ongoing legacy of colonialism and systemic oppression. Indigenous children in Canada are three times more likely to be infected with antibiotic-resistant bacteria compared to non-indigenous children. This underscores the need to not only address the scientific and medical aspects of antibiotic resistance, but also the social and political factors that perpetuate health disparities. The impact of antibiotic resistance on marginalized communities is indicative of a larger system of oppression that has perpetuated health disparities for generations.

The development of antibiotic resistance is closely tied to the capitalist system of medicine. The overuse and misuse of antibiotics by pharmaceutical companies and healthcare providers seeking profit has led to the proliferation of resistant bacterial strains. This can be seen as another manifestation of the violence inherent in capitalism, where the pursuit of profit takes precedence over the well-being of individuals and communities. The commodification of healthcare has led to the creation of a system where medical treatment is often driven by profit motives rather than by the needs of patients.

The links between biowarfare, biopower, and capitalist medicine suggest that addressing antibiotic resistance and improving health equity requires systemic change beyond the biomedical sphere. It requires addressing the underlying power structures and ideologies that enable and perpetuate these issues, including neoliberalism, colonialism, and white supremacy. This systemic change can only be achieved through the destruction of existing legislative, economic, and biomedical institutions, the creation of more equitable healthcare systems, and the promotion of cultural humility in healthcare practice. These changes can lead to a more equitable

distribution of healthcare resources, whilst mending out close to irreparable relationships with the bacterial species.

Chapter 4

The Predicament of Capitalist Healthcare

Within a system of capitalist model of production, those spheres that promote rapid capital accumulation, through enterprises in the financial spheres of capitalism, are given precedence over sectors that do not favor capital accumulation, such as public education and healthcare for the poor. Thus, effective demand and the expected realization of all the value components contained within a certain commodity can influence not only its distribution, but also what is produced, researched (cosmetic surgery for the wealthy versus basic medicine for communicable diseases that often disproportionately affect poorer countries and individuals), and where services and medical personnel are located (Kenneth, 2017). When a healthcare system is privatized, the goal becomes not only the provision of healthcare and the advancement of science and technology to better that end, but also the maximization of profit for shareholders. In the Global South, privatization and a rolling back of state services (promoted often through loan conditionality clauses from international financial institutions) have increasingly led to many non-governmental organizations (NGOs) trying to fill the void in healthcare provision (Kenneth, 2017).

While many NGOs are filled with honest people who are sincerely intent on alleviating poverty, illness or other social ills, others actively promote a neoliberal agenda. This can take form through engaging in privatization of state welfare functions, or fostering institutional reforms to facilitate market integration of marginalized populations. Arguments made by right-wing think tanks, neoliberals, and supporters of privatized healthcare (and neoclassical economists in general) are based on the assumptions that the public sector is notoriously inefficient and that government ownership (and even regulation) stifles innovation and

undermines quality in general (Turshen, 2019). Thus, the reasoning goes, private ownership and control are preferable to public ownership and control across the economy in general and in healthcare in particular. These organizations promote a "consumer choice model" that conceptualizes patients as consumers and relies on the invisible hand of the market to eradicate both inefficiency and poor quality. In spite of these overly confident affirmations, significant cracks in the support for the for-profit healthcare model have appeared even from commentators within the business press itself, at times going as far as advocating a 100% single payer health care plan for the United States, arguing that privatized healthcare is neither good for society nor sustainable for capitalists (Turshen, 2019). Since the 2008 global financial crash, there have been significant pushes for austerity measures across nations like Spain (and in the United States), with many of the cuts in social spending leading to partial privatizations of the health sector (Calvo, 2013). Much of the ideological support for austerity is based on the neoliberal/conservative positions outlined above, particularly on those that claim that public healthcare systems are unsustainable. Their central claim is that unlike government/public healthcare systems, private (for-profit) systems are self-sustaining. To examine this claim it is necessary to delve into some concepts neglected by neoclassical economics. The neoclassical economic paradigm would have believe that there is no such thing as value, and that exchange value has no intrinsic substance (i.e., socially necessary labor time in the production of a given commodity), and that price is all that is real, which is formed solely according to marginal utility of the goods in a market. This convenient distortion of human labor as the essence of value and the erasure of value as the central element around which price hovers due to imbalances in supply, demand and competition has both a distinct class character and real impacts concerning long-term economic sustainability. Karl Marx in Volume III of Capital demonstrated how the

