

# Carrera de Especialización en Esterilización

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**CONICET  
Argentina**

**Asignatura: Seguridad Operativa**

**Clase**

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Universidad Nacional de Rosario



Consejo Nacional de Investigaciones

## **UNIDAD 1.**

Infecciones y Epidemiología. Fuentes de infección y contaminación. Higiene, salud y trabajo en el ambiente laboral hospitalario. Seguridad en equipos, ropa e infraestructura. Monitoreo de contaminantes químicos y biológicos en servicios asistenciales. Epidemiología molecular.

## **UNIDAD 2.**

Bioseguridad. Definición. Medidas de bioseguridad en el laboratorio y en el hospital. Enfermedades profesionales. Concepto y definición. Accidentes de trabajo. Prevención y tratamiento. Diseminación de microorganismos multiresistentes a los antibióticos. Manejo y control de sustancias contaminadas con microorganismos. Indumentaria. Regulaciones ANMAT.

## **UNIDAD 3.**

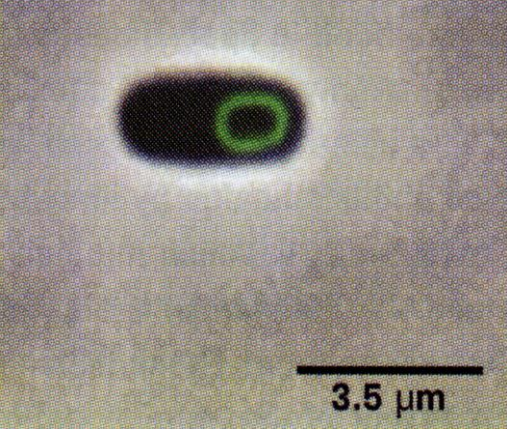
Control ambiental. Limpieza, sanitización y desinfección. Control de vectores en las distintas dependencias o servicios del hospital. Grado de infestación y su erradicación o control. Manejo de plaguicidas e insecticidas. Procedimientos de desinfección de equipos, ropas, superficies, sanitarios, sistemas de ventilación y de provisión de agua potable. Liberación de microorganismos perjudiciales al medio ambiente.

## **UNIDAD 4.**

Factores físicos ambientales. Temperatura, iluminación y ruidos en el ambiente laboral. Contaminantes químicos: sólidos, líquidos y gaseosos. Aerosoles. Vías de ingreso, efectos agudos y crónicos. Prevención de intoxicaciones y tratamiento. Concentraciones máximas permisibles. Métodos e instrumentos de medición. Incendios y clases de fuego. Prevención. Planes de respuesta, manejo y evacuación.

## **UNIDAD 5.**

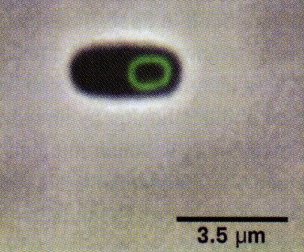
Tratamiento de residuos y efluentes químicos y biológicos. Impacto ambiental dentro y fuera del ámbito del hospital. Carga microbiana y su impacto en el manejo y control. Manejo y gestión de la basura hospitalaria.



## SEGURIDAD OPERATIVA

A hospital room **may feel sterile**, with its recycled air and scrubbed smooth surfaces. **But underneath** that antiseptic veil is a teeming, invisible world of microbes, the composition of which constantly changes. **Each new patient brings their own microbiome**—the collection of bacteria and other microbes that live in and on the body—which they shed on the hospital bed, the television remote, and anything else they touch. Each nurse, doctor, and visitor that enters the room drops microbes, too. The tiny organisms also circulate through ventilation systems and travel through the air. Some come not from humans but water systems, heaters, and other human-made niche environments. Collectively, these microbes make up the built microbiome, which exists in a unique and dynamic form in every single building on the planet.

