STANDARD DEVIATIONS: Danger, Will Robinson!

Greetings,

I remember, as a younger kid, the strange and magical sight of instant frothing as my Mom would treat a cut or abrasion with **hydrogen peroxide**. It was hard to imagine what occurred in that fascinating catalytic reaction as a child and, even now, it's still pretty cool to see.

The antiseptic properties hydrogen peroxide (at its 3% commercial concentration) are incredibly effective in ridding an affected area of bacteria, grit, dead skin, etc. leaving the area clean and germ free. Your Mom will tell you all about the myriad other applications around the house that make this product so popular over the years; from removing stains in laundry to cleaning glass.

Hydrogen peroxide works by producing destructive hydroxyl free radicals that can attack membrane lipids, DNA, and other essential cell components. It does not discriminate though; as well as killing any damaging bacteria, it also kills healthy cells. This is a major reason we came up with anti-bacterials to target just the bugs without causing further damage. And, that strong oxidative property makes hydrogen peroxide a lethal poison at higher concentrations or extended exposure.

Hydrogen peroxide is active against a wide range of microorganisms, including bacteria, yeasts, fungi, viruses, and spores. At stronger concentrations it is used as a sterilant, which the EPA defines as "a substance that destroys or eliminates all forms of microbial life in the inanimate environment, including all forms of vegetative bacteria, bacterial spores, fungi, fungal spores, and viruses". Vaporized hydrogen peroxide (VHP) is now finding a niche with applications as a low-temperature antimicrobial vapor used to decontaminate enclosed and sealed areas such as laboratory workstations, isolation and pass-through rooms, aircraft interiors, **and hospitals**.

Vaporized hydrogen peroxide has been shown to reduce incidence of nosocomial infections from a number of pathogens. *Clostridium difficile* associated disease, VRE and MRSA are all associated with environmental contamination. H2O2 vapor has been used in hospitals to eradicate villainous agents, e.g., antibiotic-resistant *Klebsiella pneumoniae*, from the environment and prevent infection of subsequent patients. It is far more effective and penetrating than UV light.

VHP has become an important tool in biosafety. Here at the Utah Public Health Laboratory (UPHL), we use VHP for disinfection of the BSL-3 space when spills or exposures pose a risk to staff from the organisms we encounter. Each time I do PM on this unit (Bioquell Z is the product we use), I am transported to my after-school afternoons in front of the TV watching Lost In Space because the machine looks just like the robot in that show!

{UPHL's Bioquell Z and Rodney the Series 1A-1998 Class YM-3 Model B-9 General Utility Non-Theorizing Environmental Control Robot}

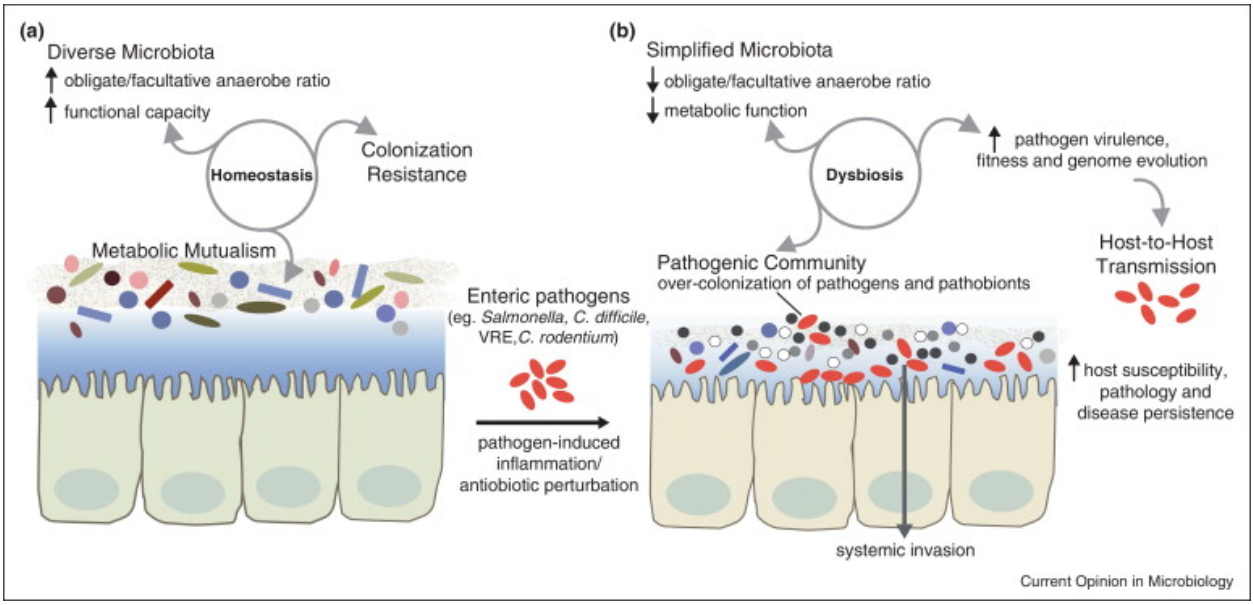
HOWEVER, as cool as this may seem, I simply needed some kind of segue to get to my real story today. If I can throw some biosafety at you then the upstairs folks are happy and I can move on to things that we really need to think about. It's still hydrogen peroxide, just more interesting.

