WHITE PAPER

Boosting School Ventilation Rates with Germicidal UV

UV Disinfection for Schools and Universities

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The Leader in UV-C Disinfection and HVAC Efficiency

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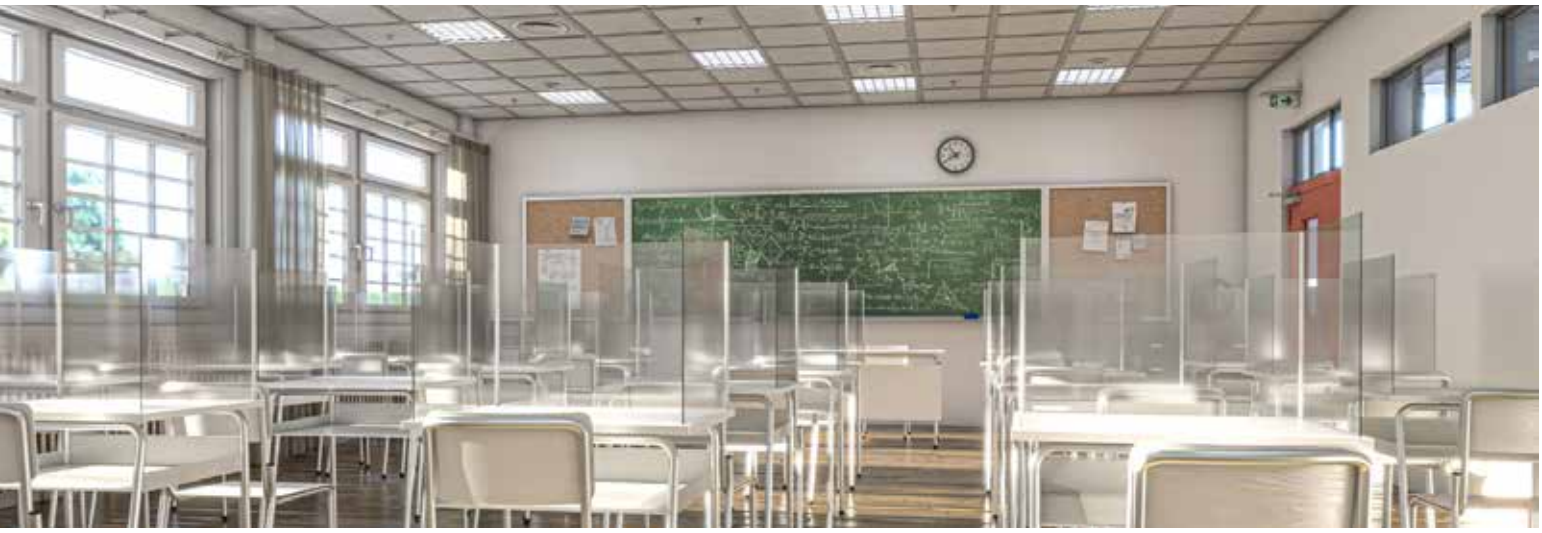
UV Disinfection for Schools and Universities



Ventilation improvements in K-12 schools are a cost-effective public health measure, according to a recent study from Johns Hopkins Center for Health Security, "School Ventilation: A Vital Tool to Reduce COVID-19 Spread."[1]

A broad conclusion of this research is that investments in healthy air in schools offer far-reaching benefits in terms of both student health and academic achievement.

To help guide school administrators' investments, researchers with the Johns Hopkins Center for Health Security identified six evidence-based "building-level public health interventions" designed to "reduce the risk of COVID-19 transmission and promote long-term health and academic performance."

Among the Johns Hopkins' public health recommendations is ultraviolet energy to disinfect room air simply, safely, and quickly without adding chemicals or other byproducts to the environment.