# POR CADA CÉLULA (HUMANA) DE NUESTRO CUERPO PORTAMOS 10 BACTERIAS

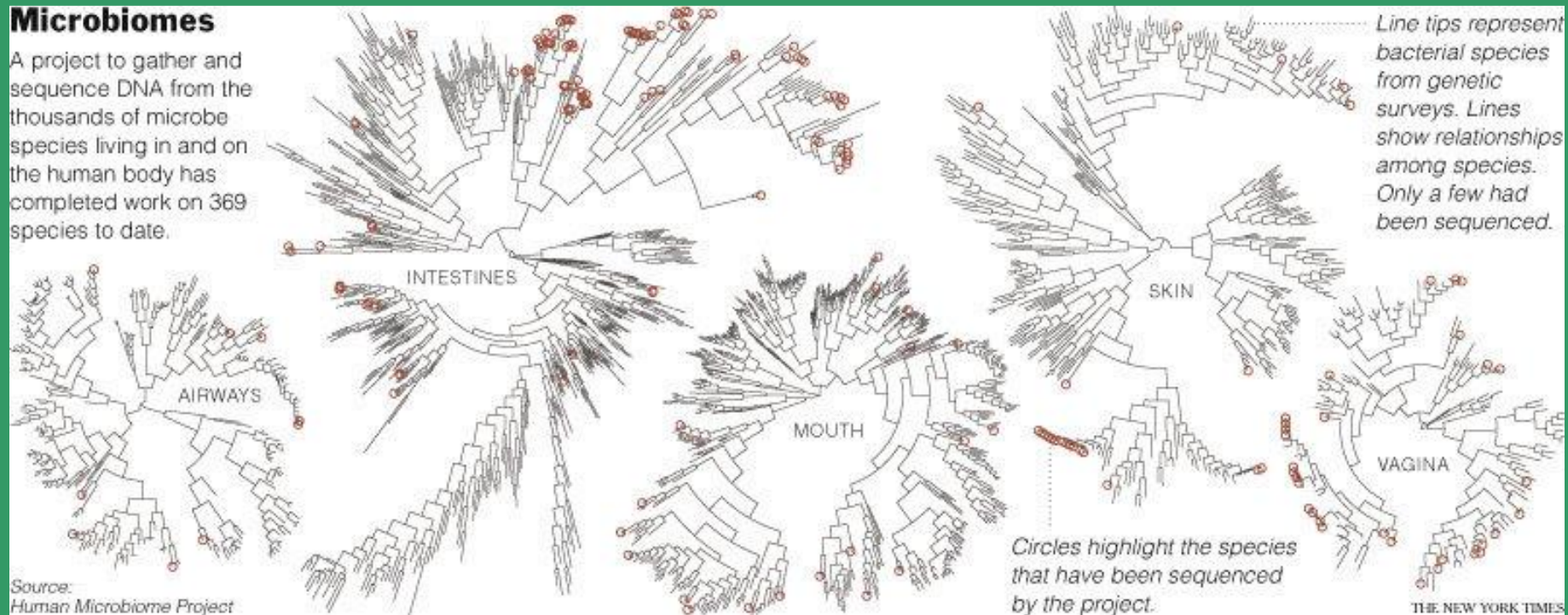


## PROYECTO MICROBIOMA HUMANO SECUENCIACIÓN DE LOS GENES TOTALES DE NUESTRA FLORA COMENSAL



### Microbiomes

A project to gather and sequence DNA from the thousands of microbe species living in and on the human body has completed work on 369 species to date.



Line tips represent bacterial species from genetic surveys. Lines show relationships among species. Only a few had been sequenced.

Circles highlight the species that have been sequenced by the project.

Source:  
Human Microbiome Project

THE NEW YORK TIMES

Not all microbes are bad, of course. Most are benign or even beneficial. But disease-causing agents are a constant in hospitals, and **every day one out of 25 patients gets at least one inadvertent infection during their hospital stay.**

**Some researchers suspect that hospitals' microbial ecosystems may influence the spread of pathogens, which in turn may affect human health.** While the research is in early stages, it may lead to changes in hospital design or practice to promote healthier built microbiomes. Researchers have been interested in microbes in hospitals since at least 1847, when Ignaz **Semmelweis**, a German-Hungarian doctor, discovered that medical students in a Vienna hospital were inadvertently transmitting puerperal sepsis from autopsy rooms to maternity wards, leading to high death rates. **Semmelweis introduced mandatory hand washing**, the first intervention for a hospital-acquired infection on record. Since then, most work on microbes in hospitals has similarly focused on preventing outbreaks of specific pathogens, especially those that are dangerous to people who are already ill or have weakened immune systems. In 1976, for example, scientists first discovered the bacteria that cause Legionnaires' Disease, **Legionella pneumophila**, after an outbreak at an American Legion convention in Philadelphia. **The bacteria, which can cause fatal pneumonia, lived in the cooling tower of a hotel and circulated through the building's air conditioning.**

The pathogen can similarly thrive in drinking fountains and hot water heaters, and is a particular concern in hospital water systems. Since its discovery, outbreaks have been identified in hospitals across the world.

