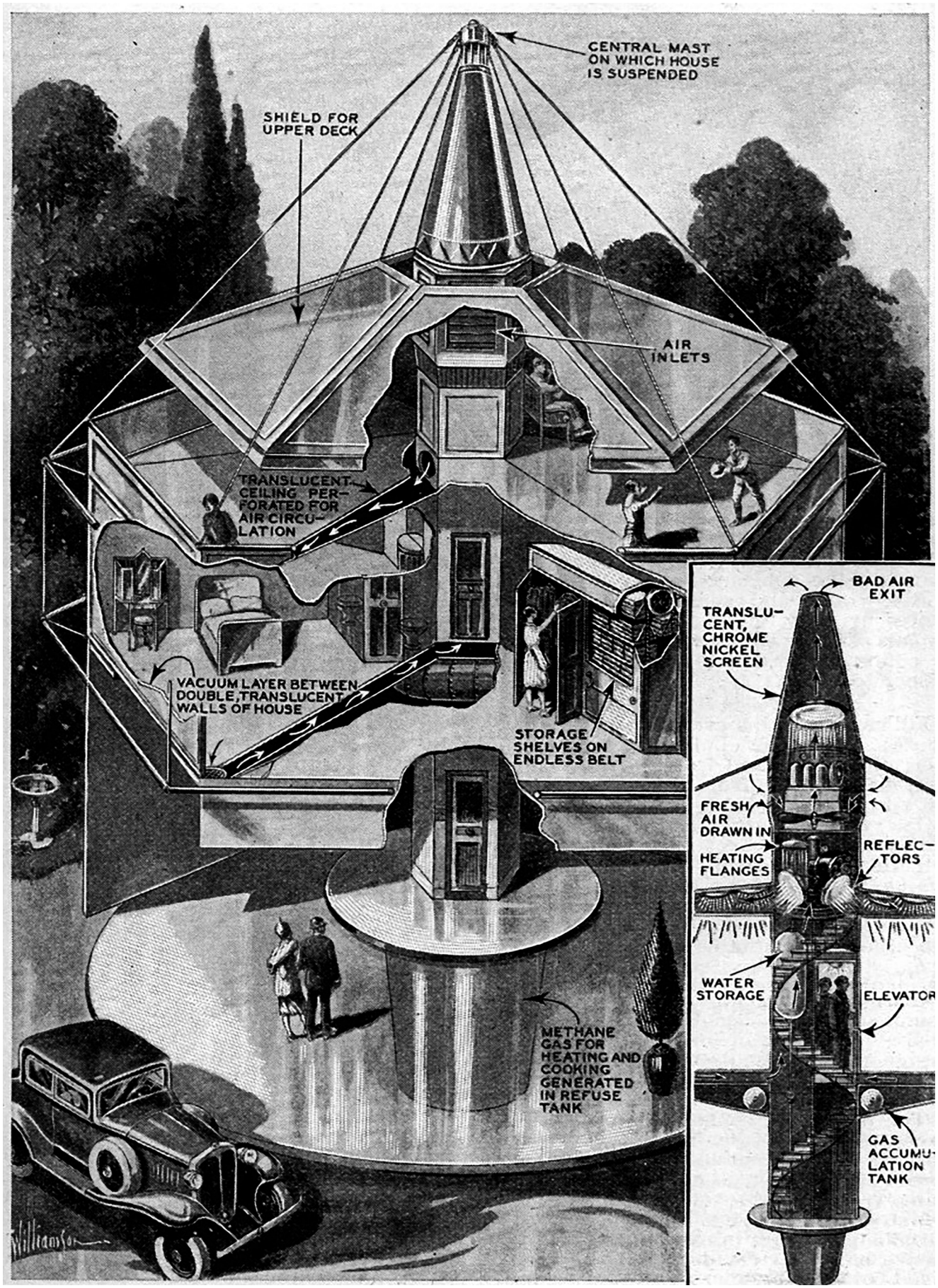



**Buckminster Fuller, cut-away drawing of Dymaxion house showing anti-bacterial self-cleaning technologies.**
**© Illustration from *Modern Mechanix and Inventions*, September 1932.**

# The Bacterial Clients of Modern Architecture

BY BEATRIZ COLOMINA AND MARK WIGLEY

The human is an unstable idea; simultaneously an all-powerful creature – capable of transforming the whole ecology of the planet – yet extremely fragile, a murky ghost.[1] Contemporary research into our microbiome portrays the human itself as a mobile ecology constructed by the endless flux of interactions between thousands of different species of bacteria – some of which are millions of years old and others joined us just a few months ago. This challenges conventional understandings of architecture. What does it mean to house the human when we no longer think that the human organism is securely contained within its skin? What is the role of architecture when the humans occupying it are understood to be suspended in clouds of bacteria shared, generated and mobilized by other macro-organisms (pets, plants, insects...) and the building itself; when the human is not a clearly defined organism or in any sense independent; when the architectural client is a massive set of ever-changing trans-species alliances that make the apparent complexity of even the largest of cities seem quaintly uncomplicated. What kind of care do architects offer if we think of ourselves as alliances between bacteria within the apparent limits of the body and throughout the spaces we occupy? What faces 21st century architects in comparison to 20th century architects?

## 1.

A hundred years ago, Modern architecture explicitly defined itself in opposition to bacteria. If architecture shelters the human, the first responsibility was now to offer shelter from microbes. Modern buildings were modern only inasmuch as they offered a prophylactic defense, a visible filter of the invisible microbiological environment. Smooth white surfaces, expansive glass, and sun terraces were primarily instruments of health.[2] The buildings were understood to be cleansing machines that must themselves be constantly cleansed but also exhibit their cleanliness, exposing anything unmodern in their vicinity as a form of dirt, a stain to be promptly removed in order to preserve the wellbeing of the human.[3] The limits of the modern building preserved the limits of the human by keeping microbes at bay. Modernizing architecture was first and foremost a medical procedure to evict millions of tiny threatening organisms.

Bacteria shaped Modern architecture, even acting as its invisible client. Buildings were formed by what they excluded rather than what they included. Physical, mental, moral, social and economic health were dependent on the apparent cleanliness of buildings, as conveyed by routine esthetic descriptions like "clean lines" and "pure form." The building itself was envisaged as an organism – a body with its own skeleton, organs, circulation system, nerves, skin and metabolism – and the architect a biologist, even a bacteriologist. Human health was seen to be dependent on the health of buildings. Truly modern buildings would radiate health and health would be as contagious as any virus.

Yet architecture needed to be cured before curing its occupants. It was seen to be deeply infected. 19th century architecture was demonized as nervous, unhealthy, and literally filled with disease, especially the bacilli of tuberculosis – the ongoing major disease threat of the time. Decorative excess was itself treated as an infection. Modernizing architecture was firstly a form of disinfection, a purification of buildings leading to a health-giving environment of light, air, cleanliness, and smooth white surfaces without cracks or crevices where contagion might lurk. Sigfried Giedion (1888-1968), the most influential historian-propagandist of the Modern Movement, insisted that the "moral" rejection of the "infected atmosphere" of ornamentation was the movement's real source since the 1890s.[4] Architecture was an unwell "organism" and "the wall had first to be cleansed of all decorative eruptions of the 19th century. There had to be a rediscovery of the esthetic values of the pure surface plane."[5] Le Corbusier (1887-1965), the loudest and most persistent architect-propagandist, argued that this act of disinfecting architecture with smooth white walls offered both physical and mental hygiene. *The Decorative Art of Today* of 1925 insists that the cleanliness of modern buildings modernizes minds, even incubates a new brain:

> *"His home" is made clean. Then there are no more dirty, dark corners. "Everything is shown as it is." Then comes "inner" cleanliness, for the course adopted leads to refusal to allow anything at all which is not correct, authorized, intended, desired, thought-out: no action before thought. (...) On white ripolin walls these accretions of dead things from the past would be intolerable: they would leave a mark. (...) The white of whitewash is absolute... Put on it anything dishonest or in bad taste – it hits you in the eye. (...) The tasks of our age – so strenuous, so full of*

*danger, so violent, so victorious – seem to demand of us that we think against a background of white.*[6]

Cleansing architecture of the disease of decoration produces a therapeutic image of white walls, white table, white porcelain and some flowers – "healthy, clean, decent," "neat and clean, pure and healthy"[7] – that in turn acts as a cleansing device for exposing and editing out anything unmodern. Cleanliness becomes synonymous with multiple gestures of stripping things down to essentials: "Throughout, all is clean, concise, brief, economical, intense, essential."[8] The white wall is clean because it is less and makes less become contagious.