> "Improved ventilation may give children and school staff healthier indoor air quality for decades in the future, providing a healthier environment for non-pandemic times and potentially reducing risks in future infectious disease outbreaks."
>
> Johns Hopkins Center for Health Security[1]

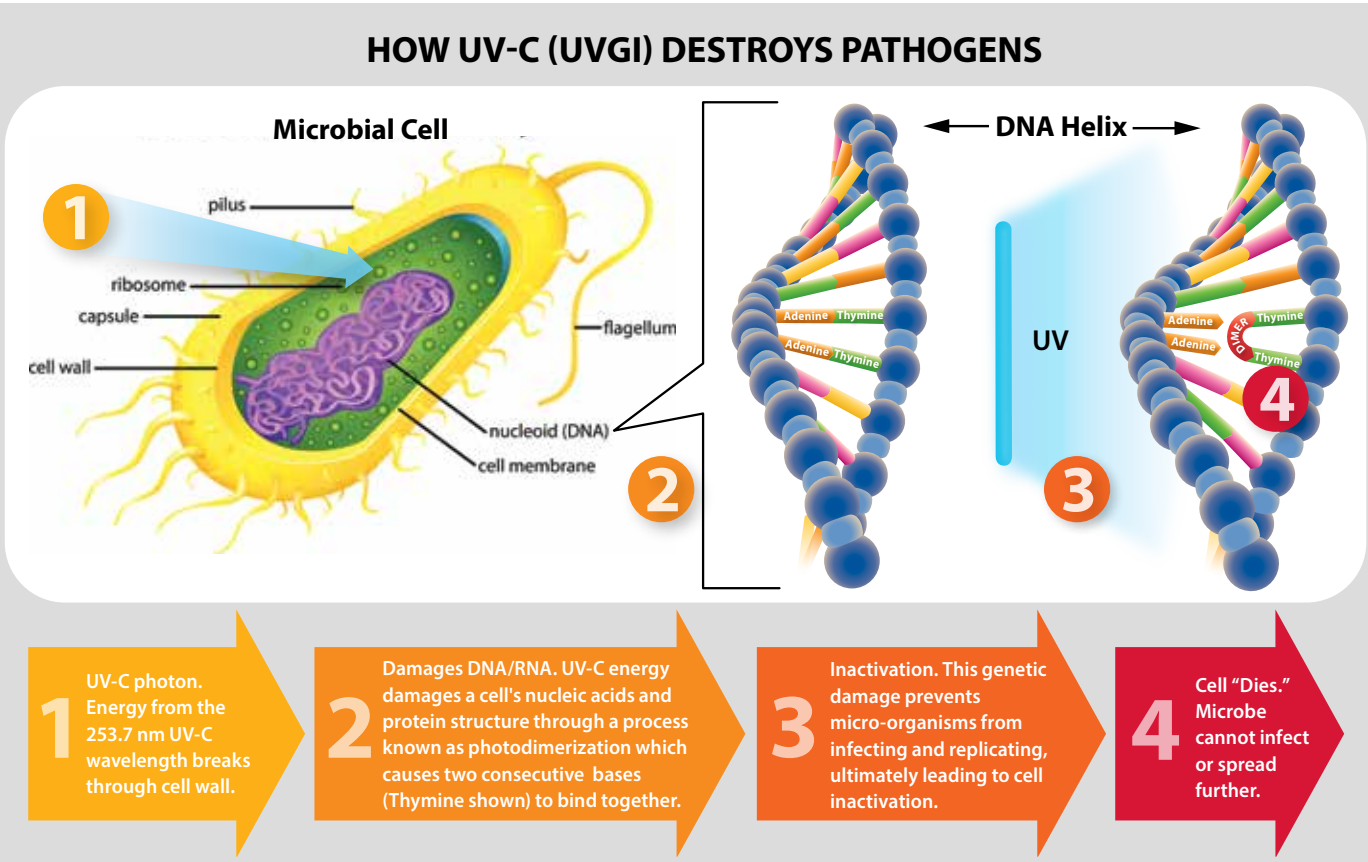


FIGURE 1: *Through a process known as photodimerization, UV-C energy damages a cell's nucleic acids and protein structure, causing two consecutive bases (Thymine shown) to bind together. This genetic damage prevents microorganisms from infecting and replicating, ultimately leading to cell inactivation.*

For nearly a century, scientists have known that Ultraviolet Germicidal Irradiation (UVGI or UV-C) energy deactivates airborne and surface-bound viruses, bacteria, and fungi **(see Figure 1)**.

"Light in the 253.7 nm Germicidal UV-C wavelength alters the protein structure in pathogens—DNA in bacteria and fungi, RNA in viruses—rendering the cell inactive and unable to replicate," explains Daniel Jones, president of UV Resources, a manufacturer of germicidal UV disinfection and HVAC-efficiency solutions.