surplus value produced by social labor is divided up between the industrial capitalist, merchant, financial sector (through the extension of credit and the collection of interest and speculative activities) and the landowning class (Marx, 1867). Since Marx's time, as capitalism has progressed, the relative strength of the financial sector has increased significantly, leading to their capturing of a greater proportion of societies produced value and the further expansion of the illusion that value creation arises from where it does not; i.e., that it arises from circulation or financial ingenuity. This illusion is fortified since the financial sector has grown wealthy relative to the industrial sector. In reality, value is merely siphoned from the sector where it is produced to the commercial and financial sectors.

Capitalism Doesn't Care about Your Health

So, where does healthcare fit into the picture? Healthcare forms part of the "necessary means of subsistence" of society and the worker and, like education, helps provide society with labor power, in addition to being a human right in and on its own terms. Healthcare provision is essential for the development of labor power, social reproduction, and the functioning of capitalism (Fernandez, 2015). It is a part of a set of investments (such as roads and expensive infrastructure) that individual capitalists prefer to externalize to other firms (when profit can potentially be made) or to the state (if it cannot). This reflects a tendency within capital to first bring all costs to a minimum and deal with the resulting problems later. Since taxes are also viewed as an infringement on capital available for valorization, the corporate sector lobbyists are avid to keep those to a minimum as well, and fear that any form of socialized healthcare will lead to an increase in taxes. Hence, the existence of socialized healthcare in a given society is due to societal compulsion resulting from past and present class struggles/balance of class forces.

What experience generally shows to the capitalist is a constant excess of population, i.e., an excess in relation to capital's need for valorization at a given moment, although this throng of people is made up of generations stunted, short-lived and rapidly replaced human beings, plucked, so to speak before they were ripe (Fernandez, 2015). Capital, which has such "good reasons" for denying the sufferings of the legions of workers surrounding it, allows its actual movement to be determined as much and as little by the sight of the coming degradation and final depopulation of the human race, as by the probable fall of the earth into the sun, and public health issues like AMR fall under this umbrella. In every stock-jobbing swindle everyone knows that some time or other the crash must come, but everyone hopes that it may fall on the head of his neighbor, after he has caught the shower of gold and placed it in secure hands. 'Aprés moi le déluge!', an expression of selfish disregard for problems that may occur in the future, is the watchword of every capitalist individual and of every capitalist nation.

Capital therefore takes no account of the health and the length of life of the worker unless society forces it to do so. Marx concluded Chapter 15 of Vol. I, stating that Capitalist production, therefore, only develops the techniques and the degree of combination of the social processes of production by simultaneously undermining the sources of all wealth—the soil and the worker (Marx, 1867). Hence, when capitalist logic is applied to healthcare systems (the sphere of mental and physical labor whose services are essential to social reproduction and to the capacity of humanity to labor), the tendency is for these services to be provided in inverse proportion to need. This is all the more true, since both the efficiency of industry and the global reach of capital have made access to cheap labor power abundant. In spite of Keynesian warnings of undermining effective demand, capital does not shy away from the immiseration of the working classes globally (since profit can be supply driven, as well as demand driven, particularly so in

the case of export-driven production). Capital risks undermining the essence of the very source of value creation: human labor power.7 Thus, the health of the working class as a whole is essential to the production of profit itself by protecting the actual value-producing substance of society itself (i.e., the life of the worker). That this reality has rendered itself invisible to the individual capitalist and to neoclassical economics should not come as a surprise. This is a consequence of the denial of the category of value itself, and of living, alienated, value-producing labor (both mental and physical) as the creator of exchange value. The confusion is deepened since surplus value not only does not accrue to the direct producers (workers), but also is siphoned from the industrial capitalist by the commercial (i.e., the relation between Wal-Mart and textile workers in Bangladesh or the relation between the Ethiopian coffee growers and Starbucks), and financial sectors (Martín-Moreno, 2015). So, what is the result of the privatization put forth as the solution to the "sustainability" crisis of socialized healthcare? When healthcare is treated as a commodity and becomes part of the private sector it becomes progressively more subject to the instabilities inherent within the logic of capital.