To prevent the bacteria from taking hold and spreading from its source to patients' rooms, hospitals regularly clean and maintain ventilation systems and position cooling towers so that potentially infected air can't circulate.

Today, other examples of hospital pathogens include **black mold from the *Stachybotrys* genus**, which may spark respiratory illness and can be controlled with ultraviolet sanitation systems, and the bacteria ***Clostridium difficile***, which cause severe gastrointestinal distress and may be wiped out of contaminated rooms by robots spewing hydrogen peroxide vapor. Antibiotic resistant bacteria such as methicillin-resistant ***Staphylococcus aureus* (MRSA)**, which can cause untreatable infections, may be tracked with genomic sequencing techniques.

Finding the source of the bacteria with genetic maps to see how they mutate over time can encourage changes in behavior of hospital staff, such as taking extra care to wash hands and keeping infected patients quarantined.

-“What is new—and is critically important and interesting—is that some people are trying to understand the entire ecosystem instead of just the impact of pathogens,” explains Jonathan Eisen, an evolutionary biologist at the University of California, Davis who specializes in microbes in the built environment.

“If we want to understand why MRSA is spreading in a hospital, we probably should understand the entire collection of microbes in the hospital.” Eisen’s lab oversees the Microbiology of the Built Environment Network (<http://microbe.net/>) (microBEnet), an online resource that tracks around two dozen groups working to understand microbes not only in hospitals, but also in other built environments including various buildings, cars, and airplanes.

Although we spend around 90 percent of our time indoors, the microbiome of the built environment is one of the last that scientists have explored. Like other work that came before—including microbial research in the ocean, soil, and even humans—Eisen and his collaborators have benefited from advances in **genome sequencing technology**, which can identify an organism’s genetic code relatively quickly and cheaply. Swabbing a room and then running the samples through a sequencing machine can identify microbes, and tracking where the swabs came from can show where they live.

-Some researchers are already using these techniques to explore hospital microbiomes. In 2012, researchers at the Biology and the Built Environment (BioBE) Center (<http://biobe.uoregon.edu/>) at the University of Oregon published a paper (<http://www.nature.com/ismej/journal/v6/n8/full/ismej2011211a.html>)

**PAPER 1** that looked at the microbial content of the air at Providence Milwaukie Hospital in Oregon. The researchers took air samples from hospital rooms that were ventilated either by open windows or mechanical systems and found that the former had greater bacterial diversity. But rooms that were mechanically ventilated and thus exposed to a smaller amount of outside air also had more bacteria related to human pathogens. While this doesn't mean that an open window will definitely benefit a patient's health, the work did demonstrate how different ventilation systems can impact a room's microbial content.

-People who spend time in a room may be affected by its microbiome, including non-pathogenic microbes. Earlier this year, a team led by researchers at the University of California, Berkeley published research (<http://www.microbiomejournal.com/content/2/1/1>) **PAPER 2** that looked at the relationship between environmental microbes and babies in the neonatal intensive care unit at Magee-Womens Hospital of the University of Pittsburgh Medical Center.

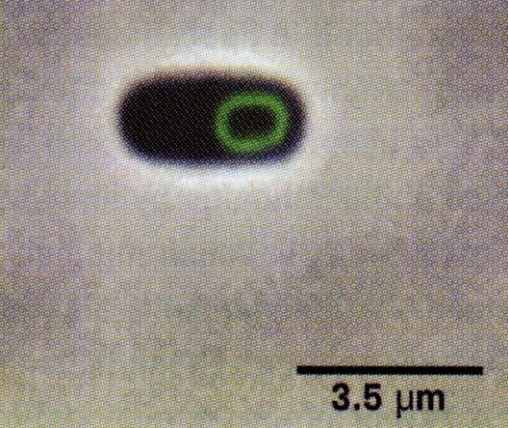


**-Babies are typically colonized with the bacteria that prime their microbiome when they are born. But the premature infants in a neonatal unit are a special case—they are underdeveloped and often must be treated with antibiotics, which means their microbiomes may have a slow start.**