In the normal, healthy gut, bacteria form our **gut microbiota.** The gut microbiome plays an important role in nutrient and mineral absorption, synthesis of enzymes, vitamins and amino acids, and production of short-chain fatty acids; gut microbe–host interactions include effects on metabolism, immune, and neuroendocrine responses.

A quick perspective: the human body expresses 20,000 eukaryotic genes while the gut microbiome expresses 3.3 million prokaryotic genes.

It may look like a win-win, but **our well-being is dependent on maintaining a barrier between the body and the biome.** The intestinal mucosal barrier refers to the property of the intestinal mucosa that ensures containment of undesirable luminal contents within the intestine while preserving the ability to absorb nutrients. It's critical in protecting mucosal tissue and the circulatory system from exposure to pro-inflammatory molecules, such as microorganisms, antigens, and toxins.

We need all the biome working but not interfering with the gut functions. So we have this thin mucoid film of a barrier that separates the two. *Trouble arises when that barrier breaks down.*

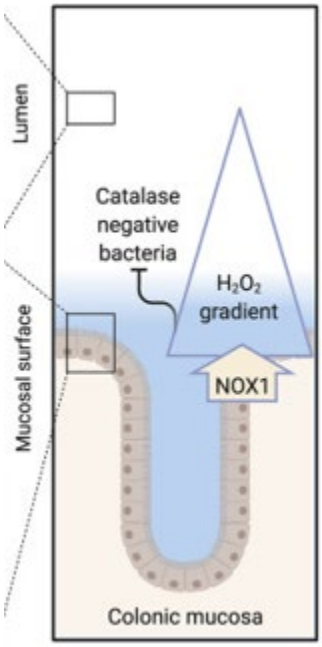


When the body experiences an imbalance in the gut microbial community, it suffers from dysbiosis which can cause inflammation and symptoms such as nausea, upset stomach and bloating. It's a precursor to more severe complications.

We have a fairly large battery of protections that support the barrier. Biochemicals like bile and gastric acid are produced by the liver. Specialized cells (Paneth cells) of the intestine secrete defensins, lysozymes, lectins, and antimicrobial peptides able to kill or hinder bacteria and

fungi. Immune cells underlie the intestinal epithelium providing immune protection and making secretory IgA blocking pathogen receptors.

This week, *a team at UC Davis reports discovery of an enzyme (NOX1) that synthesizes hydrogen peroxide in the intestinal lining*. H2O2 released into the lumen forms a gradient in the mucus layer that acts as a disinfectant. The gradient protects the mucosal surface but keeps the microbial communities at a distance from the colon surface where they remain unharmed (until now it was thought that oxygen was being released by cells to prevent microbes from coming too close to the intestinal lining). **Here is the segue!** Just like in the lab, the reactive nature of H2O2 makes it a strong disinfectant, vital to the healthy gut.