Chapter 5

From Dictatorship to Drug Resistance

The Lingering Legacy of Franco's Spain

Bacterial resistance and political resistance are two seemingly disparate phenomena, yet they share many similarities when examined through an anthropological lens. This chapter will explore these similarities, particularly in the context of Spain's history with Franco's dictatorship. By examining the ways in which Franco's regime promoted a culture of fear and repression that stifled political dissent, we can draw parallels with the emergence of drug-resistant bacteria resulting from antibiotic overuse and misuse. Furthermore, we will explore how the legacy of Franco's regime continues to impact Spanish society and contribute to the country's high rates of antibiotic resistance, despite its socialized healthcare system.

Contextualizing Antibiotics in a Francoist Dictatorship

To understand the similarities between bacterial resistance and political resistance, we must first examine the history of Spain's Francoist regime. In the summer of 1948 Alexander Fleming, known around the world as the discoverer of penicillin, visited Spain (Botey, 2016). Fleming had published his famous paper on the antimicrobial effect of the Penicillium notatum mold in 1929. During the 1930s researchers worked on methods to extract therapeutic agents from the mold, and by 1942 drug companies in the US had developed efficient methods of mass production. Penicillin was used heavily by Allied troops during the Second World War and quickly spread around the world. Smuggled supplies first arrived in Spain in 1944, with the first official batches following a year later. Its capacity to cure previously fatal infections appeared almost miraculous. It was the wonder drug which defined the new antibiotic age.

Spain was one of many overseas locales visited by Fleming during the period, and he was received with gratitude and admiration almost everywhere. But there was something different about the adulation that met him in Spain. From the moment he stepped off the plane in Barcelona he was “mobbed by members of the public, by well-wishers, by scientists and physicians, and by politicians and public figures” (Botey, 2016). Patients who had been treated with penicillin showered him with expressions of gratitude, with letters and poems lauding him as a magician, a hero, a saint. Everywhere they went, Fleming and his wife were followed by cheers and applause, and laden down with flowers and gifts. His visit was celebrated in national newspapers and newsreels. He was invited to broadcast to the nation on public radio, addressed crowds in football stadiums and bullrings, and spoke to packed halls in universities across the country. The Minister of Education gave him a medal, apparently at the special request of Franco. ‘Had I been visiting Royalty or Winston Churchill’, Fleming wrote after the visit, ‘I could not have been more widely acclaimed’ (Botey, 2016). Fleming’s reception seems particularly noteworthy given the political context of the time. It occurred during a period of post-war Spanish isolation, when the Franco regime’s ties to the fascist powers defeated during the Second World War had seen it excluded from the UN and subject to a widespread diplomatic boycott. By 1948 some of this hostility had begun to thaw, and the regime was in the process of negotiating a new trade deal with the UK. But high-profile foreign visitors to the country were still few and far between. The regime remained cut off from the institutions and debates which were shaping the post-war world, and its commitment to autocracy seemed to preclude involvement in the economic, scientific, and intellectual networks which were driving the spread of penicillin across the globe.

For the Spanish public, penicillin promised to help overcome the repression, hunger, poverty, and illness which had characterized life in Spain since the end of the civil war. Penicillin supplies were extremely scarce, managed as a privilege through government systems, or available to elites through the black market; as with other basic commodities, access to it was used as a tool to maintain social order (Rodríguez-Baño, 2007). Public responses to Fleming were not coordinated directly by the regime, but were stoked by its habits of myth-making and its promises of salvation through authority figures. They emerged from a population which had grown accustomed to worshiping heroic symbols of authority, and which was eager for scientific and technological progress to help alleviate their suffering.