The sun-drenched plain whitewashed walls of vernacular houses on the Mediterranean famously acted as Le Corbusier's model but even those walls were under threat from the "dissolving virus" of industrialized ornament transmitted around the world by popular images in the latest international media.[9] Le Corbusier cites his own travel notebooks of 1911:

*we ourselves carry the deadly germ... a cleaning out is a vital necessity, and since people have no wish to perish, they will return, yes, to health and thereby to beauty, out of simple desire to live.*[10]

The eventual book on that early journey described the contemporary love of machine-made ornament as a "dreadful germ," an "infectious germ" that ruins vernacular cultures and needs to be eradicated to recover health: "Purification is a vital necessity, and as we avoid death by the simple desire to live, we shall return – yes, to the health that belongs to this epoch, a health appropriate to our contingencies, and then from there to beauty. Throughout the world *we are recovering*... No one wants to die."[11]

Modern architecture was prescribed as a medical recovery. Health and beauty were inseparable. Beauty was even a product of health, just as the brain, in turn, was a product of beauty. For Le Corbusier, the technologies shaping modernity are intrinsically healthy. The history of technology itself is understood as a form of purification that progressively discards excess in the name of efficiency. In reverse, ornament is by definition anti-technology, anti-health. *The Decorative Art of Today* argues that with the early 20th century avant-garde movements of Futurism, Expressionism and Constructivism, the spirit "is still feverish, but this time there is a promise of a cure (...) thanks to purifying technology."[12] Modern technology will paradoxically recover the pre-technological "purity" that unites the 20th century human with their uncontaminated origins. Humanity will finally cure itself.

The 1923 manifesto *Towards an Architecture*[13] argued that most fundamental architectural gesture is to define the human by separating its organism from nature: "A house that will be this human boundary that encloses us and separates us from antagonistic natural phenomena, giving us, we men, our human milieu."[14] The human becomes human with architecture. But the antagonistic nature that now needs to be kept at a distance is bacteria. Unhealthy buildings have turned their occupants: "We are unhappy living in unworthy houses because they ruin our health. (...) The house eats away at us in our immobility, like consumption (Tuberculosis). We will soon need too many sanatoria."[15] The clear lines and Spartan smooth surfaces of medical facilities are urgently needed to recover the clearly defined outline of the human.

## 2.

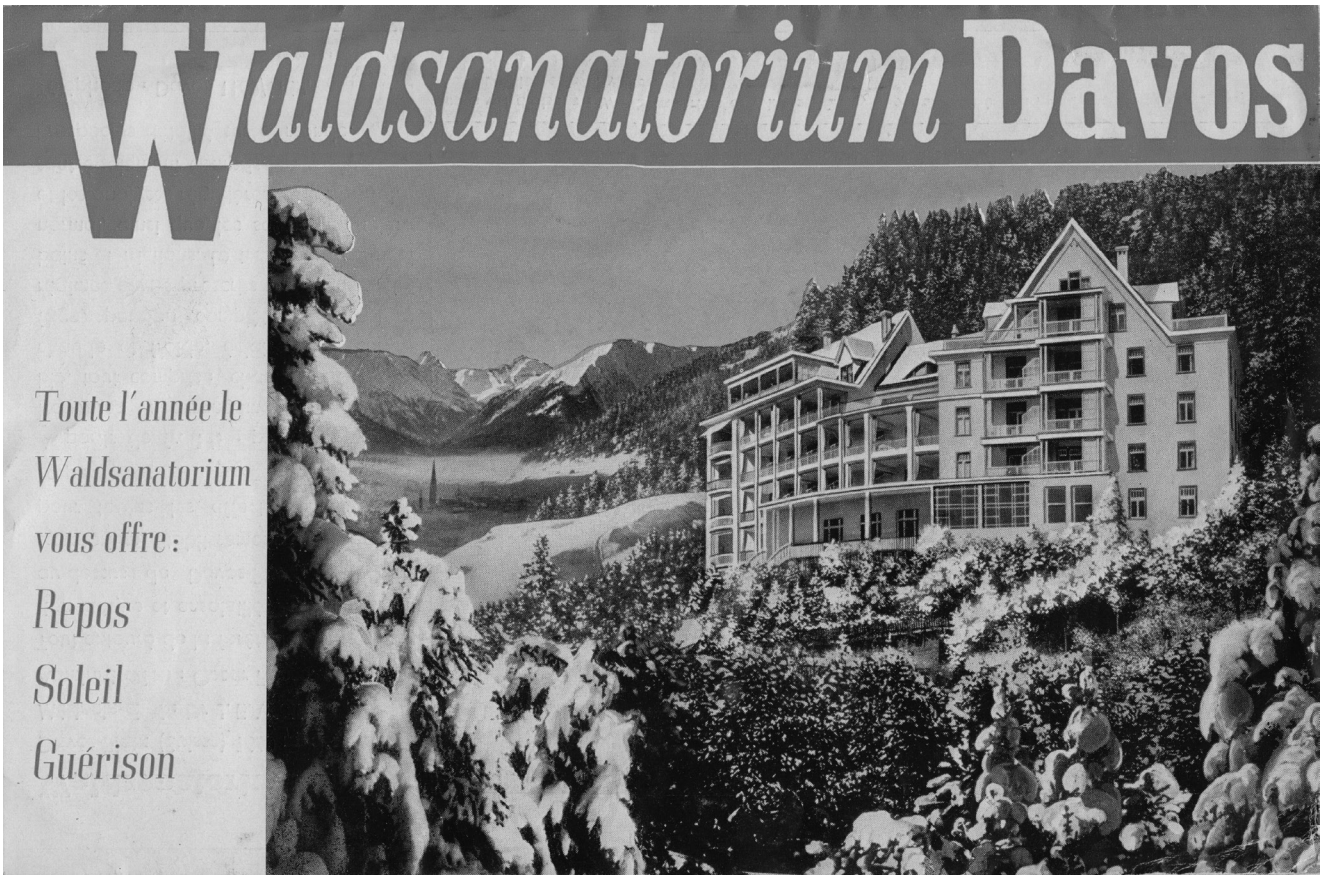
This entire medical and esthetic prescription – air, light, cleanliness, smooth surfaces, undecorated simplicity, utility rather than excess, and white walls – was made in face of the ongoing crisis of tuberculosis. Modern architects directly absorbed the design principles instituted by late 19th century tuberculosis sanatoria into all building types as both prevention and cure.[16] These principles had, in turn, been directly inherited from the sanitary reform movement. This massive movement – launched in England and France in the 1830s and spreading rapidly through the rest of Europe and the United States – was a response to waves of devastating epidemics blamed on the urban effects of industrialization and turned into law as a way of sustaining industrial development and social control even if couched in terms of a new concept of "public health." Architecture itself was identified as the cause of disease and therefore the only way to resist it. Doctors started acting as architects and architects as doctors.