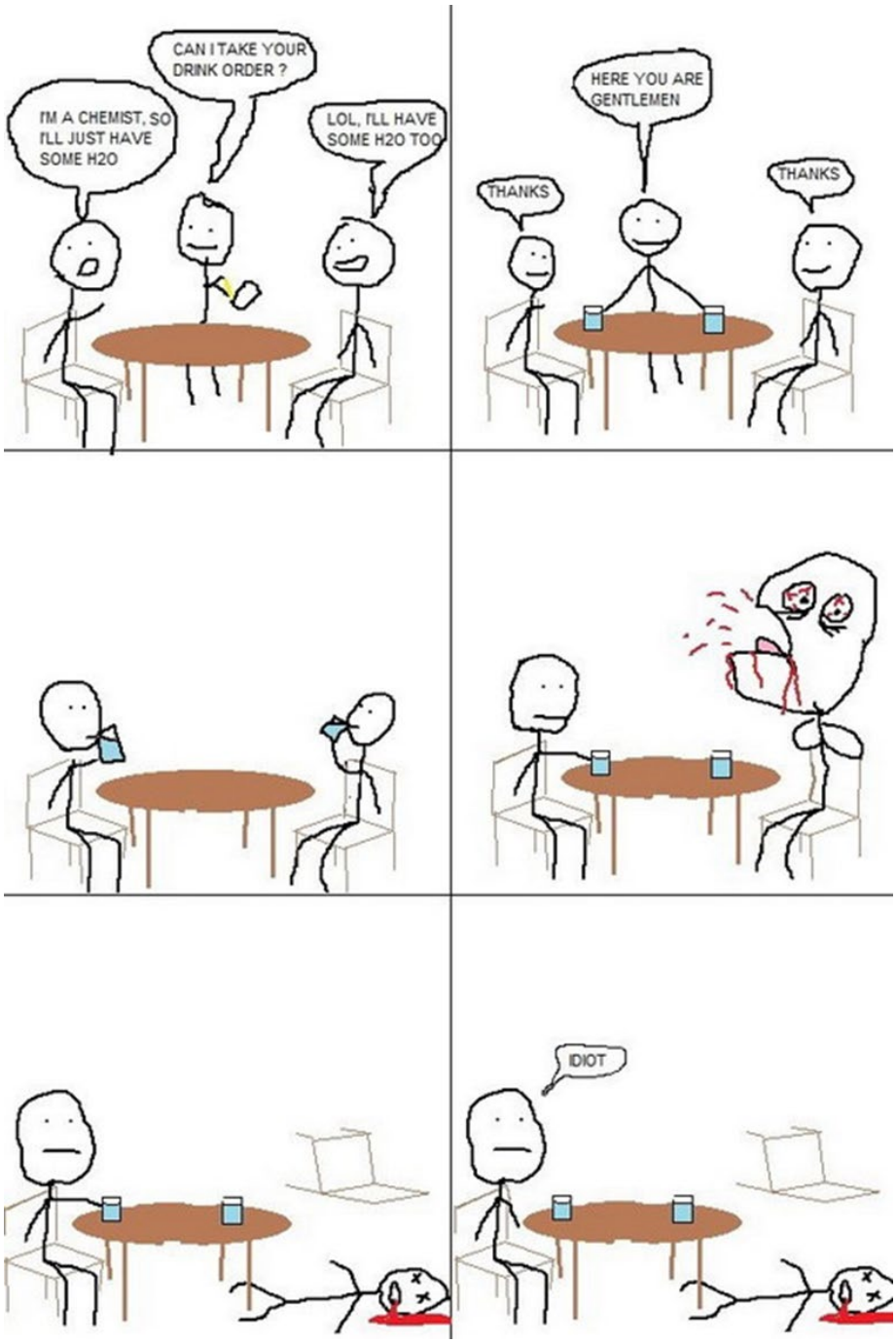
A consequence of dysbiosis is the loss of that intestinal mucosal barrier and the defense against colonization by harmful pathogens, especially those resistant to antimicrobials. Antimicrobial resistance (AMR) is leading to increased enterocolitis and diarrheal disease around the globe.

Infectious diarrhea is a well-known cause of morbidity and mortality in hospitalized patients. The most common cause of infectious diarrhea is *Clostridium difficile*-associated diarrhea. Other common causes include *Clostridium perfringens* and *Staphylococcus aureus*. AMR in these bugs is certain and guaranteed to be major public health concern. More hospitalizations will mean more nosocomial infection which, in its turn, translates to more work in the lab.

When we compromise our abilities to protect the gut from these nasty bugs the consequence is increased hospitalizations and higher morbidity and mortality.

Have a great week and be safe,

Bryan


CAN I TAKE YOUR DRINK ORDER ?
I'M A CHEMIST, SO I'LL JUST HAVE SOME H2O
LOL, I'LL HAVE SOME H2O TOO
HERE YOU ARE GENTLEMEN
THANKS
THANKS
IDIOT

{XKCD comic}