

Lung diseases

A Human-Bio report

Cystic Fibrosis

Cystic Fibrosis is a hereditary condition caused by a mutated gene in a person's genetic code. This disorder affects the lungs and other vital organs such as the pancreas and intestines, which produce essential lubricants such as mucus, gastric juices, saliva and sweat. Typically, these secretions behave as ordinary bodily lubricants; people with *Cystic Fibrosis* have a genetic defect that causes the mucus to be sticky and thick. Instead of behaving as lubricants, these secretions begin to block up various airways in the lungs and ducts in the pancreas.

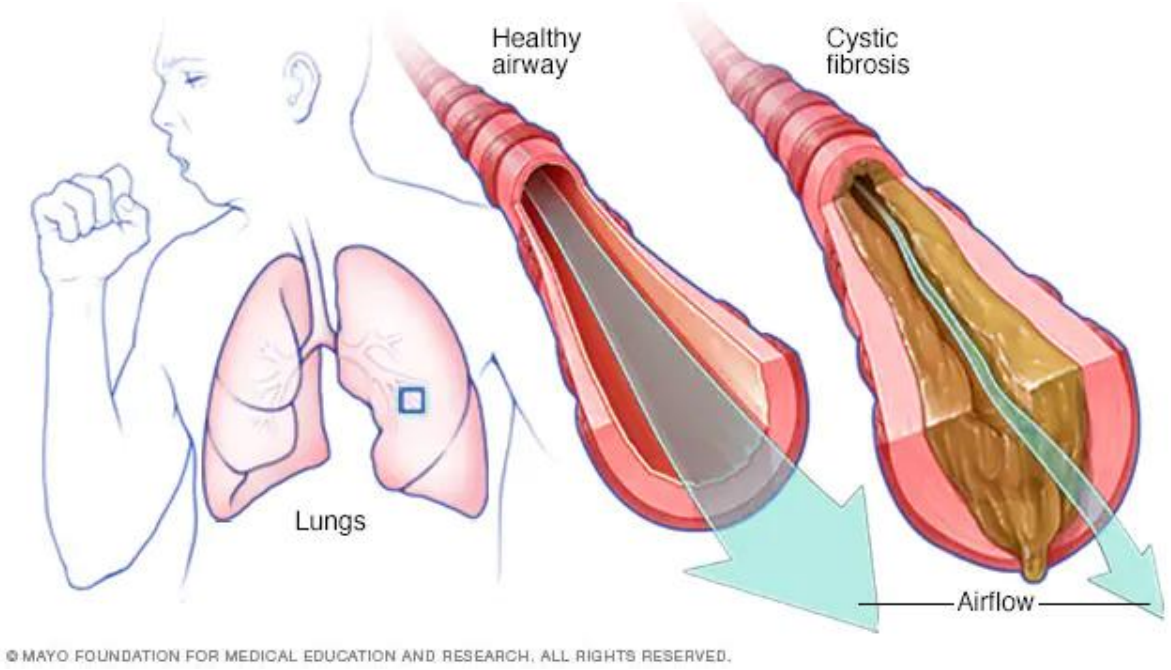

Figure 1: Cystic Fibrosis

Cause

A mutated gene in the CFTR gene in chromosome 7 (*Cystic Fibrosis*, 2021) is what causes a person to have *Cystic Fibrosis.* The disease is a recessive *single-gene disorder* (Newton, Joyce and Whan, 2020) which means that for a person to have *CF* (*Cystic Fibrosis)*, both their parents must have the mutated gene in their genetic code. However, if only one of the parents has this gene, their offspring would be carriers of this mutated gene and, therefore, can pass the gene to their offspring.