GERMICIDAL UV-C ORIGINALLY TESTED IN SCHOOLS

Ironically, UVGI technology was proven to inactive airborne pathogens in school classrooms nearly eight decades ago. In 1937, epidemiologist William F. Wells installed Upper-Room UV lamps in suburban Philadelphia day schools to combat the measles virus. He then compared the measles infection rates of students who attended schools without UV-C. Schools with the air-sanitizing equipment experienced a 13.3 percent infection rate compared to 53.6 percent for the control group.

Some 80 years later, researchers observe the SARS-CoV-2 virus to be highly susceptible to germicidal UV-C irradiation.[2,3,4] The Centers for Disease Control and Prevention[5] and ASHRAE have recommended UV-C as one technology that can "reduce the risk of dissemination of infectious aerosols in buildings and transportation environments."[6]

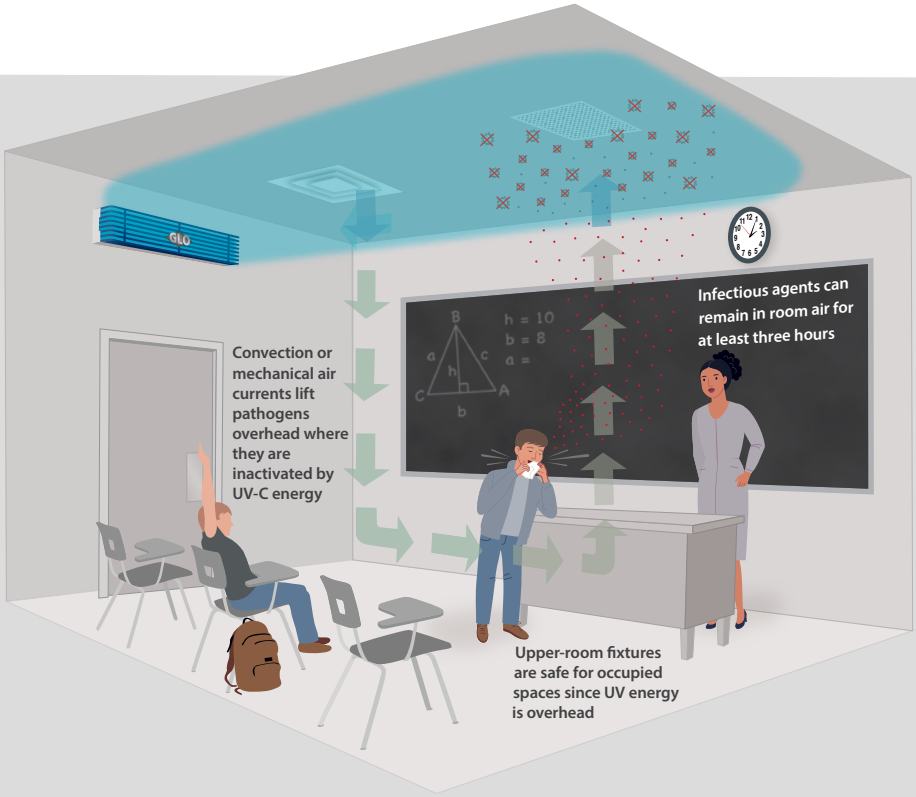


FIGURE 2: *As the natural rise-and-fall of convection or mechanical air currents lift infectious aerosols into a room's upper region, the germicidal UV-C wavelength breaks the bacteria or virus DNA chain, rendering it unable to reproduce.*

Different UV-C systems exist for Upper-Room treatment and HVAC/R applications. In the case of Upper-Room or Upper-Air UVGI, the germicidal fixtures are wall-mounted near the ceiling, and non-reflective louvers angle the UV-C energy upward and outward, away from room occupants **(see Figure 2)**.

UPPER-ROOM UV-C FIXTURES REDUCE PATHOGENS

To demonstrate the importance of proper building ventilation and its impact on infection rates, Jones' company produced a computer simulation of viral particles spreading inside a typical classroom **(Figure 2.1)**. Using computational fluid dynamic modeling, the video simulation shows how droplets from a sneeze can linger in a classroom, even with good airflow.

In a room with poor ventilation, enough droplets from a sneeze could linger in a cloud of particles even five minutes afterward, leading to possible "airborne transmission." Aerosols expelled during coughing, sneezing, or even talking can travel by air more than 30-40 feet.[7] Upper-Room UV-C fixtures can destroy microbes in a matter of seconds by creating an irradiation zone within the upper region of almost any space **(Figure 2.4).**

To demonstrate how UV-C Upper-Room fixtures operate, Jones' company conducted a side-by-side comparison of two classrooms—one fitted with germicidal UV-C fixtures and the other without.

