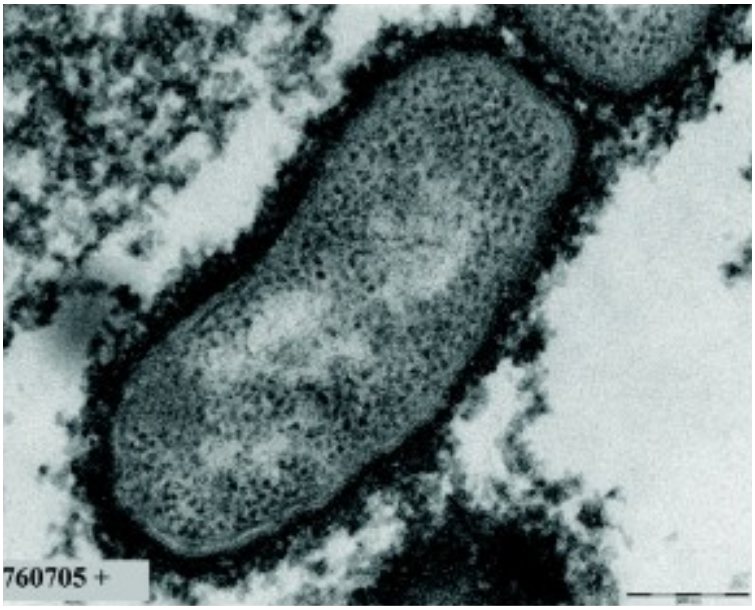
MicroRogue: Haemo (*Haemophilus influenzae*)

(Jennifer Poo)



H. influenzae Type b (Hib) with its capsule stained at 65,000X magnification. The capsule, the thick black layer surrounding the bacterium, is made up of sugars that are chained together to form a protective outer layer. File is licensed under the Creative Commons Attribution License.

Claim to fame: part of our normal microbiome, waiting for moments of weakness to cause disease

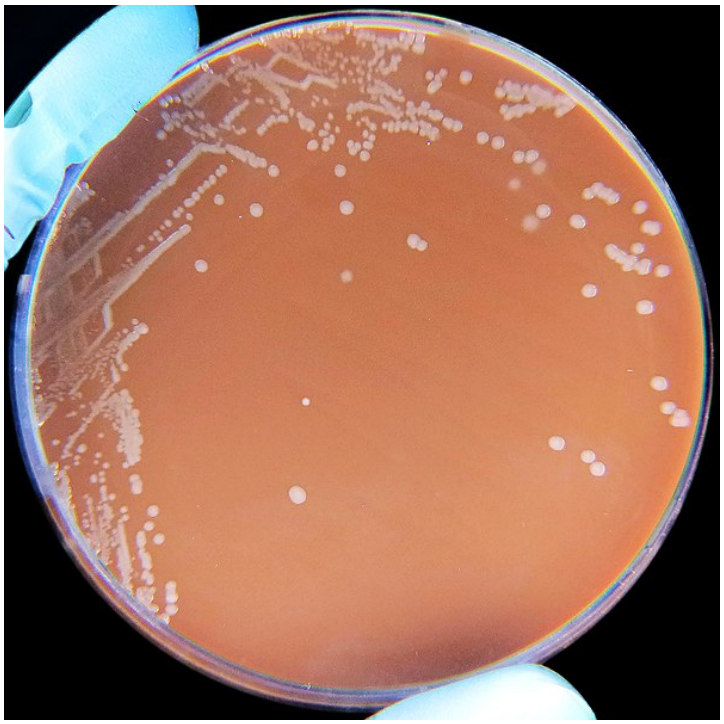
A case of mistaken identity. In 1892, the German physician and scientist Richard Pfeiffer isolated what he thought was the causative agent of influenza. He identified the small rod-shaped bacterium as *Bacillus influenzae* (*Bacillus* refers to the rod shape of the bacterium, and *influenzae* refers to the disease he thought it caused.)

Then came the 1918 flu pandemic, one of the deadliest pandemics in recorded history. In the frenzy of the outbreak, scientists and physicians were trying and failing to isolate the bacteria that Pfeiffer had originally identified from influenza patients. Many had ascribed their failures to poor technique, but a pair of scientists at the Rockefeller Institute suspected otherwise.

