IOM Panel Sees No Easy Way To Reuse Face Masks If Flu Pandemic Hits

There is no simple, reliable way to decontaminate face masks, meaning these devices cannot readily be worn more than once in the event of a major influenza outbreak or pandemic, according to a panel convened by the Institute of Medicine (IOM), part of the National Academies in Washington, D.C. (*Microbe*, April 2006, p. 165). "Even the best respirator or surgical mask will do little to protect a person who uses it incorrectly, and we know relatively little about how effective these devices will be against flu even when they are used correctly," says IOM panel cochair Donald S. Burke, professor of international health and epidemiology, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Md. "Substantial research must be done to increase our understanding of how flu spreads, develop better masks and respirators, and make it easier to decontaminate them."

injected with the experimental vaccine and then boosted orally. Other groups of mice were fed untransformed tobacco cells that lacked the toxoid in one case or plain sucrose in the other.

When the mice were challenged by drinking a liquid that contained the mouse-lethal *E. coli* serotype O91: H21, all 10 mice that received the five-day oral course of the toxoid-based vaccine and also 8 of the 10 mice that were inoculated and then orally boosted lived for up to 12 days, whereas all the mice that received only sucrose were dead within a week. Two of the mice that received toxoid-free tobacco cells survived a bit longer, possibly because *E. coli* are part of their gut flora, according to Wen. In any case, only those mice that received the experimental vaccine contained Shiga toxoid-specific antibodies in their feces.

"We feel that the systematic immunity against Shiga toxin type 2 that we observed indicates that an oral plant-based vaccine shows promise for protection against the severe, sometimes life-threatening, consequences of Shiga toxin-producing *E. coli* infection, against which no other suitable treatments or therapies are currently available," O'Brien, Wen, and their collaborators conclude.

"This paper is significant," says Charles Arntzen, codirector of the Center for Infectious Diseases and Vaccinology at Arizona State University, Tempe. The strategy of using purified components of plant tissue that includes an expressed vaccine "is good for oral delivery." However, he says about the experimental vaccine, "Just because it's technically capable doesn't mean it will lead to a vaccine. Somebody has to cover the [estimated $50–$100 million] cost" of full commercial development.

"Because we are a nonprofit research institute, we are limited in our ability to manufacture such a vaccine," Wen says. Nonetheless, O'Brien and colleagues plan to continue studying the plant-based vaccine approach for other antigens, including Shiga toxin type 1. Tailoring the tobacco-based vaccines for humans would entail extracting the active ingredient from tobacco cells, a strategy Arntzen now favors (*Microbe*, June 2006, p. 265) for plant-based vaccines, or perhaps engineering a more palatable fruit or vegetable to produce the toxoid version of Shiga toxin.

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C. crescentus Cells Produce an Extraordinarily Potent Adhesive

Caulobacter crescentus, a gram-negative bacterium that is widely distributed in aquatic environments, makes an extraordinary adhesive—for now, considered the strongest of biological origin and also exceeding the shear strength of some commercial super glues, according to bacteriologist Yves Brun at Indiana University in Bloomington. The polysaccharide-based cement is secreted through a holdfast region at the far end of each cell's long, slender stalk, he says. "We weren't looking for a glue; it just came out of basic research into the mechanisms of cell differentiation and adhesion."

When Brun affixed single cells to glass coverslips, he found that they cling so tightly that high-pressure water cannot knock them off. "A major challenge was finding a way to measure the force of attachment because it was so strong," he says. So he teamed up with physicist Jay Tang at Brown University in Providence, R.I.

One relatively new and accurate means for measuring the binding strengths of objects on a microscopic level uses laser tweezers (see page 330). Their upper limit is about 100 picoNewtons (pN), which typically is more than adequate for releasing bacteria from surfaces to which they adhere.

However, when laser tweezers failed to budge *C. crescentus* cells, the team devised a clever micromanipulation method. They first attach bacterial cells to a thin flexible pipette through their stalks. Then the re-

searchers pull on the main body of single cells with a second suction pipette, while measuring the deflection of the first pipette. From the degree of deflection they calculate the pulling force according to Hooke's law.

