Mycobacterium tuberculosis

http://ilovebacteria.com/Images/tbpic.jpg
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Microbe’s Name

*Mycobacterium tuberculosis*
Classification

- **Kingdom:** *Bacteria*
- **Phylum:** *Actinobacteria*
- **Class:** *Actinobacteria*
- **Order:** *Actinomycetales*
- Suborder: Corynebacterineae
- Family: Mycobacteriaceae
- Genus: Mycobacterium
- Species: *M. tuberculosis*
The Greek prefix *myco-* means "fungus“, alluding to the way *mycobacteria* have been observed to grow in a mold-like fashion on the surface of liquids when cultured.

*Mycobacterium tuberculosis* can cause a disease called tuberculosis, MTB or TB which is a fatal, infectious disease.

A bacillus, rod-shaped bacteria.
Nonmotile, nonsporing and noncapsulated bacillus arranged singly or in group.

Has a complex peptidoglycan arabinogalactan mycolate cell wall that is approximately 60% lipid, resulting in acid fastness, poor Gram staining (weakly gram positive) and resistance to drying and many chemicals.

The tough cell wall of *M. tuberculosis* prevents passage of nutrients into and excreted from the cell, therefore giving it the characteristic of slow growth rate.
Cell wall structure of *Mycobacterium tuberculosis*.
- *M. tuberculosis* is a facultative intracellular pathogens usually infecting mononuclear phagocytes.

- Mycosides are glycolipid derivatives of mycolic acid and these mycosides are pathogenic determinants:
  1. Cord factor (Trehalose mycolate)
  2. Sulfatides (Sulfur containing glycolipid)
  3. Wax D (complex mycoside)

- *M. tuberculosis* is genetically diverse, which results in significant phenotypic differences between clinical isolates. Different strains of *M. tuberculosis* are associated with different geographic regions.
The most commonly used strain of *Mycobacterium tuberculosis*, the H37Rv strain
- *M. tuberculosis* is a acid fast bacteria, which can form acid-stable complexes when certain arylmethane dyes are added.

- All species of *mycobacteria* have ropelike structures of peptidoglycan that are arranged in such a way to give them properties of an acid fast bacteria.

**Acid-Fast Staining of Sputum Sample**

https://www.youtube.com/watch?v=A4lZLYVXGaA
Most of the 150 different species of *Mycobacteria* are free living in soil and water, but major ecological niche for *Mycobacterium tuberculosis* is diseased tissue of humans and other warm blooded animals.

*M. tuberculosis* is an intracellular pathogen that usually invade and infect immune cells in the lungs, but they can also damage another parts of the body.
Once inside the human host cell, *M. tuberculosis* inflicts a contagious-infectious disease called tuberculosis (TB).

*M. tuberculosis* first infected humans 10,000-15,000 years ago. It has been found in early hominids originating in East-Africa.

In 1993, the World Health Organization (WHO) declared TB as a global public health emergency which estimated that one third of the world population is infected by this bacteria.
- *M. tuberculosis* forms a complex with other higher related bacteria called the *M. tuberculosis* complex.

- It consists of 6 members: *Mycobacterium tuberculosis*, *Mycobacterium africanum*, *Mycobacterium microti*, *Mycobacterium bovis* and *Mycobacterium canettii*.

- *M. tuberculosis* has very simple growth requirements and is able to grow slowly in harsh conditions.

- Their acid-fast property is the strongest when there is glycerol around. However, when glucose is the main source of nutrient, the utilization of glycerol by *M. tuberculosis* is inhibited.
Mycobacterium tuberculosis in a petri dish.
Mycobacterium tuberculosis under microscope.
Mycobacterium tuberculosis in an agar.
Metabolism and Nutrition

- Cholesterol metabolism has been studied extensively and it has been shown numerous times that *M. tuberculosis* requires cholesterol for virulence in vivo.

- *M. tuberculosis*, the causative agent utilizes cholesterol as a source of carbon, energy, and steroid-derived metabolites throughout the course of infection.
Tuberculosis infections have unique virulence factors compared to most pathogens. They infect host cell (macrophages) and persist inside phagosomes where there are limited nutrients.

Tuberculosis’ unique ability to utilize cholesterol, which is a common component of human cell membranes, plays a role in its persistence.

Furthermore, because the cholesterol catabolism pathway requires a large number of oxygenases, it is no surprise that TB infects the lungs where oxygen concentrations are highest.
Cholesterol catabolism of *Mycobacterium tuberculosis*.
Several major pathogens, including *M. tuberculosis*, parasitize host cells and exploit host-derived nutrients to sustain their own metabolism.

