

Antimicrobial Resistance Gallery

Myco (*Mycobacterium tuberculosis*): an ESKAPE¹ pathogen

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The Mycobacteria

Mycobacteria are bacteria with a very peculiar cell wall rich in lipids that make them very resistant to standard staining methods used to reveal microbes using the microscope. For this reason, they are stained with a special procedure called Ziehl-Neelsen or a fluorochrome staining and are called acid-fast bacteria.

The cell wall makes them naturally resistant to many antibiotics: mycobacteria are very well equipped to resist to the antibiotic attack and can be compared to armed tanks! They also grow slowly in culture and some of them only under very special conditions.



Photomicrograph of a sputum sample containing *Mycobacterium tuberculosis*. *M. tuberculosis* bacteria can attack any part of the body, but usually the lungs causing tuberculosis. It is spread when infected individuals cough or sneeze, releasing microdroplets into the air that contain the bacteria, which others then inhale. [Centers for Disease Control and Prevention's Public Health Image Library](#) (PHIL), with identification number [#2128](#).



Scanning electron micrograph of *Mycobacterium tuberculosis* bacteria

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¹ Multidrug resistant *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa* and *Enterobacter* species comprise the ESKAPE bacteria (<https://academic.oup.com/jid/article/197/8/1079/901561?login=false>). These bacteria, along with a few others – the ESKAPE+ bacteria – which includes Myco, top the World Health Organization list of priority pathogens that pose the greatest threat to human health (<https://iris.who.int/bitstream/handle/10665/376776/9789240093461-eng.pdf?sequence=1>).

A learner-centric microbiology education framework

There are more than 200 species of mycobacteria, most of which are opportunistic pathogens causing disease only in people whose immune defenses are low, for example because of another disease.

***Myco*: “the top infectious killer”**

The most “infamous” *Mycobacterium* is *Mycobacterium tuberculosis* which causes tuberculosis (TB). TB is a disease of the lungs (but not only!) that infects around 10 million people worldwide per year and kills 1.5 million (<https://www.who.int/news-room/fact-sheets/detail/tuberculosis>). People die or get sick with tuberculosis everywhere, but people living in some countries in Africa and Asia, and living under poor and crowded conditions, are most affected. People with HIV, children, and those with an immune system not functioning well for different causes are also at higher risk.

Tuberculosis has been around for thousands of years!

Ancient civilizations like those of the Egyptians and Greeks knew about a sickness that made people cough and feel weak and we have proof of the disease from mummies and old bones now collected in museums. In the 18th and 19th centuries, TB was called the “White Plague” because people with TB often looked pale and weak. It was a big problem in cities, especially in Europe and North America.

In 1882, a scientist named Robert Koch discovered that TB was caused by tiny bacilli. This was a big breakthrough! Still there was no therapy so people were treated with food, rest and sunlight in sanatoria, special clinics often located in nice natural areas. However, with improvement of socioeconomical conditions and availability of food, and access to antibiotic therapy, tuberculosis decreased in the “Western” world.

The TB disease

TB is mostly an infection of the lungs and is spread from person to person through the air when someone with TB coughs or sneezes, so it is a contagious disease; only a few microbes are needed to cause an infection. Tuberculosis can also affect all organs in the body. TB meningitis – an infection of the meninges, the membranes that enclose and protect the brain and spinal cord, is very serious and often deadly and difficult to diagnose form of tuberculosis and may affect children and immunocompromised people.

Not all people who become infected go on to develop the disease because people with an active immune system can kill or control the growth of the bacteria inside their body. It is estimated that one quarter of the world population has been infected with *Myco*.

Sometimes, the bacteria remain in the body in an inactive form – they are “sleeping”; people are infected but DON’T have symptoms and CANNOT transmit the disease. However, if their immune system becomes weakened, they are at risk of becoming sick with tuberculosis because *Myco* can wake up. To avoid this, adults and children who were in contact with someone with TB are offered a 1 to 4 month therapy with one or 2 drugs. This is called “preventive therapy” and cannot be used to treat people with active tuberculosis.

Diagnosis and treatment

People who become sick with TB need to be diagnosed and treated soon to avoid infecting others. This is done either by detecting Myco bacilli in the sputum – the phlem that TB patients cough up – with the microscope after special staining, or their DNA by molecular tests, and treated with at least 3 antibiotics for 4-6 months.

The problem of antibiotic resistance

Unfortunately, Mycos can modify their genes so that they are no longer killed by the antibiotics used for therapy. It's like the bacteria have a special shield that protects them from the antibiotics used to treat the disease. Antibiotic resistance is called multidrug resistant (MDR) when Myco becomes resistant to at least the two most important drugs used for treatment: rifampin and isoniazid. It is called extensively drug resistant (XDR) when Myco-MDR bacteria become resistant to at least two important drugs used to treat MDR (fluoroquinolones, bedaquiline, linezolid).

When someone has drug-resistant MTB, they need special treatment regimes – combinations of at least 3 drugs – that are stronger and might have more side effects. The treatment can also take longer, and it's very important to take the medicines exactly as prescribed by the doctor. XDR tuberculosis needs to be treated with many drugs for very long time, and the treatment may not be sufficient. If someone with Myco-MDR doesn't take their medicine correctly, or doesn't finish the full treatment, the Myco-MDR bacteria can become XDR, and harder to treat. People can STILL die from MDR- and XDR- Mycos, also in the western world.

Myco-MDR and Myco-XDR are fearsome ESKAPE+ rogues!

Don't be frightened of and discriminate against people treated for TB!

What is very important is that tuberculosis is diagnosed early and treated properly. Sometimes it is easy to make the diagnosis, sometimes is difficult: to diagnose MDR and XDR tuberculosis we need to use special diagnostic tests to predict the resistance of bacteria. The people with tuberculosis should take all the medicine prescribed, eat food and try to avoid spreading the bacteria to others. Using a face mask and changing air in the room by ventilation are important measures to decrease transmission.

Once people are under treatment, if the treatment is correct, they stop being infectious in very short time! So, it is very wrong to discriminate people with tuberculosis and we need to do all we can to help them to get diagnosed and properly treated fast.