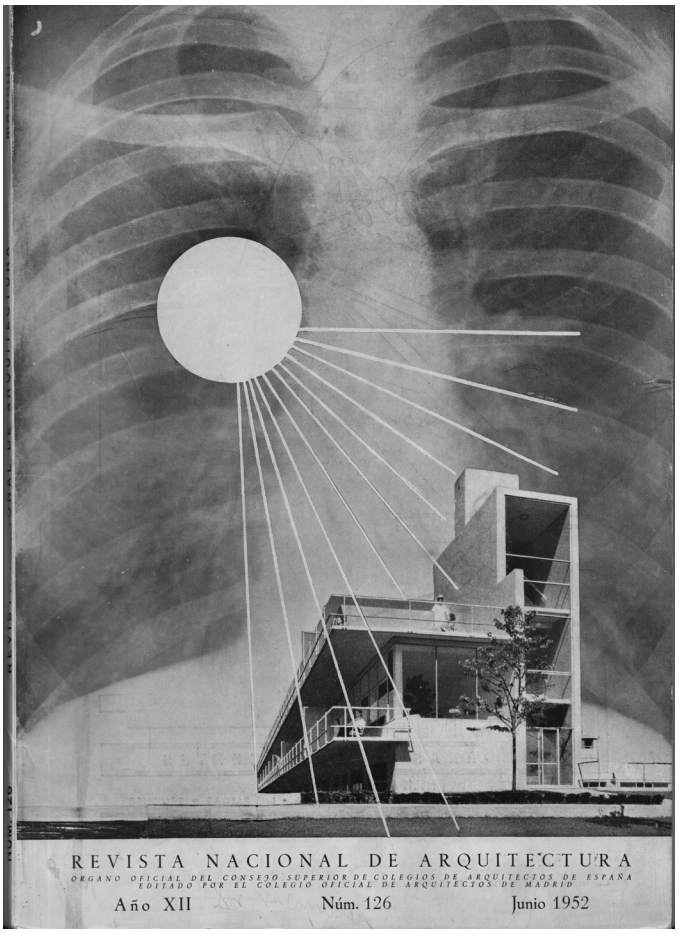
In 1883, for example, *Our Homes and How to Make them Healthy* of 1883 – a 947 page compendium of articles by doctors and architects edited by Shirley Foster Murphy (1841-1923) who was just about to become chief medical officer of London – began by arguing that the unique human ability to make buildings as protection against the external environment had "constructed" disease:

*Man, by a knowledge and skill not possessed by the inferior animals, in building cities, villages, houses, for his protection from the external elements, has produced for himself a series of fatal diseases, which are so closely associated with the productions of his knowledge and skill in building as to stand in the position of effect from cause. "Man in constructing protections from exposure has constructed conditions of disease."*[17]

Architecture itself had to be treated as a pathology. The 92 chapters of the book systematically identify the unhealthy conditions of every architectural element: site, foundations, roof, floors, walls, windows, layout, corners, plumbing, joints, finishes, plaster, paint, wallpapers, carpets, curtains, blinds, ornament, moldings, cornices, mortar, absorbent surfaces, etc. The primary enemy in the urgent battle for health is the accumulation of dust, dirt and filth that harbors disease. Anything that attracts such build-up has to be removed in favor of smooth washable surfaces. The enemy is organic, decomposing traces of the human, excrement from the gut, lungs and the pores of the skin that are absorbed by the building or accumulate in its linings, ornament, unnecessary complexities, crevices, cavities, and coverings. The house can only shelter the human by being cleansed of human traces.

**01** Publicity brochure for the *Waldsanatorium*, Davos, Switzerland, 1911.




**02** Cover of the *Revista Nacional de Architectura*, June 1952 with an image of William Ganster and William Pereira Lake County Sanatorium, Waukegan, Illinois, 1939, superimposed on an X-ray of lungs.

The healthy house needs to be detached from the human in order to cure the human. Dust means disease. Light is cleanliness. Darkness is a form of dirt.

As with Le Corbusier, the cleansing is mental, moral, and modern. The simplification of surfaces reduces stress on nerves, producing a "healthy" decoration through an esthetic sanitation of the visual field that rebuilds the morality of the occupant.[18] The very call for the removal of anything useless is again treated as a form of sanitation, removing sources of dust and dirt, but also cleaning the eye, organization patterns, mechanical operations, and the mind.

Throughout the book, the requirements of a healthy house are the same as for a hospital, with so many people sickened by their dwellings that homes were paradoxically also hospitals. There are extended chapters on "home hospitals" (turning housing into public hospitals) and the need for designated "sick rooms" within private houses.[19] The specific "directions" to follow are those of Florence Nightingale (1820-1910), the activist nurse whose *Notes on Hospitals* of 1859 called for ventilation, large windows, cleanliness, smooth floors without gaps and white walls (polished to be sealed, reveal dirt and increase light levels), simple plans with few corners, minimal utilitarian furniture and no extraneous fabrics or decoration.[20] In her most famous book, *Notes on Nursing* of the same year, this architectural prescription was immediately applied to "preserving the health of houses."[21]

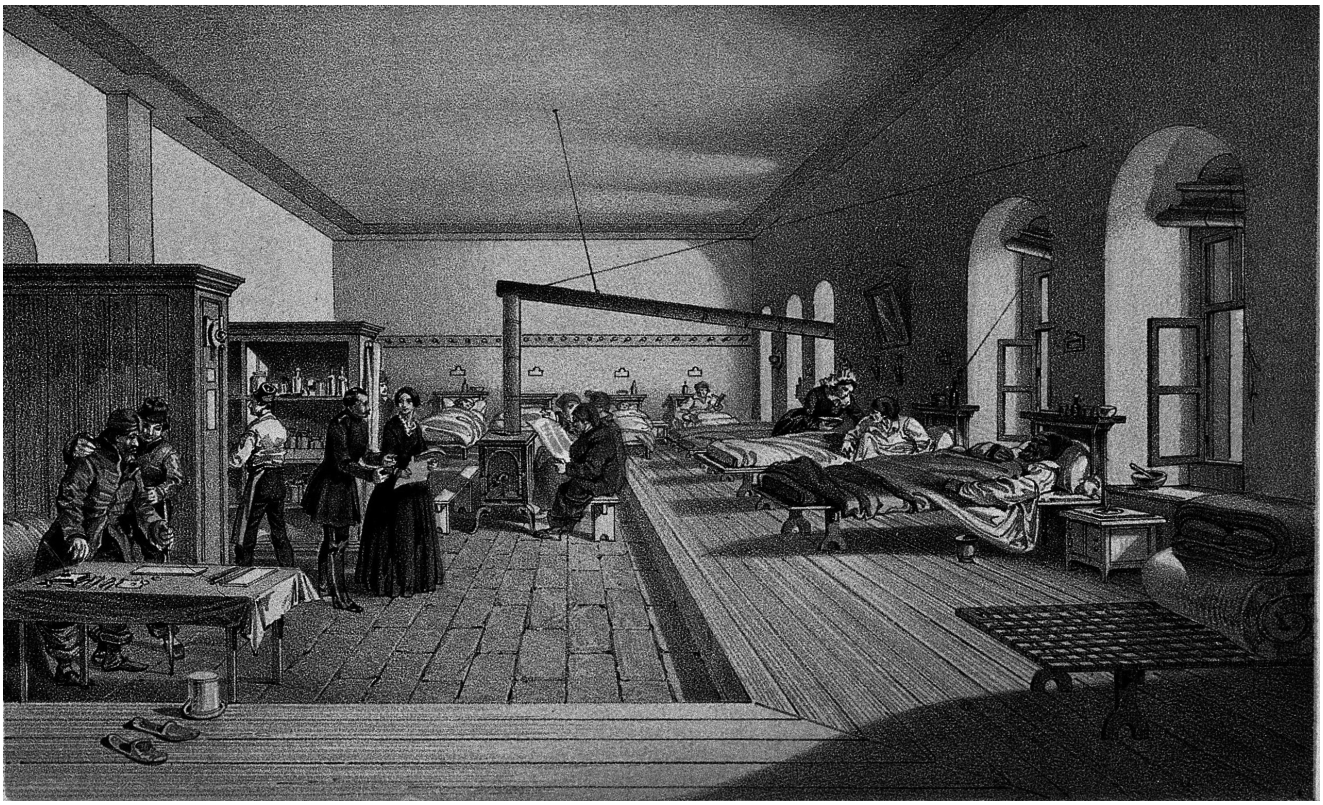
Nightingale advocated an environmental theory of disease – where environment specially means the human environment, human-made conditions of inhuman life. Disease was the product of "organic matter" attaching itself to every surface only to foul the air and thereby return to sicken the human. The Nightingale prescription was to develop systems whereby anything coming out of the human body passes through the building to the outside via disposal systems that don't leave a trace on the building or city – starting with bandages, clothing, bedding, furniture, and room surfaces. The idea was to relentlessly clean the body of the building and the body of the human, flood the space between them with health-inducing fresh air and light, then keep that space under constant surveillance. As with Le Corbusier, the blankness of a wall surface from which all human traces have been removed allows the human to restore itself physically and mentally. Nightingale wrote extensively on the need to reduce noise and visual complexity to calm the nerves of patients so that the body could cure itself.