To replicate particles generated by a sneeze or cough, droplets of four different sizes and velocities were dispersed in the computer model, using the center of a generic 34-foot by 27-foot classroom with 10-foot high ceilings (9,180 cubic feet). The simulation assumed four HVAC supply vents in the ceiling, a return air vent positioned above the "teacher" on the front wall, and a maximum capacity of 35 students.

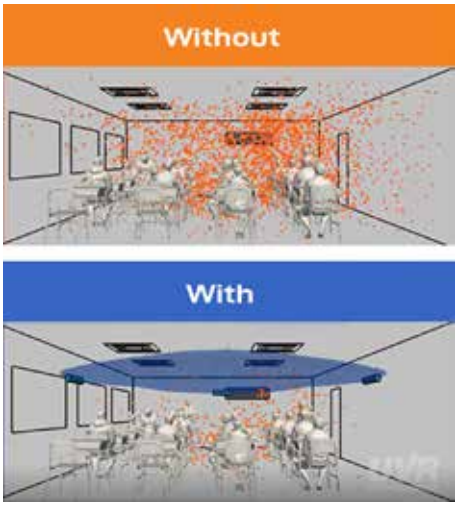


Figure 2.1

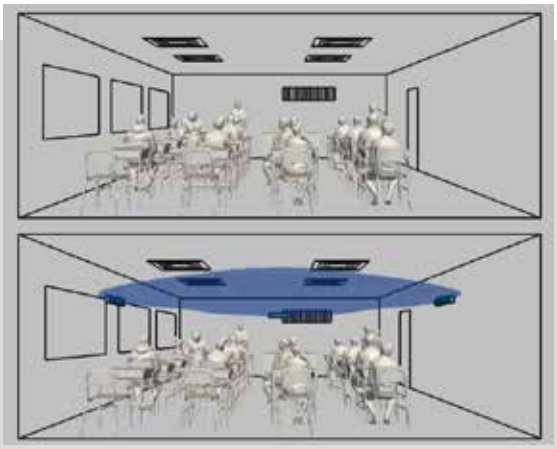


Figure 2.2 *Classroom: Time=0.0 sec; Top: No UV, Bottom: With UV*

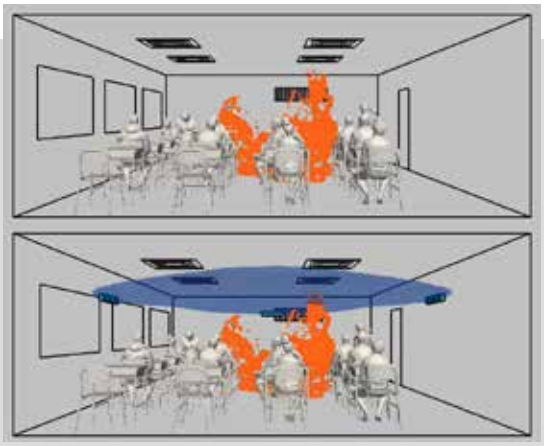


Figure 2.3 *Classroom: Time=50.0 sec; Top: No UV, Bottom: With UV*

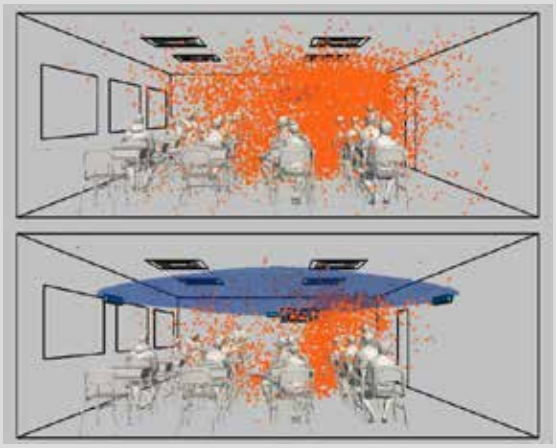


Figure 2.4 *Classroom: Time=5 min.; Top: No UV, Bottom: With UV*

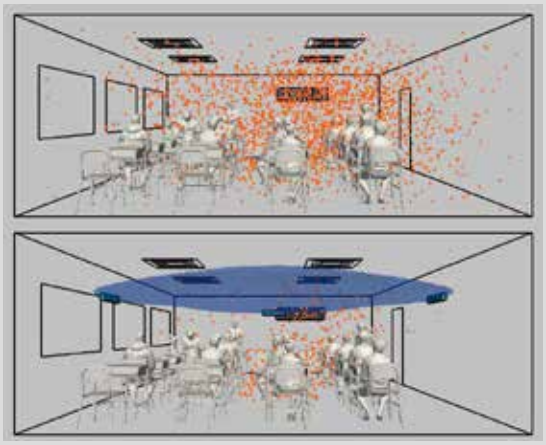


Figure 2.5 *Classroom: Time=15min.; Top: No UV, Bottom: With UV*

Researchers believe that smaller droplets from a sneeze or cough of an infected individual remain in the air considerably longer than larger ones that fall almost immediately. That means ventilation systems could drive the viral particles throughout an entire classroom or even school and infect more people.

In addition, because fresh air ventilation helps control infectious particles by diluting space air with outside air, ASHRAE 62.1 "ventilation for acceptable indoor air quality"[8] specifies minimum ventilation rates and other measures to reduce adverse health effects for occupants. School classrooms typically require between four and ten air changes per hour (ACH), and Jones' computer modeling assumed six (6) ACH or recycling the classroom's air volume every 10 minutes. The higher the ACH rate, the lower the risk of spreading airborne disease.

"Our simulation demonstrates how convection or mechanical air currents lift pathogens overhead where they are exposed to UV-C energy and inactivated in a matter of seconds," explains Jones. "Because air movement is continuous, pathogen concentrations are further reduced with each subsequent pass of recirculated air ("multiple dosing") through the Upper-Room germicidal zone."

In spaces without UV-C, such as the top classroom **(Figure 2.5)**, contagious droplets can linger for several minutes. Moreover, the longer a person is exposed to viral particles, the more likely they become infected and allow further spread of the disease.

By eliminating airborne allergens, bacteria, and viruses, Upper-Room UV-C fixtures installed near a room's ceiling neutralize microbes as they circulate from the natural rise-and-fall of air currents.

Students