**-Although neonatal units are kept as sterile as possible to help prevent the babies from getting sick, the Berkeley researchers found that the microbes on various surfaces in the Pittsburg unit—mostly associated with human skin—were highly genetically similar to those in the gastrointestinal tracts of premature babies who lived in the unit during the first month of their life.. **The environmental microbes were likely colonizing the infants, just as a mother's microbes would typically infiltrate their bodies during birth****

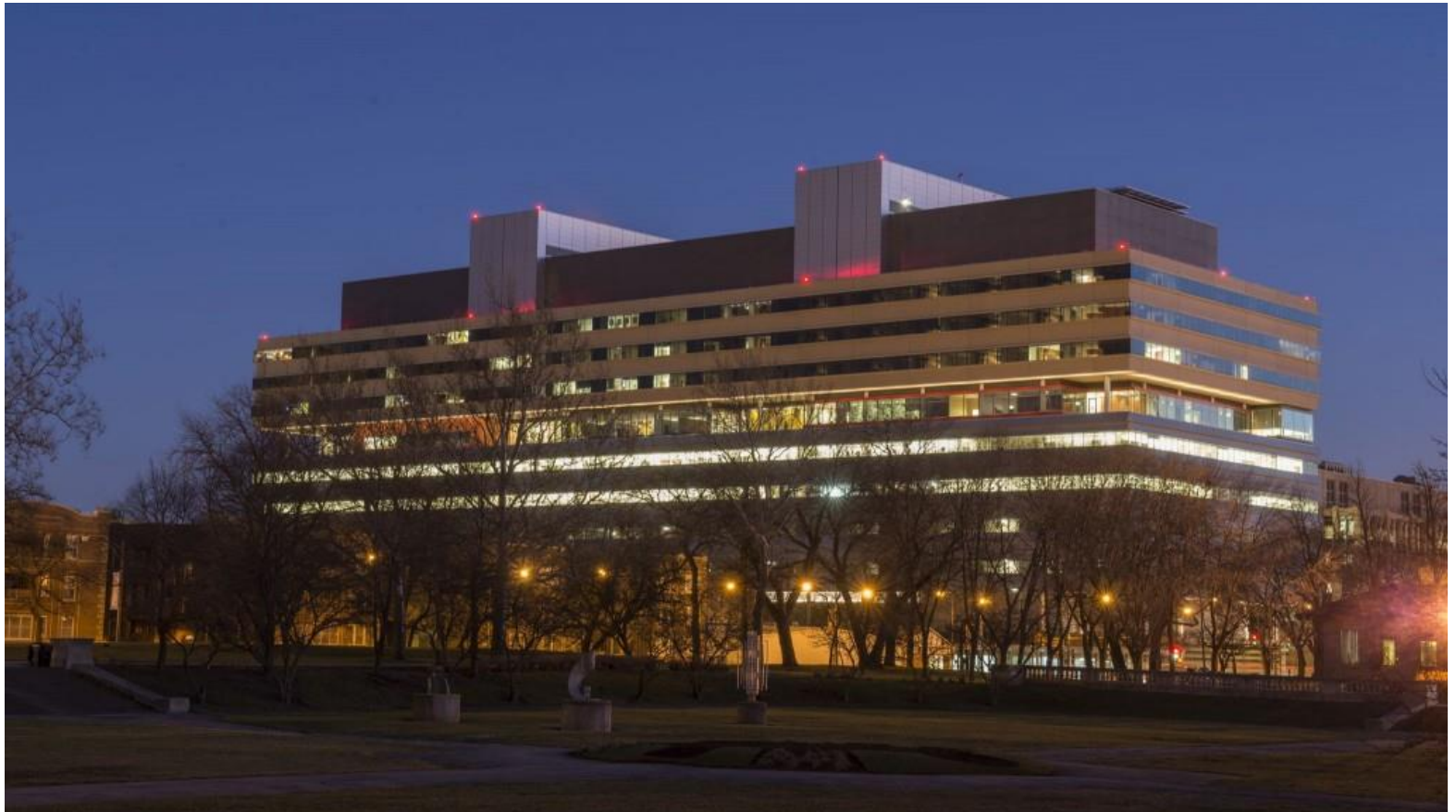
**-Similar scans of other hospital rooms, from where patients sleep to where they are treated, may reveal similar ways that people and the built environment swap microbes.**