Nightingale had taken over the role of the main spokesperson for the sanitary reform movement in England from Edwin Chadwick (1800-1890) whose 1842 statistical report to the government on the unhealthiness of the modern metropolis (drawing on data, observations and recommendations from medical officers throughout the British Isles, along with reports from France and Germany) had led to the first public health laws in 1848 that would be echoed throughout Europe and included the public imposition of "whitewashing, cleansing, or purifying" of houses on private home owners and occupiers.[22] Yet it is better to understand such figures as symptoms of a broad, multi-disciplinary, international movement rather than its instigators or leaders. The arguments were being made in an extremely wide range of professional and popular journals, newspapers, exhibitions, associations, parliamentary debates, and the courts. Nightingale's architectural protocols had already been formulated in diverse texts by others on hospital design, home hospitals, sick rooms and domestic interiors.[23] The massive infrastructural work of constructing urban clean water and sewer systems in the face of devastating epidemics like cholera and typhoid fever wanted to head indoors from the beginning. In fact, Chadwick's report began with a discussion of the unhealthy interior of working-class dwellings before talking about the unhealthy exterior and the interrelationship between them. It was all a matter of social engineering. Cleaning the street is inseparable from cleaning the home that supposedly encourages people to clean themselves, which increases morality, respect for law, and productivity. The domestic interior becomes the basis of national regimes of surveillance, discipline and control.

But Chadwick's recommended strategies for compelling the cleaning of dwellings, removing ornament, smooth surfaces and white walls were already well established.[24] Deep cleaning of buildings, furniture and fabrics followed by white-washing had been the standard strategy of disinfection imposed as a "police action" since the early 1830s, in the face of cholera , that was itself based on the imposed deep cleaning and whitewashing of dwellings at the turn of the century in response to small pox infections.[25] Public legislation increasingly entered private dwellings throughout the century to carry out these cleansing actions out.[26] The real innovation of the sanitary reform movement represented by Chadwick was to transition from using this strategy to cure infected houses to using it to make houses that prevented infection.[27] Architects were immediately mobilized by the concept of preventative health-inducing buildings.[28]

The sanitary reformers rejected the theory of contagion (infection through touch) for most diseases in favor of the atmospheric concept of miasma (foul air) but had no problem in absorbing the germ (bacterial) theory of contagion once demonstrated in the laboratories and field tests of Louis Pasteur (1822-1895) and Robert Koch (1843-1910) in the early 1880s, even deploying it to their own ends. As Bruno Latour (1947-) has shown, the sanitary reformers actually propelled the bacteria theory, not just absorbing it but accelerating it way beyond the available evidence at the time.[29] The huge 1884 health exhibition in London, for example, (where all the writers of *Our Homes and How to Make them Healthy* played a prominent role) already included a working biological laboratory demonstrating the techniques of Pasteur and Koch's work, with banks of microscopes for the public to looking at living bacteria. All the environmental protocols remained in place with the new theory, since they were, by chance, all effective against bacteria – with experiments of the late 1870s having shown that bacteria were, indeed, harbored in dust and that

**03** Richard Döcker, Waiblingen Sanatorium 1928, patients on the stepped terraces. © Illustration in Sigfried Giedion, *Befreites Wohnen*, 1929.



**04** Lithograph of Florence Nightingale in one of the renovated wards in the hospital at Scutari (Turkey) during the Crimean War, 1856, exhibiting the spaciousness, light, ventilation, and whitewashed walls that she advocated. © Tinted lithograph by E. Walker after W. Simpson. Wellcome Collection.

sunlight rapidly kills them. When these countless billions of invisible bacteria became the main actors, and needed to be evicted from buildings, the call to modernize architecture and the strategies to do so remained the same. If anything, it simply took on a whole new level of urgency.

## 3.

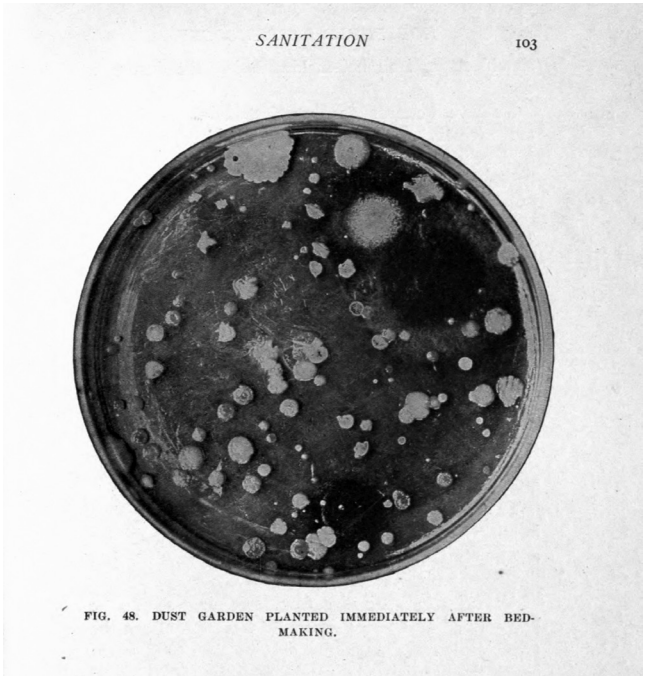
This discourse at the intersection of medicine and architecture was fully absorbed by subsequent generations of architects. Not by chance does the first book simply entitled *Modern Architecture*, published by Otto Wagner (1841-1918) in 1896, identify the two main conditions demanded by "modern man" as: "The Greatest possible convenience and the greatest Possible Cleanliness." Anything inconsistent with utility and hygiene "will prove incapable of living."[30] The text insists on "the fact that artistic effect is inseparable from cleanliness" and that architects have to keep abreast of the field of hygiene because "these modern achievements demand truly new artistic forms."[31] The need for "smooth surfaces," "systematically cleaning,"[32] light and clean air are just demands. Wagner complained about Vienna's "cultures of bacteria" and "hygienic practices that cannot be sufficiently condemned"[33] as opposed to the "more habitable, healthier, cleaner, and more beautiful" examples to be found in well planned German cities.[34] Unsurprisingly, Wagner favored smooth white surfaces and suggested that hospital rooms be the models for all domestic spaces.