It is also noteworthy the new light which the story of penicillin sheds on gender and gender relations in Franco's Spain. In the aftermath of the civil war, the regime sought to re-establish the traditional gender roles which it felt had been undermined by the modest reforms of the Second Republic. Part of this involved dissuading women from participating in the labor market, restricting access to employment, and curtailing economic rights, all with the aim of limiting women to the domestic sphere and boosting the regime's pro-natalist policies. It comes as something of a surprise, then, to discover that women played an important role in the manufacture of penicillin in Spain, and that women workers featured prominently in contemporary press and publicity about Spanish penicillin factories (Rodríguez-Baño, 2007). But their presence was both symbolically and structurally aligned with the regime's gendered values. Penicillin itself was envisaged as "a caregiver, a savior, a clean, pure final product from the manufacturing line able to cure" (Rodríguez-Baño, 2007). As such, its production was promoted as a delicate task associated with the way women provide care. Women workers were generally restricted to certain roles within the manufacturing process, of course, managed by and paid less

than men. However, there were a number of pioneering Spanish women who managed to reach senior technical and research positions within the industry, their overlooked role paralleling the significant contribution of women in the UK and US to the discovery and development of penicillin between the 1920s and the 1940s (Rodríguez-Baño, 2007).

The circulation of penicillin also forms an important part of the history of rationing, smuggling, and the black market in Franco's Spain. The 'hunger years' which followed the end of the civil war saw widespread shortages of basic goods, including food and medical supplies (Botey, 2016). Rationing allowed the regime to manage this scarcity, claiming that it was ensuring supplies would go to the most needy. In reality it prioritized the regime's supporters over those of the defeated Republic. Systematic corruption allowed regime insiders to sell supplies on the black market, making huge fortunes in the process, and further restricting access of working-class populations to basic goods. Penicillin was one of these goods (Botey, 2016), initially only available through the black market before official supplies began to enter the country, and afterwards still an important resource when distribution was controlled by a special government committee.

For many people, it was a product surrounded by risk and rumor, sought out in bars and cafes and hidden from public view. It was both a legal and illegal product, imported and distributed through legal channels, and smuggled across borders on boats and donkeys (Botey, 2016). The black market raised prices beyond the reach of many, but represented a way for others to survive privation and evade official restrictions. The regime sought to regulate its supply and stamp out smuggling, at the same time as the black market flourished and corrupt officials grew rich off its back.

From the 1950s penicillin played its part in the ‘developmentalist’ phase of the dictatorship, which witnessed the liberalization and modernisation of the economy, and which paralleled Spain’s semi-integration into the political structures of the Cold War West. Spain’s penicillin production had begun in 1950, with two factories established by joint ventures between Spanish firms and foreign drug companies which owned manufacturing patents (Botey, 2016). Although production was approved and managed by the regime’s laissez faire industrial agencies, these agreements reflected the importance of purchased foreign patents to Spanish industry by the late 1940s. In 1954 one of these collaborations, between the Spanish firm CEPA and the US drug company Merck, was expanded into a research programme for new antibiotics. The screening processes involved the analysis of soil samples to detect antimicrobial activity, integrating Spain into international post-war practices of industrial research. As with penicillin production, this screening programme featured significant contributions from female researchers (García-Martin, 2016). By 1966, the laboratory had succeeded in identifying a previously unknown antibiotic, thanks largely to the introduction of new screening techniques transferred from the US.

From the early 1970s, phosphonomycin was manufactured and marketed in Spain and licensed around the world; this drug is still being prescribed today. Its discovery was presented to the Spanish public as a proud achievement of Spanish research and the expanding, globally-integrated Spanish economy. The search for new antibiotics, of course, was driven by the fears and reality of antibiotic resistance. As in other countries, there was growing scientific and public awareness of the dangers of antibiotic resistance from the 1950s. Penicillin usage had originally been regulated by the Franco regime during the early years of scarcity, at least outside of the black market. But as supplies increased these restrictions were removed, and the

fragmented and underfunded Spanish health system lacked the structures necessary to effectively monitor antibiotic usage. It was only with the transition to democracy after 1975, and the health reforms that followed in the 1980s, that a revitalized public health system could begin to address the issue of overprescription and resistance in a coordinated manner.