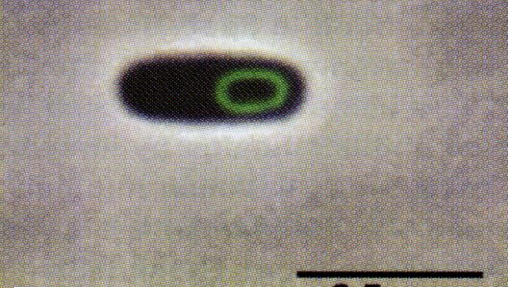
**-Larger projects are on the way. The Hospital Microbiome Project (<http://hospitalmicrobiome.com/>), for example, recently wrapped up a year's worth of data at the Center for Care and Discovery, a new hospital associated with the University of Chicago. Samples were collected daily in ten rooms virtually identical in terms of layout and ventilation.**



# PROYECTO SOBRE EL MICROBIOMA DEL HOSPITAL

## HOSPITAL MICROBIOME PROJECT

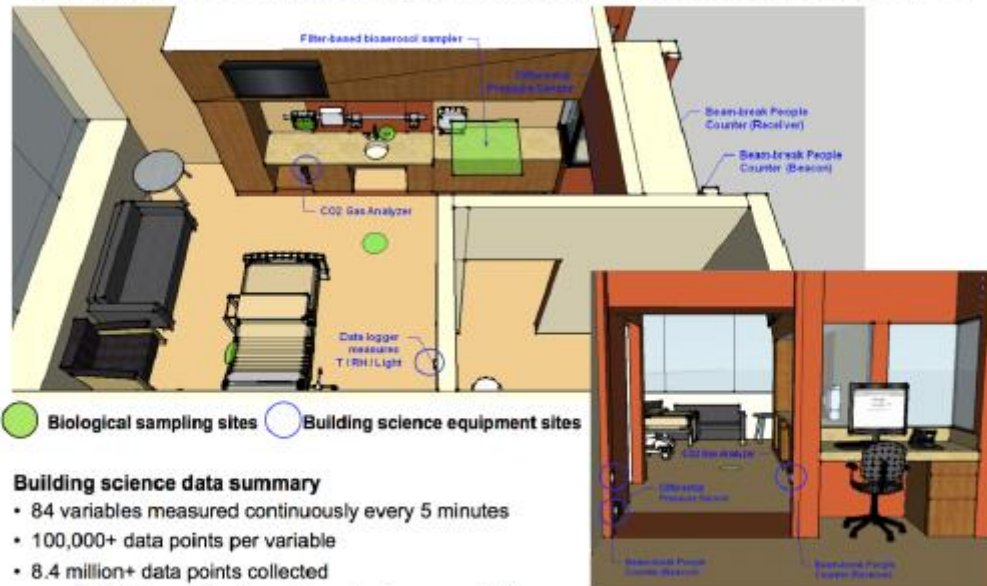




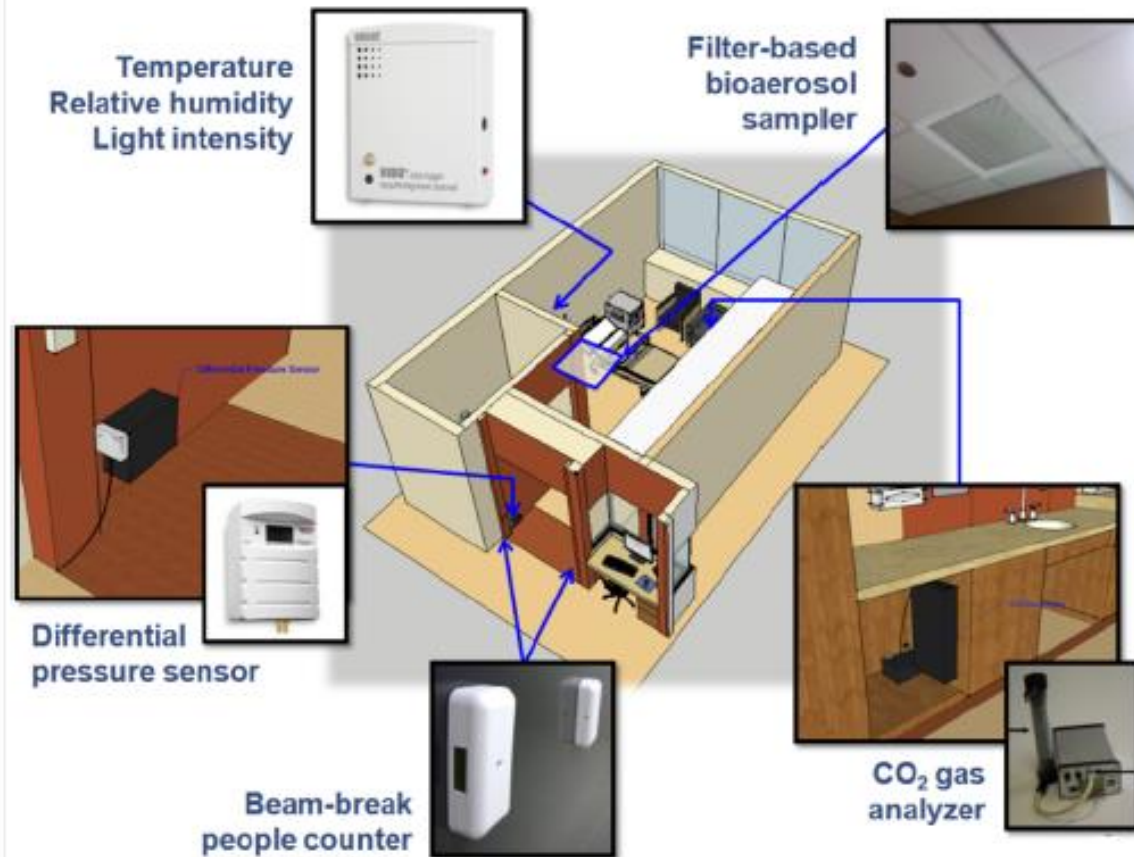
# PROYECTO SOBRE EL MICROBIOMA DEL HOSPITAL

In 2012, we began working on a new project at the University of Chicago's new hospital facility: the [Center for Care and Discovery](#). The [Hospital Microbiome Project](#) was designed to collect microbial samples from surfaces, air, staff, and patients from the University of Chicago's new hospital pavilion in order to better understand the factors that influence bacterial population development in healthcare environments. Of particular importance and interest are the microbes and viruses that may influence the spread of hospital acquired infections.

## Building science measurements in the Hospital Microbiome Project



# Building science sensors



Summary of sensors used in the patient rooms

◀ Microbial Populations in a Hospital Under Construction

Posted in Findings