Although the carbon sources that are used by *M. tuberculosis* have been extensively studied, the mechanisms by which mycobacteria capture and metabolize nitrogen, which is another essential constituent of biomolecules, have only recently been revisited.

The central nitrogen metabolism is the mechanisms that are used by this pathogen to obtain nitrogen from its host and the potential role of nitrogen capture and metabolism in virulence.
Nitrogen metabolism in *Mycobacterium tuberculosis*. 

http://www.nature.com/nrmicro/journal/v12/n11/full/nrmicro3349.html
Cholesterol Catabolism Is Critical For *Mycobacterium tuberculosis*

https://www.youtube.com/watch?v=noO5XMJGV6c
Some species in *M. tuberculosis* complex have adapted their genetic structure specifically to infect human populations.

*M. tuberculosis* can be isolated in labs and stored at –80 degrees to be studied extensively.

One way to study *M. tuberculosis* in culture is to collect samples of mononuclear cells in peripheral blood samples from a healthy human donor and challenge macrophages with the MTC.
- 32% of the human population is affected by TB, caused by infection of *M. tuberculosis* in one way or another and about 10% of them becomes ill per year.

- The significance in understanding the genome of the pathogen is to develop and improve strategies for treatment by developing specific drugs that target the gene products of *M. tuberculosis*. 
Transmission of TB occurs primarily by the aerosol route but can also occur through the gastrointestinal tract.

Coughing by people with active TB produces droplet nuclei containing infectious organisms which can remain suspended in the air for several hours.

Only 10% of immunocompetent people infected with *M. tuberculosis* develop active disease in their lifetime. The other 90% do not become ill and cannot transmit the organism.

However, in some groups such as infants or the immunodeficient (e.g. those with AIDS or malnutrition), the proportion who develop clinical TB is much higher.
How The Body React With Tuberculosis

https://www.youtube.com/watch?v=IGZLkRN76Dc
In many countries, vaccination against TB is routinely practised. The Bacillus Calmette-Guerin (BCG) vaccine is a live, attenuated strain of *Mycobacterium bovis* which was introduced in 1922.

However, the true efficacy of BCG is unknown. Early clinical trials in Europe showed up to 80% protection, but more recent trials in India and Africa showed little value.

The first effective treatment for TB was developed in the 1940s which is using streptomycin.
TB is currently treated by means of combination therapy, using cocktails of 3-4 drugs with different properties: antibacterial activity (isoniazid, rifampin, streptomycin) and inhibiting the development of resistance (isoniazid, rifampin, ethambutol).

**Tuberculosis Prevention**

https://www.youtube.com/watch?v=EBdC9H00BHY
Articles

- **Infectious disease: TB's revenge**
  http://www.nature.com/news/infectious-disease-tb-s-revenge-1.12115

- **Advances in Mycobacterium tuberculosis Therapeutics Discovery Utilizing Structural Biology.**
  http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3695056/
- **Effect of BCG Vaccination Against *Mycobacterium tuberculosis* Infection in Children: Systematic Review and Meta-analysis**
  
  [http://www.bmj.com/content/349/bmj.g4643](http://www.bmj.com/content/349/bmj.g4643)

- **Outwitting the Perfect Pathogen**
  

- **Origin, Spread and Demography of the *Mycobacterium tuberculosis* Complex**
  
First of all, I feel very happy to do this “Adopt A Microbe” project. It is a new experience for me to make a digital scrapbook. This project also has brought me closer into microbial world. I get to know many other things about this wide world of tiny creatures that I never learned in class before. As example, I have read many articles and new founding about my microbe of interest.
I have decided to study about *Mycobacterium tuberculosis* because we have a close relationship before. I have been diagnosed with Tuberculosis in 2011 but I did not know about this disease or the bacteria at that time. Hence, by using this opportunity I can learn better about them.

In my opinion, “Adopt A Microbe” is a very good project for me and also to the other Microbiology students. It help us to increase the interest in our study as well as growing the effort to explore new information.
My Self

My name is Nur Atikah Nadia Binti Ariffin. I was borned on 11th March 1995 in Hospital Pasir Puteh, Kelantan. Now, I live in Rompin, Negeri Sembilan with my small happy family. I am the last child of two siblings.

I completed my foundation in UiTM Puncak Alam, Selangor before pursuing my studies in Universiti Putra Malaysia. I am very interested in Microbiology and amazed everything about them.

I hope that I can enjoy my future exploring in this field an be just like what I think about microbes - “A small organism with many great specialities and abilities”.
Microbiology Student In UPM

https://www.youtube.com/watch?v=dqdmNP7qdLA
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- http://vet.sagepub.com/content/49/3/423.short
The End.