- Improved academic performance
- Fewer missed school days
- Higher scores on cognitive function tests

Teachers/Staff:

- Decreased respiratory symptoms
- Increased teacher retention
- Improved morale

Source: *Designing Infectious Disease Resilience into School Buildings Through Improvements to Ventilation and Air Filtration Study.*[9]

STUDENT HEALTH/PERFORMANCE OUTCOMES DRIVEN BY IMPROVED IAQ

Researchers have found that better ventilation and air quality not only influences student health, but also academic performance outcomes, according to a position paper from the LANCET COVID-19 Commission Task Force on Safe Work, Safe School and Safe Travel.

To help put school air quality in perspective, 87 of 100 classrooms studied had ventilation rates below-recommended minimum standards, according to the LANCET Task Force paper,[9] suggesting that nearly nine-of-every-ten classrooms lack sufficient healthy air.

"In addition to decreased airborne infectious disease transmission, research shows that ventilation and **air cleaning improvements are likely to lead to improved academic performance** (in particular reading and math performance), **fewer missed school days** for students, higher scores on **cognitive function tests**, and many benefits for teachers including **decreased respiratory symptoms, increased teacher retention, and improved morale."**[10] [emphasis added]

VALUE OF VENTILATION

LANCET Task Force researchers link schools with poor ventilation to above-average rates of infection.

While Upper-Room UVGI fixtures are not standard in classrooms, the CDC notes boosting room ventilation rates can reduce the number of infectious viral particles. "Ventilation interventions include opening windows, using fans, adding high-efficiency particulate air (HEPA) fan/filter systems, and adding Upper-Room ultraviolet germicidal irradiation (UVGI)."

The public health agency notes that UVGI kills airborne pathogens at their source (as contaminants are spread in room air), and fixtures are installed to prevent direct UV exposures to people in the room.[11] Therefore, the CDC recommends UVGI for indoor spaces with insufficient or no mechanical HVAC systems or spaces where adequate natural ventilation cannot be maintained year-round.

If adequate building ventilation and airflow mixing levels are not appropriate, concentrations of pathogens will multiply, raising the risk of infection for

Did you Know?

Federal Coronavirus Aid, Relief, and Economic Security (CARES) Act and Elementary and Secondary School Emergency Relief (ESSER) funding may significantly offset school & college's investment in UVGI technology.