Penicillin circulated in the wake of infections which spread freely across national and territorial borders (Botey, 2016). But that circulation was not a simple process. It involved the circulation of physical objects—mold samples, drug flasks, manufacturing equipment—transported by governments, drug companies, smugglers, and patients. It also involved the circulation of technical knowledge through paper (correspondence, scientific journals) and people (exchanges of researchers, study visits). And around these new products and techniques circulated the hopes and fears of ordinary people: information carried in press reports and newsreels; rumors about supply, cost and availability; faith in scientific progress; and fears about antibiotic resistance. These patterns of circulation were shaped by women, smugglers, and workers, by industrialists, financiers and politicians, and contributed to making penicillin a powerful and symbolic medicine. The case of Spain also highlights the impediments to such circulation. Particularly during the 1940s and early 1950s, the Franco regime placed restrictions on the movement of people, money and goods; government spending favored defense over science; public health was never a priority; and the regime's political isolation hindered knowledge exchange and economic cooperation (García-Martin, 2018). The creeping resistance against antibiotics reminds us that, beyond the trend towards global narratives, or any apparent homogenization through standardization, nations and national histories remain relevant within the history of antibiotics.

Chapter 6: Resistance to (Bacterial) Resistance: Public Opposition to Neoliberal Policies

Over the past decades, economic globalization and neoliberal processes have impacted deeply on the welfare states of European countries, which has led to a significant change in national policies within the context of a new supranational governmentality (Corbett, 2015). Along with the New Public Management (NPM), and the so-called processes of "endoprivatisation", nation-states have assumed a new identity, generalizing—in different degrees and intensities, depending on the country—the "mercantilising" logic within public institutions. This includes state educational systems.

The economic crash of 2007 served to intensify neoliberal practices in a large number of the European countries through the implementation of well-known "policies of structural adjustment" and "austerity," which have led to the most significant cuts in social rights known to date (Corbett, 2015). For the first time in history, governments were reducing the rights of many of their own people while further weakening the rights of more traditional denizens, migrants. Neoliberalism is in permanent change and evolution and, in a similar way, the state is mutating with it, hybridizing and restructuring itself through "innovations" and forms of governance, which are debilitating, impoverishing, and criminalizing working classes. In short, all this is fostering the birth of a new "precariat" (Corbett, 2015),or precarious reality of neoliberal futures in so called "socialized" European nations.

The violence and dispossession of neoliberal crisis that we see in nations like Spain today compounds the already tenuous conditions of many in an era marked by unhinged

financialization and a brand of ‘revanchist state politics’ that works to dissolve any collective basis for social welfare. This has brought millions of people onto the streets in numerous countries worldwide, resulting since 2010 in crucial mobilizations and citizen protests, ranging from the Arab Spring in Tunisia, Libya, Syria, and Egypt, to the Indignados Movement in Spain and the Occupy Movement in the United States (Turshen, 2019). These events were symptomatic of a historical phenomenon which was to be of deep importance, in addition to fostering the emergence of a number of social movements, aimed at challenging neoliberal practices.

Numerous citizen groups, which articulate practices of “resistance” against neoliberal logic and defend the common good, have resulted from the 15M-Indignados Movement in Spain (Gago, 2019). This movement has also been the germ of the so-called “Mareas Ciudadanas” in Spanish (or Citizens’ Tides). These “tides” are categorized by color to identify which section of the public sector they defend in the face of neoliberal austerity policies and “structural adjustment” programs. There is, for example, the “Yellow Tide,” which fights against the privatization of the public justice sector; the “Blue Tide,” which struggles against the privatization of water, defending it as a basic public good; the “White Tide,” which aims to defend public health and opposes privatization; and the aforementioned “Green Tide,” which aims to defend a system of inclusive state education in addition to fighting the privatization of state education (Gago, 2019).