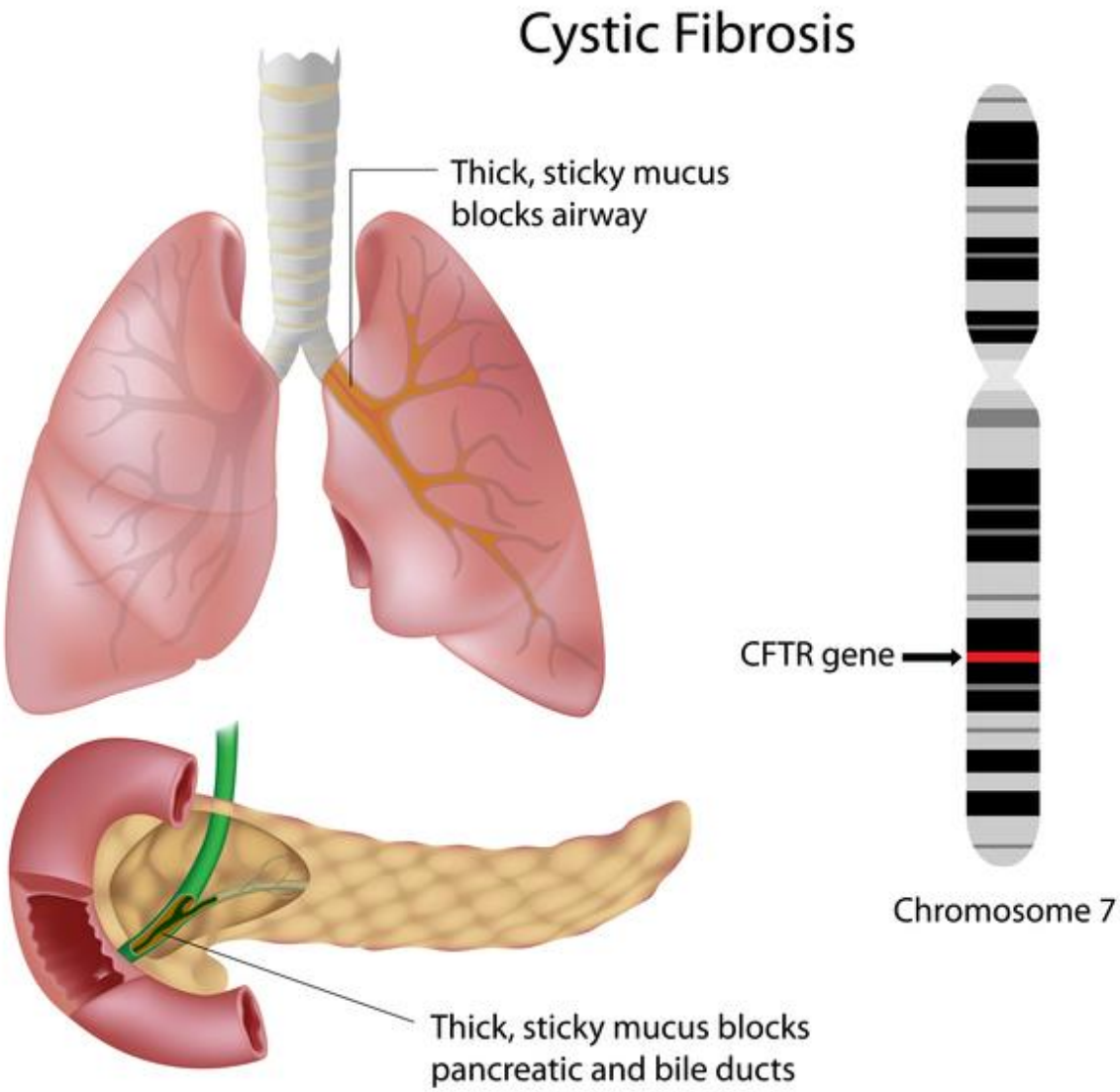

Figure 2: Mutation in the CFTR gene causes Cystic Fibrosis

Symptoms

Cystic Fibrosis can have various symptoms but is split into two categories which are respiratory and digestive, depending on the affected area. Respiratory symptoms include but are not limited to persistent chest infections, inflammation of the lungs, and persistent sinusitis. Digestive symptoms are primarily caused by the mucus blocking the pancreas' ducts, which transport digestion enzymes, which causes patients to have malnutrition, 20% of infants with *CF* also develop meconium ileum (*Meconium Ileus* - Seattle Children's, 2022), a type of intestinal blockage. It is also worth noting that patients with *CF* have a high salt discharge which could signify why they have a higher saline concentration in their sweat (Cystic fibrosis - Symptoms and causes, 2022). *CF*

can also cause cysts and scars to form in the lungs, hence *Cystic Fibrosis*. The seriousness of the disease alters the symptoms that a patient with *CF* experiences. Some patients may not experience symptoms until adolescence or adulthood, and others experience symptoms as early as infancy.

Diagnosis

Within days of birth, a baby's blood test is done by pricking the heel and analysing the blood for diseases like *cystic fibrosis,* or a sweat test may be conducted to check for *CF*; a CT scan or chest X-ray can also be conducted (Cystic Fibrosis, 2022). For individuals who want to check for the inheritance of *CF*, genetic testing is done to determine whether they carry the disease in their genes (Newton, Joyce and Whan, 2020).