Wagner's student Leopold Bauer went further in an 1899 book that equated utility and simplicity with cleanliness, physical exercise, and modern clothing. The "simple, clear, prismatic basic forms" with "large white wall surfaces" of vernacular houses in Capri were the model – along with the latest English designs and attitudes to hygiene. In contrast, the excessively ornamental woodwork of the Austrian interior attracted dust and dirt that needs to be "repelled" by smooth shiny surfaces in a "war on dust" to be fought in the streets and in interiors.[35] Bauer's colleagues (his fellow architects in the Vienna Secession and his two classmates at the Brno technical college a decade earlier, the permanent rivals Josef Hoffmann and Adolf Loos) disagreed about almost everything yet collectively turned Vienna into the epicenter of the sanitary aesthetic of white.[36]

Similar arguments for "hygienic" buildings, the codification of smooth white surfaces and use of hospital rooms as the model, were made by many architects in the first years of the 20th century.[37] It was a time in which popular magazines were relentlessly insisting on white as the basis of cleanliness in domestic management (on walls, counter-tops, towels, sheets, table cloths, aprons, etc.). An 1898 article by the feminist writer and home economics pioneer Helen Campbell in the magazine *House Beautiful* even argued that "the microbe" had been the most active promoter of advanced interior design: "without him the best forms of interior finishing would still be but the dream of the too-progressive architect."[38] Architects had unwittingly devoted themselves to making perfect "lodging" for microbes with layers of ornamentation and were only just catching up to the call for "smooth surfaces" without cracks to remove the "housewarming" they had long offered invisible microbes. Women were advised by fellow home economics founders like the scientists Ellen Richards (1842-1911) and Sophronia Maria Elliott to leave out petri dishes to see if any bacteria had survived their cleaning routines. With these exercises in "household bacteriology," a magnifying glass or preferably a microscope was recommended as a standard domestic tool to study the "colonies" of different bacteria in response to different cleaning strategies in each part of the house.[39] The house itself was to be treated as a laboratory presided over by the housewife-bacteriologist.

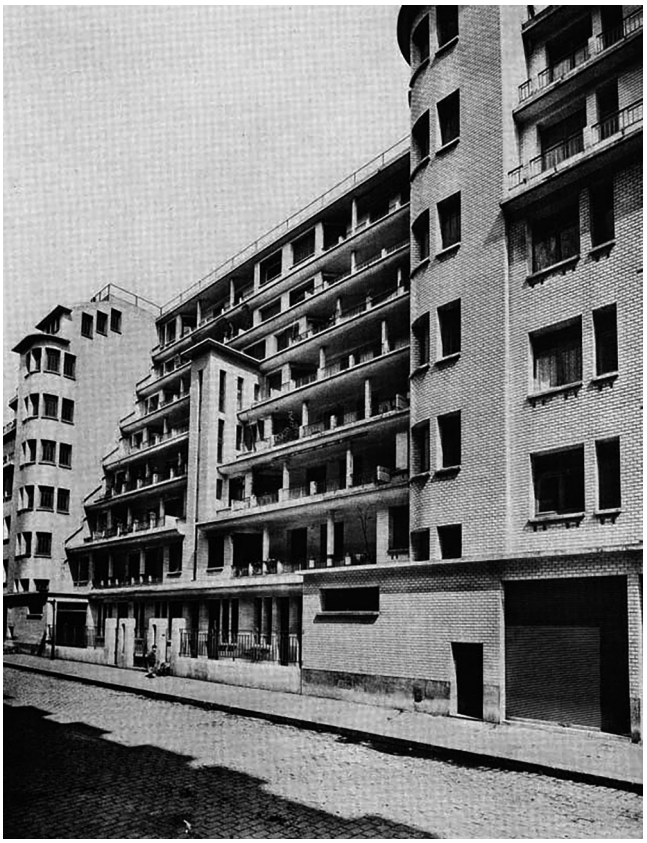
Architects typically pursued the protocols of hygienic architecture in projects for worker's housing but also middle or upper class dwellings and civic buildings, in close collaboration with doctors and social reformers. Many were on government commissions or medical committees, publishing books on the subject and establishing building societies devoted to it.[40] The very idea of social reform was treated as a medical act, with a concept of social hygiene and a thinly-veiled undertone of eugenic purification of "the" species.[41] The white code was unambiguously racial. Even the advice to housewives to defend the house against bacteria was understood as the defense of a white race. A clean environment was equated with a "pure" race.[42] The threat was both external – bacteria as the invasive alien – and internal – with the need to expel all excreted traces of the inhabitant in a kind of reverse xenophobia of the body's own interior by creating highly surveilled borders to keep what was once inside emphatically outside. Le Corbusier's insistence that a law requiring smooth white walls in all houses would be "a police task of real stature and a manifestation of high morality" simply restated the original sanitary reform argument that clean houses produce clean bodies and minds that had already been written into the law as a matter of racial purification.[43]

Le Corbusier and his post-war colleagues inherited rather than invented a set of architectural protocols that rehearsed the environmental theory of disease in the name of bacteria, preserving the basic idea of removing traces of the human from buildings and calling for the smoothest surfaces of building and body and the associated culture of surveillance. At the intersection of miasma and contagion, Le Corbusier published statistics on the huge number of bacteria per cubic meter in the air of Paris streets and insisted on the need for "exact air" that is "freed of dust, disinfected," "purified" like the water supply to prevent epidemics.[44] This bacteria-free air circulating inside buildings independent of the outside air was to be the very "cornerstone" of modern urbanization and a rebirth of the human: "I place man in a new environment: he is strong, smiling, healthy. Illness suffers a crushing defeat."[45] The "artificial" environment essential to human wellbeing is a disconnection from bacteria. The basic principle is disinfection and isolation, the core defense against epidemics. Modern architecture is an epidemiological strategy. Le Corbusier described his architectural work as that of a bacteriologist, just as Giedion would of history writing.[46]




**05** Bacteria grown in petri dish immediately after bed making.
© Illustration in S. Maria Elliott, *Housebold Bacteriology*, 1904.

**06** Leopold Bauer, kitchen of Villa Kurz, Jägerndorf, 1902-1903.
© *Dekorative Kunst*, Vol. 8, 1905.



**07** Henri Sauvage and Charles Sarazin, "hygienic" housing absorbing the sanatorium logic with stepped sun terraces and complete cover with white ceramic tiles, Paris, 1922. © Illustration from *L'architecture vivante*, spring, 1926.

**08** Le Corbusier and Pierre Jeanneret, entrance to Villa Savoye, 1929.
© Illustration from *OEuvre complète Volume 2, 1929-1934*.

With the canonic Modern architecture of the 1920s, the almost century-old sanitation strategy targeting ornament and crevices in the name of smooth white walls and utility was no longer a way of treating infected architecture or using architecture as a form of preventative treatment against infection. It was not something done to or with architecture but was now the very sign of architecture itself. Le Corbusier's innovation was simply to edit anything out of buildings that didn't contribute to the logic and esthetic of sanitation. He didn't just polemically flaunt white porcelain cleansing equipment in living spaces.[47] The whole building had become a piece of sanitary equipment.

Le Corbusier was an extreme symptom constructed by the diseases he resisted, yet was far from alone. Buckminster Fuller (1895-1983), for example, was convinced that the death of his first child in 1922 in Chicago at the age of four was caused by the unhealthy quality of the apartment they were living in and devoted himself to a self-cleaning and filtering architecture with relentless anti-bacterial details like no crevices for harboring germs or door handles to distribute them, the obsessive design of sanitary equipment and even microscope photographs of bacteria on the skin of his students.[48] There were no white walls in Fuller's architecture since even walls were evicted in favor of "healthy" 360 degree windows. Fuller the germophobe was an extreme case of what would be a generic sustained logic. Charles Eames (1907-1978), John Entenza (1905-1984), Eero Sarineen (1910-1961) and Herbert Matter (1907-1984), for example, re-asked Le Corbusier's question "What is a House?" in 1944 – a year after the discovery of the antibiotic streptomycin but five years before it was successfully used on patients to cure tuberculosis. The industrialized house of the near future would feature an array of anti-bacterial technologies in addition to chemical sprays which guard against insects for six months, including: a device for electronically cleaning air of bacteria, a "bacteria destroying" lamp in the refrigerator, and sterilization lamps "the rays of which destroy bacteria, can arrest the spreading of infectious diseases" in water and storage units.[49]

This matches the anti-microbial obsessions of post-war domestic life with its ever-expanding array of disinfecting chemicals, application methods, and cleaning protocols targeting the bacteria on different surfaces of buildings, furnishing, appliances and people. The filters once found only in laboratories and hospitals migrated into the home to sanitize the water and air and a kind of hygienic glow became the very mark of domesticity – reinforced by ever-expanding medicine cabinets targeting different parts of the body's interior.