Peter Olitsky and Frederick Gates collected nasal secretions from patients with influenza during the 1918 pandemic and passed those secretions through special filters that exclude bacteria based on size. They then took their filtered samples and found that, even after filtering out bacteria, the nasal secretions from influenza patients were still able to cause disease in rabbits, ruling out bacteria as the causative agent of influenza.

Since then, the bacterium Pfeiffer originally identified as *Bacillus influenzae* has been renamed *Haemophilus influenzae* (*Haemo-* referring to the protein hemoglobin found in blood and *-philus* meaning beloved in Latin). This new name refers to bacteria that grow more robustly in

the presence of hemoglobin, while "*influenzae*" was retained in reference to its original misidentification.



Haemophilus influenzae grown on a chocolate agar plate. Chocolate agar is often used to grow difficult to grow bacteria. It contains hemin and animal blood that contribute to its "chocolate" appearance. File is licensed under the Creative Commons Attribution 2.0 Generic license. https://commons.wikimedia.org/wiki/File:Haemophilus_influenzae.jpg

Resident microbe. While Haemo is best known to us as a cause of illness, many adults and children host it in their normal microbiomes without even knowing it. Microbes that reside on and within us without harming our health are described as "commensal" so, although Haemo can cause disease, for most healthy individuals it is a part of our normal, commensal microbial communities.

Over half of children are colonized with Haemo by the age of 6 and at least 75% of healthy adults carry a strain of the bacteria without issue. Haemo colonizes the mucosal lining of the upper respiratory tract of healthy individuals, primarily the nasal passages and the throat.

Opportunistic pathogen. Haemo does not typically cause disease on its own; instead, it waits for the host to be afflicted by something else before causing problems. For example, a viral infection might weaken the immune system, which then allows Haemo to invade the lower respiratory tract, causing pneumonia.

These types of pathogens are described as *opportunistic* because they only cause illness when other factors provide them with an opportunity. For this reason, individuals who are most susceptible to Haemo infection are those who are sick with a different infection,

immunocompromised, or suffer from a chronic inflammatory disease, such as chronic obstructive pulmonary disease (COPD).

Haemo's capsule. There are two main types of Haemo: encapsulated and unencapsulated. The cells of encapsulated strains, the most prominent one being *H. influenzae* type b (Hib), have a protective outer layer (see image above) that protects the bacterium from being killed easily by our immune system.

Hib causes a variety of different diseases depending on the location of infection. Pneumonia occurs when bacteria infect the lower respiratory tract; *H. influenzae* can also infect the membranes lining the brain and spinal cord, causing bacterial meningitis; and complications from both pneumonia and meningitis can cause bloodstream infections.

Unencapsulated *H. influenzae*, on the other hand, lack the coating and are less pathogenic than encapsulated strains. Most commensal *H. influenzae* are unencapsulated; however, they still can cause disease. Unencapsulated *H. influenzae* strains most commonly cause nasal infections, ear infections, and eye infections.

Haemo is a horrible sneaky MicroRogue!

Treatment. Haemo is particularly susceptible to the penicillin family of antibiotics, otherwise known as beta-lactams. The way these antibiotics work is by disrupting the machinery needed for the bacteria to construct their cell walls.

However, Haemo can develop resistance to these antibiotics; the most common way is by acquiring genes that produce enzymes called beta-lactamases that degrade these antibiotics. In the event that Haemo is resistant to penicillin-related antibiotics, antibiotics of the quinolone and macrolide families are often used instead. However, as rates of antibiotic resistance rise, scientists are looking for other ways to manage these bacterial infections.

What we can do to prevent Haemo infections? The key to prevention of Haemo infections is vaccination of people before they suffer predisposing issues that open the door to Haemo. In the USA, vaccination against *H. influenzae* type b (Hib) is part of the routine pediatric vaccination schedule.

The Centers for Disease Control and Prevention (CDC) recommends children be vaccinated against Hib at 2 months, followed by up to 3 boosters within the first 15 months of life. Initially in the US, children older than 18 months began being vaccinated for Hib; shortly after, in 1990, the vaccine was approved for infants, who are the most susceptible to Hib infections. Since then, the incidence of Hib infections in children under the age of 5 has decreased by 99%.