Parasite and bacterium illustrate convergent evolution: Both hijack cells' 'post office'

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The protozoan parasite *Toxoplasma gondii* and the pathogenic bacterium Chlamydia trachomatis exemplify convergent evolution, the development of a similar biological trait in unrelated lineages, according to research presented today at the American Society of Cell Biology's 50th Annual Meeting in Philadelphia.

The biological trait shared by the two pathogens is their modus operandi – how they operate inside human host cells to reproduce themselves, said scientists at the Johns Hopkins Bloomberg School of Public Health, working with researchers at the University of Maryland Dental School and the University of Zurich in Switzerland.

Both *T. gondii* and Chlamydia hijack their host cells' Golgi apparatus, the "post office of the cell" because it packs up and dispatches cellular cargoes such as lipids in sealed vacuoles. After taking over the Golgi, both pathogens reorganize the organelle into mini-stacks conveniently aligned just outside each invader's hiding place in the cell.

In addition to being an example of convergent evolution, the pathogens' predatory similarity is a possible clue for improving therapies to contain two of the most common infections on earth, said Julia Romano, Ph.D., and Isabelle Coppens, Ph.D.

The research that lead to the discovery of *T. gondii* and Chlamydia's similar mode of action was prompted by a study on how Toxoplasma secures a nutrient supply inside an infected host. In that National

Institutes of Health supported study, scientists noticed a strong parallel with chlamydial infection that had not been suspected since protozoa and bacteria stem from distant evolutionary branches.

Romano and Coppens investigated Toxoplasma-infected host cells to determine how the parasite hijacks lipids named ceramides and found that the protozoan hid from the host's immune system by living inside its own capsule, parasitophorous vacuole (PV). They then determined that the protozoan was able to grab nutrients without exposing itself, because it had located its PV near the hub of the cell's cargo system, the pericentriolar region, and thus close to the Golgi. Within 32 hours of infecting a host cell, the protozoan had sliced the Golgi into fragmented mini-disks and was ingesting intact vacuoles containing ceramides through its PV membrane.

The remodeled Golgi, the PV's location in the pericentriolar region, and the efficient capture of the host's sphingolipid supply reminded the researchers of infection by C. trachomatis, which causes the most frequently reported sexually transmitted disease in the U.S. To test the parallel, the researchers co-infected mammalian cells with *T. gondii* and C. trachomatis and then observed the two pathogens' quickly dividing the Golgi between them. The two disparate pathogens' distributing the fragments of the organelle equally indicates a common evolutionary strategy.

According to the U.S. Centers for Disease Control (CDC), 1.2 million cases of C. trachomatis infection were reported during 2008 in the U.S. "Silent," untreated C. trachomatis infections can cause infertility in women. Spread by infected meat, Toxoplasmosis is the third leading cause of death attributed to food borne illness.

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