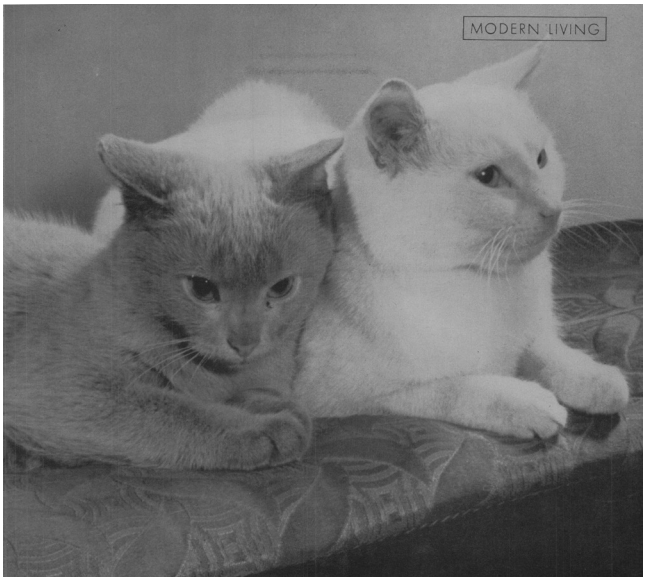
## 4.

Today this paradigm of relentless defense against bacteria is understood to be a direct threat to human health. The sick building syndrome, for example, is paradoxically produced by the supposedly clean, isolated and air-conditioned works of Modern architecture. The prophylactic line between inside and outside is unhealthy. In fact, the latest science supports the late 19th century argument that the very ability of humans to define a protective interior with architecture is the source of illness.[50] The oldest traces of infectious diseases like tuberculosis are found in 9000 year old Neolithic settlements that coincide with the earliest agriculture and domestication of animals.[51] These diseases are a product of architecture and have co-evolved with their human host, where the host is now understood to include buildings as a living part of its organism. There was never an uncontaminated architecture and that very concept is a threat to the human.

According to the "hygiene hypothesis," the reduction of infections in urbanized society has fed the rise of allergies and auto-immune disorders linked to cancers, diabetes, depression and neurodegenerative disorders like Alzheimer's. The argument is not against domestic or personal cleaning and regimes of public health, but the multiple logics of isolation in contemporary urban society that reduce microbial diversity. More precisely, our effort to detach ourselves and evict the greatest threats is self-sabotage when it also removes many of the seemingly insignificant micro-organisms that we co-evolved with long before using buildings to make settlements.[52] Bacteria were the first life forms on land – more than three billion years ago – and we recent arrivals – just a few hundred thousand years ago – are made of bacteria and dependent on them. Reducing the diversity of bacteria is now understood to be the real problem. This calls for a return to an environmental theory of health. Yet this time it is not about a bacteria-harboring environment but bacteria as environment.

The idea of bacteria as an alien invasion gives way to understanding bacteria as our oldest companions – inside, on, and outside the limits of our skin. This paradigm shift can be grasped with the obvious yet destabilizing thought that the human is made of its apparent outside. We continually make ourselves by breathing and eating, digesting what seems to be outside through countless filters and expelling much of what has been temporary made to seem inside, and continually rebuilding all those parts that seem fixed in a relentless flux of billions of elements. The line between inside and outside was never a line but a vast number of overlapping and enfolded sets of filters. There was never a discrete organism but an extended ecology with countless alliances with other ecologies – and bacteria everywhere doing the work of filtering, decomposing, and recomposing. The human is a bacterial macro-organism. Anti-bacterial architecture is anti-human.

Buildings are part of this ecology, part of the body, not just carrying the human microbiome but contributing to it and transforming it. Humans expel 36 million genome copies of bacteria per hour and these bacteria occupy spaces and return to the body, along with the bacteria of other macro-organisms. Forensic work can even identify who has been occupying a space by analyzing its microbiome. But the building microbiome, where every surface receives and sustains unique combinations of bacteria, is not simply that of humans, it is also that of other macro-organisms, companion species like plants, pets and insects. Since humans in the so-called developed north now spend 90% of




**09** "Cat at left lives in ordinary Pittsburgh house, is really pure white just like the one on the the right which lives in Precipitron-Equipped home."
© Illustration in "Dirty Air: Precipitron, an Electronic Filer, Will Keep Homes Clean," ***Life magazine***, April 1945.

their time indoors, life is lived in a kind of continuous interior, or succession of hyper conditioned interiors, each with a specific microbiome, or rather a specific microbiome on each of its surfaces and spaces. It is now recommended that children eat dirt to strengthen their immune system, and likewise we are all advised to go outside, to get away from architecture, but no longer just to get fresh air and escape bacteria but to savor a greater diversity of micro-organisms.

The new wave of research into the microbiome of buildings began with hospitals. Just as Nightingale started her work with the observation that hospitals kill more people than cure them, contemporary research focuses on the fact that more people who die in hospitals do so from diseases of the hospital building itself than anything else. It is now argued that to be operated on in a room with an open window to the outside is probably better than in hyper-cleansed and isolated operating theater nurturing super bugs. A child born by caesarian section carries the microbiome of the delivery room rather than that of the mother, and maintains it for years, with negative health outcomes, particularly on the immune system,[53] and much of the long term microbiome of premature children comes from hospital rooms.[54]

Building microbiome research has now moved from hospitals to schools, offices, and houses. Buildings are thought of as microbial "islands," with interacting "communities" of microbes forming a kind of urbanism. And these communities are understood to operate as "networks."[55] The idea of individuals isolated by a building from the evident complexities of urban and natural ecologies gives way to the idea of an immeasurable invisible internal networking complexity. The very idea of the individual dissolves. A new kind of politics, even an ethics of architecture, emerges in this reimagined bacterial urbanism.[56]

Architecture has to rethink itself as preventive care, or even dissolve any sense of a fixed line between prevention and cure, in more holistic understanding in which the concept of health doesn't mean absence of infection, decay, degradation, but a co-evolution with bacteria that cannot be simply divided between "good" or "bad" bacteria but much more complex.

Each pandemic, like COVID-19, necessarily reactivates all the emergency protocols of isolation, social distancing, and sanitization of every surface. These protocols are essential to slow down the spread of disease, but they weaken immune systems if turned into the ongoing basis of everyday life, just as the over-use of anti-biotics only incubates more deadly multi-drug resistant pathogens. Modern architecture was produced under emergency conditions – with millions of people still dying each year because there was no cure for tuberculosis. It treated everyday life as an emergency by monumentalizing early 19th century sanitary reform protocols as the very image of health. Alternative understandings of health are long overdue. All the architectural concepts of protection, stability, environment, comfort, order, etc. need to be reconsidered. Or, to say it more simply, the very idea of shelter and care needs to be rethought. It no longer makes sense to live in a hospital.

**Notes**

1 See Beatriz Colomina and Mark Wigley, *Are We Human? Notes on the Archeology of Design*, Zurich, Lars Muller, 2016.
2 See Beatriz Colomina, *X-Ray Architecture*, Zurich, Lars Muller, 2019. The standard arguments promoting Modern architecture in terms of technology, function, new materials, efficiency, lightness, mobility, standardization, and industrialization were actually subordinate to the concept of a healthy and health-inducing building.
3 See Mark Wigley, *White Walls, Designer Dresses: The Fashioning of Modern Architecture*, Cambridge, MIT Press, 1995.
4 Sigfried Giedion, *Space, Time and Architecture: The Growth of a New Tradition*, Cambridge, Harvard University, 1967, 293.
5 Ibid., li.
6 Le Corbusier, *The Decorative Art of Today*, trans. by James I. Dunnett of 1925, Cambridge, MIT, 1987, 188-192.
7 Ibid., 87, 90.
8 Ibid., 32.
9 Ibid., 190.
10 Ibid., 211.
11 Le Corbusier, *Journey to the East*, trans. by Ivan Zaknic of 1966 book based on 19** manuscript, Cambridge, MIT, 2007, 171.
12 Le Corbusier, *The Decorative Art of Today*, 142.
13 *Vers une architecture* was translated into English as *Towards a New Architecture. Towards an Architecture* is a modern translation of the book and most Modernists in the English-speaking world knew Corbusier's book to be *Towards a New Architecture.*
14 Le Corbusier, *Towards an Architecture*, trans. by John Goodman of 1923 book, Los Angeles, Getty Research Institute, 2007, preface of 2nd edition of 1924, 83.
15 Ibid., 94.
16 Beatriz Colomina, *X-Ray Architecture*, 61-116.
17 Benjamin Ward Richardson, "Health in the Home," introduction to Shirley Forster Murphy (ed.), *Our Homes and How to Make them Healthy*, London, Cassell & Company, 1883, 5. (Quotation marks represents italic in original) Richardson, a doctor, then goes on to list all the major diseases caused by human's "self-invented and self-constructed protections from external influences" and details which architectural features actively promote each of them. The book aims to establish uniform codes of "domestic sanitation," understood of the basis of urban and national health, to produce new "homes for human beings," or improve existing ones, and establish protocols for continuously cleansing them.
18 In the section of the book on Internal Decoration, Robert W. Edis insists that the jarring effect of poorly designed excessive decorated