**-When people check into a hospital, the microbial communities that coat their bodies quickly colonize treatment areas, according to a research consortium based at the University of Chicago in Illinois.**

**-The finding is the first from the Hospital Microbiome Project, a year-long effort to monitor the microbial ecosystem of a new University of Chicago hospital to see how microbes including pathogens travel through its halls.**

**-Research began before the hospital opened its doors. Since January 2013, researchers have taken weekly swabs of light switches, floors, airways, water systems and bed rails at the Center for Care and Discovery in Chicago, to collect genetic material that can identify microbial inhabitants.**

**-When the hospital opened to patients and staff in February, researchers started swabbing them too, collecting samples from their noses, armpits, faeces and hands — testing some individuals on a daily basis.**

**-Sampling will continue until the end of the year, by which point the scientists expect to have collected more than 15,000 swabs.**

**-After sequencing DNA collected on the swabs, Gilbert and his team identified around 70,000 types of microbe that had moved in during construction, probably transported by air, water and construction materials and workers. After the hospital opened, patients and staff contributed new strains of microbes from their skin and shoes, altering the invisible ecosystem.**

**-Still, roughly 1.7 million hospital-associated infections are reported each year in the United States, and the pathogens that cause them must come from somewhere.**

**-It is possible that harmful germs will eventually gain a toehold in the Chicago hospital, says Mark Hernandez, an environmental engineer at the University of Colorado Boulder. Some patients will shed pathogens as well as harmless bacteria, he says.**