Starting from this context, we analyze, first, and on a more global level, how outstanding social and citizen initiatives have been set up in recent years. These include the Indignados Movement in Spain, which strongly opposes the prevailing neoliberal worldview. In the field of education, these movements are aiming to establish synergies between progressive, critical intellectuals, and the wider educational community. Through a series of socio-educational

practices of “resistance,” they are trying to construct a new subjectivity outside that of the neoliberal performativity. Second, on a micro level, we analyze the so-called “Green Tides” for the State Education in Spain, connecting them to some of the basic dimensions of critical pedagogy.

Based on the critical analysis of current activist discourse, this chapter aims to establish a series of connections between the Green Tides’ manifesto and beliefs, on one hand, and the dimensions of critical pedagogy on the other. Specifically, this will be demonstrated by how the Indignados, in general, and the Green Tides, in particular, have developed what is known as “prefigurative politics,” while looking for visions of a society which presents an alternative to the mantra of cuts in social rights, austerity policies and other neoliberalization processes.

Furthermore, although the focal point of this section is to discuss neoliberalism in the context of healthcare, it is fundamentally critical to note the paramount role academic and social movements such as the Green Tides in education play in creating critical pedagogy (Sandoval-Almazán, 2017). Critical pedagogy can become a truly transforming practice in conjunction with these social movements. Likewise, critical pedagogy could progress more rapidly due to the drive of social movements and these, in turn, could be enriched by the contributions of critical pedagogy. In this respect, and in this pivotal point in history, we are facing an authentic example of how the dimensions of critical pedagogy can be applied to the aspirations and campaigns of social and citizen movements.

Constructing New Subjectivities Outside Neoliberal Logic: Mobilizations and Resistance in Education

The Arab Spring, the protests in Syntagma Square in Greece, the Indignados Movement in Spain, Occupy Wall Street (OWS), the challenge of citizens revolutions in Latin America, refusing follow the guidelines of the World Bank (WB) and the International Monetary Fund (IMF), among others, all represent a new collective imagery on which critical pedagogy and critical theorists in education can help to rewrite the categories of what is real (Costa, 2019). Moreover, educational movements and protests against neoliberal privatization and austerity, such as the Green Tides for the State Education in Spain and the student protests in London, both of which took place in 2011, the Maple Spring student uprising in Québec, the Chicago teachers strike of 2012, and the Chilean Education Conflict of 2014, indicate that this same type of process is active within the educational environment (Costa, 2019).

Despite the increase in, and the growing international proliferation of, these social protests, we are still far from what he calls “radical democracy”, however, the need to build new forms of educational organization from democratic and egalitarian perspectives is critical, as mentioned previously. Education must be imagined from the perspective of new, creative proposals in which cooperation among professions in education and emerging citizen social movements can experience spaces of subsistence and cohabitation. After all, critical pedagogy, in its very essence, can become an important factor in mobilizing energy within social movements. Mobilizing critical ideas is crucial to mobilizing people and movements.

A good example of this vital connection between critical pedagogy and social movements is based on a series of interviews with seven teachers/activists from OWS (Sandoval-Almazán, 2017). These teachers used five strategies aimed at fighting neoliberalism in education. First,

they unmasked the neoliberal narrative based on meritocracy, the benefits of privatization, and so on. Second, these activist-teachers introduced the topic of educational justice as a specific section of OWS within the practices of their movement. Moreover, they gave a voice to people who had been previously silenced through practices of direct and participatory democracy, such as general assemblies in which traditionally marginalized groups had a voice. Fourth, they built a strong sense of solidarity by deconstructing those narratives which have divided people and groups, such as the gap between teachers and students, or parents and children. Finally, they empowered people by means of democratic action which gave control of educational institutions over to citizens themselves (Sandoval-Almazán, 2017). Here, critical pedagogy becomes a transformative practice.