interiors not only harbor impurities but "exercise to an important degree an influence equally damaging to our mental as bad drainage and improper ventilation do to our bodily health." Ibid., 313.

19 Every dwelling was recommended to have at least one sick-room within it for isolating infectious disease and the volume repeatedly cites the 1869 book on hospital design by the engineer Dr. Douglas Galton, specifically on the need for air and light and smooth walls without angles or ornament that attracts dust and therefore incubates disease. Galton wrote the sections of the volume on ventilation and his writings on hospital design, along with his own hospital designs, like the Herbet Hospital of 1865, closely following the principles promoted by Florence Nightingale.

20 "Pure, white, polished, non-absorbent cement is the only material fit for hospital walls." Florence Nightingale, *Notes on Hospitals*, London, Longman, 1859, 15.

21 Florence Nightingale, *Notes on Nursing: What it is and What it is Not*, London, Harrison, 1859, 20. Dougles Galton would also apply the principles of hospital design to all "dwelling" types, even if "the sick are more easily affected by insanitary conditions than persons in health." Observations on the *Construction of Healthy Dwellings Namely Houses, Hospitals, Barracks, Asylums, etc.*, Oxford, Clarendon Press, 1880, 164.

22 Edwin Chadwick, *Report on the Sanitary Condition of the Labouring Population of Great Britain*, London, R. Clowes & Sons, 1842.

23 Most of Nightingale's protocols were already laid out, for example, in the 1854 essay by the surgeon John Robertson that argued that it was well known in the medical community that most hospitals were unhealthy, harming patients rather than curing them, and eloquently captured the thought that the real threat to the human is the human itself: "of all the aerial poisons, none, perhaps, is much more hurtful to man than his own expelled breath, when detained long around him and breathed again." John Robertson, "On the Defects, with reference to the Plan of Construction and Ventilation, of most of our Hospitals for the reception of the Sick and Wounded" "On the Defective Ventilation of Hospitals," *Transactions of the Manchester Statistical Society*, 1855-1856, 135.

24 An 1841 book on *The Domestic Management of the Sick-Room* by a prominent doctor, for example, spoke of the "tenacity" with which "infectious matter" adheres to clothes, bedding, furniture, ornament and floors and ornaments. Sick rooms need "smooth and polished surfaces," no ornament, no unnecessary furniture and constant cleaning of everything in the room and afterwards the furniture needs to be purified and the walls white-washed. Anthony Tood Thomson, *The Domestic Management of the Sick-Room: Necessary, in Aid of Medical Treatment, for the Cure of Diseases*, London, Longman, 1841.

25 In 1802, a society that had been set up in London in 1794 to carry out cleaning of infected working class dwellings was already recommending generalized whitewashing as prevention. "The committee immediately turned their attention, not merely to the relief and restoration of the sick, but to the prevention of the return of the disease by latent and uncorrected infection. A resolution was adopted of gratuitously whitewashing all the houses of the poor." *The Reports of the Society for Bettering the Condition and Increasing the Comforts of the Poor*, Vol. III, London, W. Bulmer, 1802, 304. The society followed the "Rules of Prevention" published in 1793 by the epidemiological pioneer John Haygarth that called for clean, airy and spacious rooms with protocols of whitewashing and cleansing of body, clothing, linen, floor, furniture, and utensils.

26 Graham Mooney, *Intrusive Interventions: Public Health, Domestic Space, and Infectious Disease Surveillance in England, 1840-1914*, Rochester, Rochester University Press, 2015.

27 The emphasis on proactive prevention over emergency reaction was already in the concept of public health that emerged in late 18th century in France, became an activist movement there in the late 1820s and contributed to the rise of the sanitary reform movement in England that in turn became the model for France. Ann La Berge, *Mission and Method: The Early Nineteenth-Century French Public Health Movement*, Cambridge, Cambridge University, 1992.

28 Much of the arguments about hospitals and homes had been made directly to architects from the beginning. The leading architectural magazine, *The Builder*, devoted itself to the issue ever since Chadwick's report and Nightingale often directly addressed designers. Anthony King, "Hospital Planning: Revised Thoughts on the Origin of the Pavilion Principle in England," *Medical History*, Vol. 10, No. 4, 1966, 360-373. Architects were actively involved in the transformation of hospital design since the 1860s into the French pavilion model advocated by Robertson and Nightingale but many of them had already been mobilized in the 1840s by the concept of buildings as preventive care, starting with worker's housing but gradually applying it to all building types. Model housing projects based on the new concept and strategies of public health were constructed since the early 1840s by philanthropic associations like Metropolitan Association for Improving the Dwellings of the Industrious Classes, and were extensively covered by newspapers and journals and exhibited. A model building of "clean" workers housing with whitewashed smooth walls designed by Henry Roberts was constructed in Hyde Park, for example, during the Great Exhibition of 1851, walls and featured a room full of architectural plans, publications and pamphlets for model hygienic designs.

29 Bruno Latour, *The Pasteurization of France*, trans. by Alan Sheridan and John Law of 1984 book, Cambridge, Harvard University Press, 1993.

30 Otto Wagner, *Modern Architecture: A Guidebook for His Students to This Field of Art*, trans. by Francis Mallgrave of 1896 book, Los Angeles, Getty Research Institute, 1988, 116.

31 Ibid., 113.

32 Ibid., 114.

33 Ibid., 115.

34 Ibid., 104.

35 Leopold Bauer, *Verschiedene Skizzen, Entwürfe und Studien. Ein Beitrag zum Verständnisse unserer modernen Bestrebungen in der Baukunst*, Wien, 1899.

36 Joseph August Lux, the new editor of *Das Interieur*, presented all the arguments for hygienic interiors (ornament as disease, white walls, lack of decoration as the new decoration, all bedrooms treated as sick rooms, cleaning protocols, etc.) in his survey centered on the work of architects based in Vienna. Joseph August Lux, *Die moderne Wohnung und ihre Ausstattung*, Vienna, Vienna Verlag, 1905. Hermann Muthesius noted the fusion of sanitary and aesthetic motives. The sanitation of ornament in favor of functional forms with "a certain clean conciseness of form" and white surfaces was not just a matter of being clean but of representing that cleanliness: "a specific requirement for cleanliness – a demand not only to hinder undesired accumulation of dirt but also to demonstrate symbolically that it is not present, that everything is neat and in the best of order. Our starched white linens also follow the same example. Thus there is a coincidence here of certain sanitary and aesthetic concerns. And the combination of the two appears everywhere in modern designs as we now begin to see, for example, in our dwellings. Here, reforms are taking place – we recognize them most fully in the contemporary English house – that strive to increase the amount of light and air, to design strictly functional rooms, to avoid all useless appendages in the decoration, to eliminate heavy, unmovable household furnishings, and to strive for an overall sense of brightness and impression of cleanliness." Hermann Muthesius, *Style-Architecture and Building-Art: Transformations of Architecture in the Nineteenth Century and its Present Condition*, trans. by Stanford Anderson of 1902 book, Los Angeles, Getty Research Institute, 1994, 80.