**-The project's results provide an early glimpse of how the hospital microbiome works, but Thomas Schmidt, a microbial ecologist at the University of Michigan in Ann Arbor, warns that more research is needed to investigate what these patterns might mean for patients.**

**-Some of that research is likely to come from Gilbert's team. The consortium hopes to conduct microbiome studies at further new hospitals, as well as older medical facilities.**

## **What do we need to know about the building we're sampling from a microbial perspective?**

**There is a bunch of evidence that shows humans are a huge source of bacteria, and a lot of that is pretty new," Stephens says. "So perhaps the number of people in these environments is important. And as far as survival on surfaces, we know that both temperature and humidity have a big influence on microbial communities." To collect all that information, Stephens's team put several types of data loggers in each of the study rooms to measure temperature, humidity, pressure, and light. They also added infrared sensors to each doorway that, along with carbon dioxide sensors, could estimate how many different people entered the room on a daily basis.**

**Coupled with the genetic information that will identify specific bacterial species and their locations, the environmental data might reveal how these factors influence the microbes' presence and growth.**

**-Although a paper on the study likely won't be published until at least 2015, **PAPER 3** Gilbert says the preliminary results show a huge boost in microbial diversity after the hospital started admitting patients, which is no surprise. Early results also suggest that the microbes in a hospital room might not only depend on how long a patient stays in the room but on what treatments the patient receives—how they are treated with antibiotics, for example, or whether they are going through chemotherapy. These different microbial ecosystems may influence how hospital-acquired infections spread. “We think that the rest of the microbial community in the hospital impacts how pathogens are transferred in much the same way as when a pathogen that finds its way into a river suddenly finds itself surrounded by soil bacteria and often is outcompeted and unable to survive,” Gilbert says. “We think the same occurs in hospital environments. If there is a rich microflora, the pathogen can't compete. But if that microflora is absent due to sterilization of the facilities, for example, it finds it can persist for a lot longer.” **It's possible, then, that less sterile rooms could reduce the prevalence of harmful microbes.****



## ¿The Future of Hospital Design?

Of course, some parts of the hospital will always require careful sterilization, such as operating rooms. And in general, infection control is a major goal throughout any hospital. “We’re trying to kill all the pathogens,” says Nancy Iversen, the Director of Patient Safety and Infection Control at Billings Clinic in Montana. “That’s what we’re after in hospitals, we’re trying to kill them all and keep microorganisms out of the air and provide protected environments for our at-risk patients, largely because of outbreaks.”

While Iverson is intrigued by the implications of the built microbiome and the role of beneficial bacteria, she worries about patient safety. Plus, she adds, there are plenty of potential snags involving regulatory guidelines: “How would you get patients to enroll in studies where you didn’t disinfect traditionally under regulator standards—what the Centers for Disease Control requires”

## ¿The Future of Hospital Design?

-Research on the built microbiome is already influencing how some architects think about building design. “The lens I use in looking at buildings has gained a new dimension since becoming part of this research,” says Jeff Kline, an architectural researcher and building scientist at the BioBE Center at the University of Oregon. “Now I’m understanding, at least a little bit, about how architectural decisions about building form, organization, materials, and systems, especially ventilation, provide mechanisms that affect the composition of indoor microbiomes.” Kline adds that the research is too new to be applied to building design now. But there are intriguing possibilities for the future. **Operating rooms and neonatal intensive care units may need to remain sterile**, says Eisen from microBEnet, **but it could be beneficial to allow a more diverse microbial ecosystem in, say, the room where a patient sleeps**. There may also be better ways to control temperature, humidity, and airflow to encourage beneficial bacteria, or strategies to keep patients on intense antibiotic treatments away from those with compromised immune systems. “I don’t think we know enough now about building microbial ecology to really say exactly what is going on or exactly what the optimal strategy is for design,” Eisen says. “But I think it’s fair to seriously question the strategy of trying to kill everything.”