It can be deduced from the above that the collective action of the different agents which make up the educational community, in addition to the common search for spaces of resistance, is fundamental in challenging neoliberal harassment. Additionally, there is the need to generate practices of resistance, revitalizing critical approaches in education as a way of facing the falsely discourses and practices. This is the reason why critical vigilance, counter-discourses, and counter-conduct, and reappropriation are categorized as individual and collective practices of resistance which encourage critical thinking, change discourses and narratives, and look for alternative visions of life. This is a process of reconstruction of the individual which involves teachers, students, and families. In this respect, the connection which exists between the educational system and the community requires a type of educator who is committed to the idea of the public good; in other words, such resistance would insist on a professional ethos with the public good at its center.

The political dimension given to education by critical and progressive approaches is a strategy aimed at the common fight against domination. This is because education is not, and never has been, neutral. To explain, constructing subjectivity outside neoliberal performativity involves a practice of resistance in itself. To realize how neoliberalism, in its different expressions, transforms and molds us is like perceiving subjectivity as the point of contact between self and power. This process of "resistance," of the deconstruction of oneself, helps us to see ourselves with other eyes, to perceive reality through other lenses, which, in our case, transcend mercantilising logic. This kind of metamorphosis enables a critical vision of education which can be used as a tool for the transformation of social life. It favors synergies between professional groups in the socio-educational field in addition to citizen activists who advocate more democratic forms of social organization and, therefore, presents different ways of understanding the educational process. In this line, it is of utmost importance to revitalize counter-hegemonic experiences in the educational context and linking them to the transformative potential of social movements as a strategy of struggle against growing inequality in our societies. During the submerged or latent phases of movement activity, social movements experiment with alternative forms of deliberation and decision-making, generate new lifestyle and cultural practices, develop alternative solutions to social problems and, in some cases, engage in prefigurative politics (Corbett, 2015). The activities of social movements in latent phases are largely directed inward towards other social movement participants, crucially in the generation of shared or collective identities, which give a shared collective definition of the social movement that enables it to successfully resist or challenge authorities (Sánchez-Cantalejo, 2013).

From this perspective, social movements perform practices of critical education when generating autonomy, care, respect, reciprocity, and equality, as well as for their critical capacity. This is the antithesis of unitary neoliberal thinking. They reconstitute themselves outside neoliberal logic, theorizing on possible ways of being with approaches which are more collaborative and integrated, and focused on a joint and shared vision of social reality. Thus, it is precisely this aspect of the prefigurative politics in which we can find a very important link between critical pedagogy and social movements.

From the perspective of critical pedagogy, the fact that the Indignados movement mobilized such a large number of people, who had previously not participated in political protests, makes it an outstanding phenomenon to analyze. This is because it performed a critical educational process of great significance among broad and diverse segments of the population, proving that profound education processes are an indispensable precondition for steering the cultural change needed to wean people from a system of representative democracy (Corbett, 2015). In this way, these protests became open schools of citizenship where social and political knowledge was constructed in a collective and participatory way through assemblies, and where heterogeneous meanings were reconstructed through real and virtual interactivity, as well as reconstructing subjectivities beyond the neoliberal dogmatism.

The Indignados did a remarkable job in creating both critical awareness and the social construction of new subjectivities, as they embraced a strong 'awareness impact,' that is, the dissemination of a particular worldview and of what we could call in Gramscian terms an alternative common sense. Forging alternatives to alienation, developing social skills for participation in a real democracy, but, above all, questioning neoliberal "common sense," the movement led to collective learning on the practice of democracy and self-organization. It taught

us to begin to learn to unlearn to get rid of the hegemonic ideas about reality. It has helped to spread, in the Gramscian sense of the term, an *alternative* common sense.

The Indignados questioned concepts of democracy, citizenship, education, information, communication, and the prevailing political discourse. At the same time, they laid out an expansion and extension in the practice of these concepts in order to reconstruct, in a more public way, educational vision and renewed politics in accordance with modern society and its information and communication possibilities. It is in these areas the confluences between critical pedagogy and the Indignados movement are seen to have reached their most significant dimensions, in the prefigurative politics which characterizes this movement.