Figure 3: *The GLO Family of Upper-Air UV-C Fixtures disinfect room air simply, safely and quickly without the use chemicals.*

room occupants and viral spread. Even with proper ventilation, the possibility exists that HVAC systems can spread airborne pathogens beyond the source classroom.

What makes Upper Room UVGI particularly appealing is that it can be easily and affordably installed in existing classrooms," explains Jones. "Unlike in-duct fixture, these fixtures do not require knowledge of HVAC systems to install, and our product representatives can help guide in-house electrical or maintenance staff on proper fixture mounting and safety."

According to Jones, Upper-Room UVGI and in-duct UV fixtures are often used with other technologies in a multibarrier infection control strategy. Facility managers are encouraged to implement a layered approach incorporating multiple infection-control measures to ensure that any pathogen that cannot be removed by one method (e.g., filtration, cleaning) is inactivated by another (UV-C).[12]

MITIGATING CLASSROOM INFECTIONS

These recommendations align with long-standing industry guidance from ASHRAE in the control of airborne infections. For example, as part of its Position Document on Infectious Aerosols, developed by the Society's Environmental Health Position Document Committee, ASHRAE states:

"Dilution and extraction ventilation, pressurization, airflow distribution and optimization, mechanical filtration, ultraviolet germicidal irradiation (UVGI), and humidity control are effective strategies for reducing the risk of dissemination of infectious aerosols in buildings and transportation environments."

LEARN MORE

Reach out to our UV-C disinfection experts today to learn how ultraviolet energy in the 253.7 nm wavelength can help improve your indoor air quality, whether in a classroom, commercial office, restaurant, or community center.
See why HVAC researchers and infection preventionists view germicidal UV airstream (in-duct) disinfection and Upper-Room UVGI technologies as an extremely promising control strategy against infectious diseases.
Call us today at 877.884.4822 or email UVR.info@UVResources.com.

CASE STUDY

Community College Combats Infections with UV-C

At Schenectady County Community College outside New York, Facilities Director Alan Yauney has been fighting the war against infectious diseases for the past two decades.

Before the COVID-19 pandemic, Yauney sought to bolster campus infection control with Ultraviolet-C (UV-C) Germicidal Irradiation, which has improved indoor air quality and safety for the 50-year-old junior college.

WHY UV-C?

Yauney knew that UV-C would be an effective tool for infection control at the college, especially when he learned about Upper-Room germicidal UV-C light fixtures.

The wall-mounted fixtures create an irradiation zone within the upper region of almost any space. Thus, as the rise-and-fall of convection or mechanical air currents carry infectious pathogens upward into this disinfection zone, they are inactivated in seconds by the UV-C energy.

"UV-C's high infection kill rate makes it a no-brainer on a college campus like Schenectady, which is around 400,000 square feet and enrolls roughly 6,500 students," says Yauney.

Different UV-C systems exist for wall- and HVAC/R applications. In this case, the college wanted the ability to provide on-the-spot infection control with specific stand-alone installations of the Upper-Room UV-C fixtures.

So convinced was Yauney of UV-C's hygienic value that he managed to diversify payment for the units. "It wasn't a hard sell to persuade Administration to pay for UV-C once they understood the indoor air quality benefits it could yield," he says.

DROPPING THE BOMB ON INFECTION

Wishing to spare no expense on health and safety, Yauney moved forward to purchase and install 20 UV-C units from UV Resources across campus at a total cost of roughly $11,000. Units were positioned in the areas where infections are typically most entrenched, such as the cafeteria and daycare center.

"We installed between five and eight units in the daycare center alone because young children tend to be ill more frequently than adults and their interaction with one another makes transmission rates higher," explains Yauney. Units were also installed near the security desk, the cafeteria and Café, as well as the student forum and lounge.

Yauney argues that although most facility managers are probably not as germ conscious as he is, it's a valuable trait to have. "Anywhere you put thousands of people in close proximity, be it a hospital, airport, large office building or college, it's advisable to try to eliminate disease transmission as much as possible. Otherwise, the money you save will be lost to absenteeism and poor indoor air quality," asserts Yauney. ■

Student lounges and study areas are protected by several GLO Upper-Room UV-C fixtures around campus.

Students order food in the cafeteria as a GLO Upper-Room UV-C fixture disinfects room air.

ENDNOTES

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