# SEMINARIOS

## **1: Architectural design influences the diversity and structure of the built environment microbiome (2012)**

Buildings are complex ecosystems that house trillions of microorganisms interacting with each other, with humans and with their environment. Understanding the ecological and evolutionary processes that determine the diversity and composition of the built environment microbiome—the community of microorganisms that live indoors—is important for understanding the relationship between building design, biodiversity and human health. In this study, [we used high-throughput sequencing of the bacterial 16S rRNA gene to quantify relationships between building attributes and airborne bacterial communities at a health-care facility.](#) We quantified airborne bacterial community structure and environmental conditions in patient rooms exposed to mechanical or window ventilation and in outdoor air. Building attributes, specifically the source of ventilation air, airflow rates, relative humidity and temperature, were correlated with the diversity and composition of indoor bacterial communities. Keywords: aeromicrobiology; bacteria; built environment microbiome; community ecology; dispersal; environmental filtering.

# SEMINARIOS

## **2: Microbes in the neonatal intensive care unit resemble those found in the gut of premature infants (2014).**

The source inoculum of gastrointestinal tract (GIT) microbes is largely influenced by delivery mode in full-term infants, but these influences may be decoupled in very low birth weight (VLBW, <1,500 g) neonates via conventional broad-spectrum antibiotic treatment.

We hypothesize the built environment (BE), specifically room surfaces frequently touched by humans, is a predominant source of colonizing microbes in the gut of premature VLBW infants.

Here, we present the first matched fecal-BE time series analysis of two preterm VLBW neonates housed in a neonatal intensive care unit (NICU) over the first month of life.

# SEMINARIOS

## 4: Exploring Bacterial Diversity in Hospital Environments by GS-FLX Titanium Pyrosequencing (2012).

Understanding microbial populations in hospital environments is crucial for improving human health. [Hospital-acquired infections are an increasing problem in intensive care units \(ICU\)](#). In this work we present an exploration of bacterial diversity at inanimate surfaces of the ICU wards of the University Hospital A Coruña (Spain), as an example of confined hospital environment subjected to selective pressure, taking the entrance hall of the hospital, an open and crowded environment, as reference. Surface swab samples were collected from both locations and recovered DNA used as template to amplify a hypervariable region of the bacterial 16S rRNA gene. Sequencing of the amplicons was performed at the Roche 454 Sequencing Center using GS-FLX Titanium procedures. Reads were pre-processed and clustered into OTUs (operational taxonomic units), which were further classified. A total of 16 canonical bacterial phyla were detected in both locations. This is the first study using deep sequencing techniques made in hospital wards showing substantial hospital microbial diversity.

## 5: Bacterial Diversity in Two Neonatal Intensive Care Units (2013).

Infants in Neonatal Intensive Care Units (NICUs) are particularly susceptible to opportunistic infection. Infected infants have high mortality rates, and survivors often suffer life-long neurological disorders. The causes of many NICU infections go undiagnosed, and there is debate as to the importance of inanimate hospital environments (IHEs) in the spread of infections. We used culture-independent next-generation sequencing to survey bacterial diversity in two San Diego NICUs and to track the sources of microbes in these environments. Thirty IHE samples were collected from two Level-Three NICU facilities. We extracted DNA from these samples and amplified the bacterial small subunit (16S) ribosomal RNA gene sequence using 'universal' barcoded primers. The purified PCR products were pooled into a single reaction for pyrosequencing, and the data were analyzed using QIIME. On average, we detected 93±239 (mean ±2 standard deviation) bacterial genera per sample in NICU IHEs. Our findings provide evidence that NICU IHEs harbor a high diversity of human-associated bacteria and demonstrate the potential utility of molecular methods for identifying and tracking bacterial diversity in NICUs.

## SEMINARIOS

**6a: Bacterial flora on the white coats of medical students (2000).**

**-6b: Meticillin-resistant *Staphylococcus aureus* contamination of healthcare workers' uniforms in long-term care facilities (2009).**

# SEMINARIOS

## **7a. Natural Ventilation for the Prevention of Airborne Contagion (2007).**

Institutional transmission of airborne infections such as tuberculosis (TB) is an important public health problem, especially in resource-limited settings where protective measures such as negative-pressure isolation rooms are difficult to implement. Natural ventilation may offer a low-cost alternative. Our objective was to investigate the rates, determinants, and effects of natural ventilation in health care settings.

## **7b. Control of airborne infectious diseases in ventilated spaces (2009).**

We protect ourselves from airborne cross-infection in the indoor environment by supplying fresh air to a room by natural or mechanical ventilation. The air is distributed in the room according to different principles: mixing ventilation, displacement ventilation, etc.