Working for an "Authentic" Individualism

Neoliberalism as a political philosophy involves a return to a primitive form of individualism: an individualism that is "competitive," "possessive" and construed often in terms of the doctrine of "consumer sovereignty" (Gago, 2019). It involves an emphasis on freedom over equality, where freedom is construed in negative terms and individualistic terms. Negative freedom is freedom from state interference that implies an acceptance of inequalities generated by the market.

To move away from this "negative individualism," from this distorted vision of individual wisdom, critical education aims to create a genuine form of individualism. This is an individualism which has political rights and connects to economic, social, and cultural dimensions. By rejecting the abstract and selfish individual, typical of neoliberal capitalism, this authentic individualism promotes harmony within the wider social and democratic context in

which the subject is inserted. It is actually about respecting the individual, provided that the individual's rights do not endanger the common good.

Thus, against the idea of a competitive individualism, more typical of the neoliberal model, the Green Tides for the State Education propose, in their document "Bases para una nueva Ley de Educación", a nondiscriminatory form of education which guarantees the inclusion of all citizens (Sandoval-Almazán, 2017). They hold that inclusivity is inherent to state education. On the basis of equal rights, they advocate allocating more public resources to those who need them the most. Furthermore, under this redistributive principle applied to state education, they defend the right "to configure the curricula from an intercultural and inclusive approach, promoting the recognition of students from migrant and minority families, sexual diversity and gender equality" (Sandoval-Almazán, 2017).

Advocating an inclusive approach to state education reinforces the idea of working for an authentic individualism. Starting from the principle that everyone has the same right to a quality state education moves away, at least theoretically, from approaches focused on the competence of both resources and results. The participants in the Green Tides are fully aware that not all students start from similar family, economic, and social situations. This situation, widely contrasted by the academic literature, conditions the concept of some alleged "equal opportunities" which is increasingly used to justify the social and economic inequalities which are clearly visible in society (Corbett, 2015). Advocating inclusive models is to publicly defend more solidary positions, while moving away from a discourse which is biased in favor of a more competitive and possessive individualism.

Conclusion

The emergence of antimicrobial resistance (AMR) is a complex issue that, as demonstrated in this thesis,requires a multidisciplinary approach to be solved and ultimately, eradicated. The research and discussions conducted in this thesis have highlighted the role of medical, cultural, historical, and political factors in contributing to the rise in neoliberal healthcare policies, and as a result, the development of AMR, particularly in Spain. The normalization of antibiotic use during the Franco era, coupled with the profit-driven healthcare system, has led to a culture of overuse and misuse of antibiotics, which has contributed to the emergence of drug-resistant bacteria. However, the problem is not unique to Spain, as the misuse of antibiotics is a global issue that affects both humans and animals. To tackle AMR, there is a need for a comprehensive approach that involves not just the medical community but also policymakers, economists, and social scientists. One approach that has gained momentum in recent years is antibiotic stewardship, which promotes the responsible use of antibiotics to preserve their effectiveness. This involves education and training for healthcare professionals and the public on the appropriate use of antibiotics, as well as the development of guidelines and protocols for prescribing antibiotics.

However, as outlined in the latter half of this paper, antibiotic stewardship alone is not enough to reverse the damage caused by neoliberal policies. There is a need for a broader systemic change that involves dismantling the capitalist system that drives the profit motive behind the pharmaceutical industry. The focus on profit maximization rather than public health has led to the development of antibiotics as commodities, which has contributed to overuse and misuse of antibiotics. The solution lies in a healthcare system that prioritizes public health over profits, where the development of antibiotics is driven by public health needs rather than market

forces; in the education system that has conditioned us into not asking the important questions; and the socio-political systems that profit off the backs of the sick. In conclusion, the issue of AMR is a global challenge that requires a comprehensive and multidisciplinary approach. While antibiotic stewardship is a step in the right direction, it is not enough to reverse the damage caused by AMR. To achieve a sustainable solution, there is a need for a fundamental shift in the healthcare system that prioritizes public health over profits. The destruction of capitalism, coupled with antibiotic stewardship, offers a promising way forward in the fight against AMR.

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