Commercial super glues typically break when a shear force of 18 to 28 N/mm^2 is applied to attached objects. In contrast, a shear force of 68 N/mm^2 is required to detach *C. crescentus* from pipette surfaces, according to Tang and Brun, whose findings are detailed in the April 11, 2006 issue of the *Proceedings of the National Academy of Sciences*.

The *C. crescentus* glue is even stronger than the adhesive force of setae, or bristles, protruding from the toes of geckos that enable them to run upside down across ceilings. Setae depend on strong van der Waal interactions, and are considered one of the strongest biological adhesive mechanisms. Nonetheless, gecko adhesion fails when subjected to a shear force of a mere 10 N/mm^2, making it nearly sevenfold weaker than that of *C. crescentus*. Other sticky microbes, such as sulfate-reducing bacteria and *Bacillus mycoides* spores, produce adhesive forces of less than 1 N/mm^2. Commercial dental cement bonds at strengths of up to 30 n/mm^2.

Thus, the strength of *C. crescentus* exceeds all of these. "Given microbial diversity, I doubt this is the strongest glue out there," Brun says. He plans to isolate other surface-adhering *Caulobacter* species to evaluate the relative strengths of their glues.

Brun also is learning more about the biophysical mechanisms that give the *C. crescentus* adhesive its strength. He already knows that one critical component is N-acetyl glucosamine. Indeed, treating *C. crescentus* with lysozyme, which degrades polymers containing N-acetyl glucosamine, greatly reduces the adhesive properties of the cells. Brun suspects that polysaccharides containing N-acetyl glucosamine serve as support structures for other adhesive molecules, which he is seeking to identify and characterize. However, he says, "We're having trouble getting glue off surfaces to analyze it."

Potential commercial applications of this bacterial adhesive, which works on wet surfaces, include surgical glue or as a coating to prevent fouling by biofilms on surfaces, such as ship hulls. Although polyethylene glycol (PEG) coatings can prevent biofouling, PEG does not adhere well to surfaces. Possibly the bacterial glue may be formulated with PEG to improve its ability to coat surfaces and, in turn, better prevent biofilms from forming.

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Distinctive Quorum Sensing in Yeast

Like many types of bacteria, yeast cells communicate among themselves through quorum sensing, according to Hao Chen and Gerald Fink of the Massachusetts Institute of Technology in Cambridge, Mass. However, the mechanistic details of this chemically mediated self-control pathway in *Saccharomyces cerevisiae* not only are distinct from those in bacteria but also differ in some ways from those in the yeast *Candida albicans*, they report in the April 17 issue of *Genes & Development*. For instance, *S. cerevisiae* cells use aromatic alcohols as signals to stimulate filamentous growth when they are starved for nitrogen. However, these alcohols do not elicit a morphologic shift in *C. albicans*, indicating that these fungal quorum-sensing signals are species-specific. "The ability of these quorum-sensing molecules to stimulate growth or alter morphology could be important in pathogen virulence where the infecting organism is initially present in only small numbers of cells," Fink points out.

Environments Profoundly Shape Bacterial Gene Expression Patterns

Bacterial species adapt to new environments by changing gene expression much more than by changing the genes themselves, according to L. Aravind of the National Center for Biotechnology (NCB), National Institutes of Health, Bethesda, Md.; M. Madan Babu, who is visiting the NCB, and Sarah Teichmann of the MRC Laboratory of Molecular Biology at the University of Cambridge in Cambridge, United Kingdom. Based on data from 174 microbial genomes containing about 500,000 protein sequences, they and their collaborators conclude that regulatory networks of different bacterial species converge when those species occupy similar environments.

"We found that at every level of organization, the shape of the transcription network structure has been determined primarily by the environment in which the organism lives," says Madan Babu. Thus, seemingly similar bacteria are finely tuned for the very specialized niches that they occupy, even when those niches all happen to be within a single species, such as humans.

For example, Madan Babu points out, "*E. coli* normally lives in a relatively stable environment, where it makes sense not to switch to anaerobic respiration in response to small