37 Joseph August Lux, the new editor of *Das Interieur*, illustrated much of this work when presenting all the arguments for hygienic interiors (ornament as disease, white walls, lack of decoration as the new decoration, all bedrooms treated as sick rooms, cleaning protocols, etc.) in his survey centered on the work of Josef Hoffmann and his followers in the Wiener Werkstatte, *Die moderne Wohnung und ihre Ausstattung*, Vienna, Vienna Verlag, 1905.

38 "The microbe is to-day one of the most active promoters of genuine household art (…) He is promoter of the general scheme, not positive worker on the detail side; yet without him the best forms of interior finishing would still be but the dream of the too-progressive architect." Helen Campbell, "Household Art and The Microbe," *The House Beautiful*, Vol. 6, No. 5, October 1899, 218. "Enter the microbe. Is he a modern invention purely, or has he been with us since creation ended its work and man began his? (…) His real discovery waited the microscope, the biologist, the chemist, the modern physician equipped with forms of leaning and with appliances of healing that would have sent him to the stake three hundred years ago. In the mean time the microbe, unknown and thus in undisputed possession, led a career of phenomenal activity, all civilized life being under absolute if unconscious submission to his dominion, and arranged for his special delight and perpetual reproduction. (…) Where beauty at its highest dwells, he has no place." Ibid., 219.

39 S. Maria Elliott, *Household Bacteriology*, Chicago, American School of Household Economics, 1904. In 1907, *Household Bacteriology* became one of the volumes of the highly influential set on *Home Economics.*

40 Henri Sauvage and his partner Charles Sarazin, for example, formed a building society for the production of "hygienic" workers housing in 1901 and worked repeatedly on stepped housing projects with large windows, sun terraces, and all surfaces covered with white ceramic tiles. Caroline Ford, "The Paris Housing Crisis and a Social Revolution in Domestic Architecture on the Eve of the WWI," *The Journal of Modern History*, No. 90, September 2018, 580-620. See also, Brian Brace Taylor, "Henri Sauvage and Hygienic Housing; or, The Cleanliness Revolution in Paris," *Architèse*, No. 12, 1974, 13–29. Books by architects on hygiene include: Henry Baudin, *Le Rôle le social de l'hygiène, Société pour l'amélioration du logement* , 1905; Paul Juillerat and Louis Bonnier, *La tuberculose et l'habitation*, Paris, 1905.

41 See Fabiola López Durán, *Eugenics in the Garden: Transatlantic Architecture and the Crafting of Modernity*, Austin, University of Texas, 2018.

42 Kirsten R. Egan, "Conservation and Cleanliness: Racial and Environmental Purity in Ellen Richards and Charlotte Perkinds Gilman," *Women's Studies Quarterly*, Vol. 39, No. 3/4, Fall/Winter 2011, 77-92.

43 "Whitewash is extremely moral. Suppose there were a decree requiring all rooms in Paris to be given a coat of whitewash. I maintain that that would be a police task of real stature and a manifestation of high morality, the sign of a great people." Le Corbusier, *The Decorative Art of Today*, 192.

44 Le Corbusier, *The Radiant City*, trans. by Pamela Knight, Eleanor Levieux, Derek Coltman of 1964 book, New York, Orion Press, 1967, 41-42.

45 Ibid., 43.

46 "We need a diagnosis and a line of conduct. In 1922 I tried to delve into an analysis. I did some laboratory work. Isolating my microbe. I watched it develop. The biology of my microbe appeared in indisputable clarity. Certitudes acquired; diagnosis. Then, by an effort of synthesis, I drew up the fundamental principles of modern city planning." Le Corbusier, *Precisions: On the Present State of Architecture and Urban Planning*, trans. by Edith Schreiber Aujame of 1930 book, Cambridge, MIT, 1991, 143. "It is not enough for a physician to know that a body is attacked by a disease. Even if he is not a bacteriologist, he must push his research into usually invisible realms, he must have a modest knowledge of bacteriology, he must know when the organism was attacked and how the tuberculosis spread. Likewise, the historian cannot dispense with the microscope. He cannot relent in tracing the theme to its origins. He has to show when an idea first appears; how quickly or slowly it spreads or disappears. He cannot confine himself to mechanization alone any more than the doctor can to bacteria. He must take psychic factors into reckoning, for often they exert a decisive influence." Sigfried Giedion, *Mechanization Takes Command: A Contribution to Anonymous History*, New York, Oxford University Press, 1948, 5.

47 Beatriz Colomina and Mark Wigley, "Toilet Architecture: An Essay about the Most Psychosexually Charged Room in a Building," *Pin-Up*, No. 23, 2017-2018.

48 See Mark Wigley, *Buckminster Fuller Inc.: Architecture in the Age of Radio*, Zurich, Lars Muller, 2015, 75-129.

49 Charles and Ray Eames, John Entenza, Eero Saarinen and Herbert Matter, "What is a House?," *Arts & Architecture*, July 1944, 32-49. The article was referring to the "Precipitron" and "Sterilamp" devices for removing bacteria from air and surfaces that were manufactured by Westinghouse since the late 1930's and advertised for use in homes in architectural journals during the war.

50 A. J. McMichael, "Environmental and Social Influences on Emerging Infectious Diseases: Past, Present and Future," *Philosophical Transactions: Biological Sciences*, Vol. 359, No. 1447, 29 July 2004, 1049-1058.

51 Israel Hershkovitz, Helen D. Donoghue, David E. Minnikin, Gurdyal S. Besra, Oona Y-C. Lee, Angela M. Gernaey, Ehud Galili, Vered Eshed, Charles L. Greenblatt, Eshetu Lemma, Gila Kahila Bar-Gal, Mark Spigelman, "Detection and Molecular Characterization of 9000-Year-Old Mycobacterium tuberculosis from a Neolithic Settlement in the Eastern Mediterranean," *PLoS one*, October 2008, Vol. 3, No. 10, 1-6.

52 The "hygiene hypothesis" hinted by late 19th century scientists but first formulated in 1989 is increasingly being confirmed in epidemiological studies and therapeutic trials. Graham Rook and colleagues significantly revised the hygiene hypothesis in 2003 with the concept of "Old Friends," the micro-organisms that co-evolved with humans in the development of the immune system in the hunter-gatherer phase before the first settlements – again effectively portraying the beginning of architecture as ultimately unhealthy for its inhabitants and industrialization urbanization as having accelerated this. Graham A. W. Rook, "Hygiene Hypothesis and Autoimmune Diseases," *Clinical Reviews of Allergies and Immunology*, No. 42, 2011, 5-14. Hygiene per se is not the issue. After all, there is no such thing as a sterile environment. Even the cleanest house is teaming with microbes. The issue is which microbes are lived with. As summarized by a major research review: "The problem is not one of being too clean: it's one of reduced contact with the right kind of dirt." Rosalind Stanwell Smith, Sally F. Bloomfield and Graham A. Rook, "The Hygiene Hypothesis and its Implications for Home Hygiene, Lifestyle and Public Health," *International Scientific Forum on Home Hygiene*, 2012.

53 Fredrik Backhed, et.al., "Dynamics and Stabilization of the Human Gut Microbiome during the First Year of Life," *Cell Host & Microbe*, 17, 13 May 2015, 690–703.

54 Brandon Brooks, et.al., "Strain-resolved analysis of hospital rooms and infants reveals overlap between the human and room microbiome," *Nature Communications*, 1814, 2017.

55 Caitlin V. Hall et.al, "Co-existence of Network Architectures Supporting the Human Gut Microbiome," *iScience* 22, 20 December 2019, 380-391.

56 Penelope Ironstone, "Me, My Self, and the Multitude: Microbiopolitics of the Human Microbiome," *European Journal of Social Theory*, Vol. 22, No. 3, 2019, 325-341.

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