Treatments

There is no cure, but technology is becoming increasingly advanced, so treatments are getting better. Despite having no cure, patients with *CF* can still have a 'normal' life with the help of specific dietary requirements, medicines such as antibiotics and daily exercise. The specific requirements include foods or supplements high in carbohydrates, fat, and protein. Along with pancreatic extract and substantial dosages of vitamins A, D, and K (What is CF, 2022; Newton, Joyce and Whan, 2020. Patients with *CF* take certain medications that target the genetic defect that caused *CF.* The newest installation of this type of medicine is called 'Trikafta', which combines three drugs (elexacaftor, ivacaftor and tezacaftor) to reduce the effects caused by the defective gene (Cystic fibrosis - Diagnosis and treatment - Mayo Clinic, 2022). There are different combinations of these drugs for different ages. Gene editing or genetic engineering is a significant breakthrough in the medical field since it introduces the ability to change genetic information. Genetic splicing tools such as CRISPR-CAS9 can remove mutated genes and replace them with a normal functioning gene. The permanent change in the genetic code means that the process will not be repeated; if a stem cells' DNA can be corrected with CRISPR-CAS9, it will continually create cells with the corrected gene (Cystic Fibrosis Foundation, 2019).

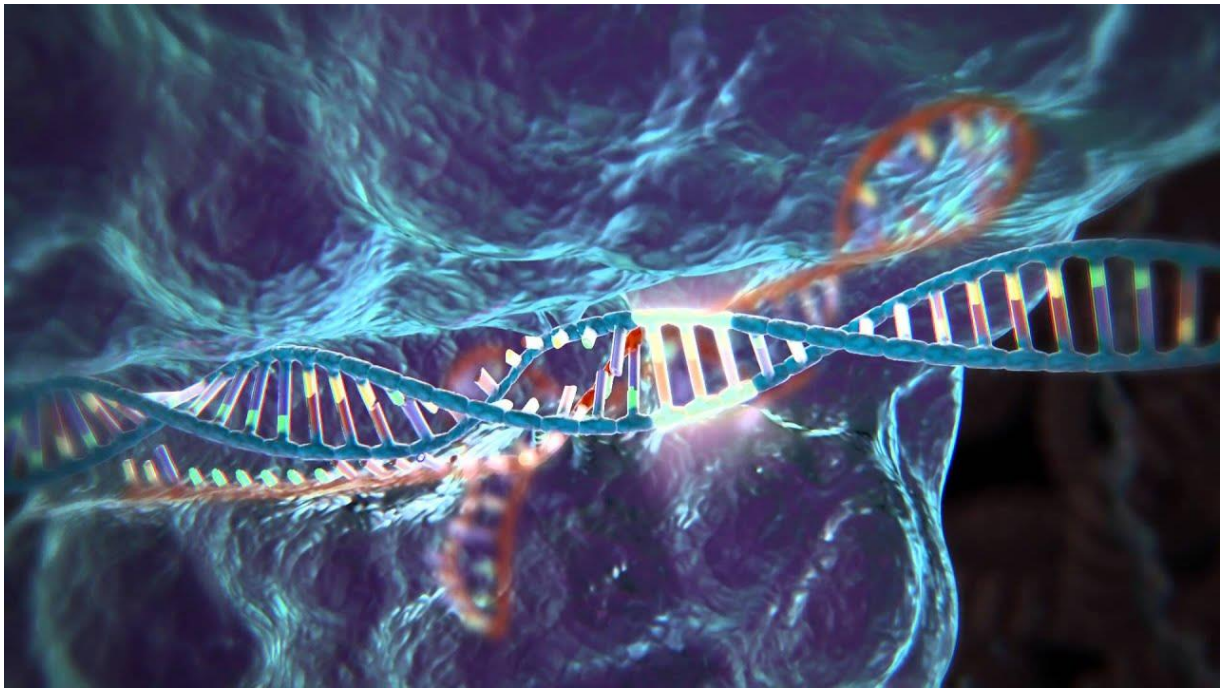

Figure 3: CRISPR-CAS9 could give rise to new opportunities

Prevention

The most common way of preventing is through genetic testing. If a couple wants to start a family and be aware of any genetic mutations within their genes, such as *Cystic Fibrosis,* before having a baby, they can do so with a blood or saliva test ("Cystic Fibrosis", 2021). Testing for *CF* can also be done if the mother is pregnant through CVS (Chorionic Villus Sampling) ("Chorionic villus sampling - Mayo Clinic", 2020).

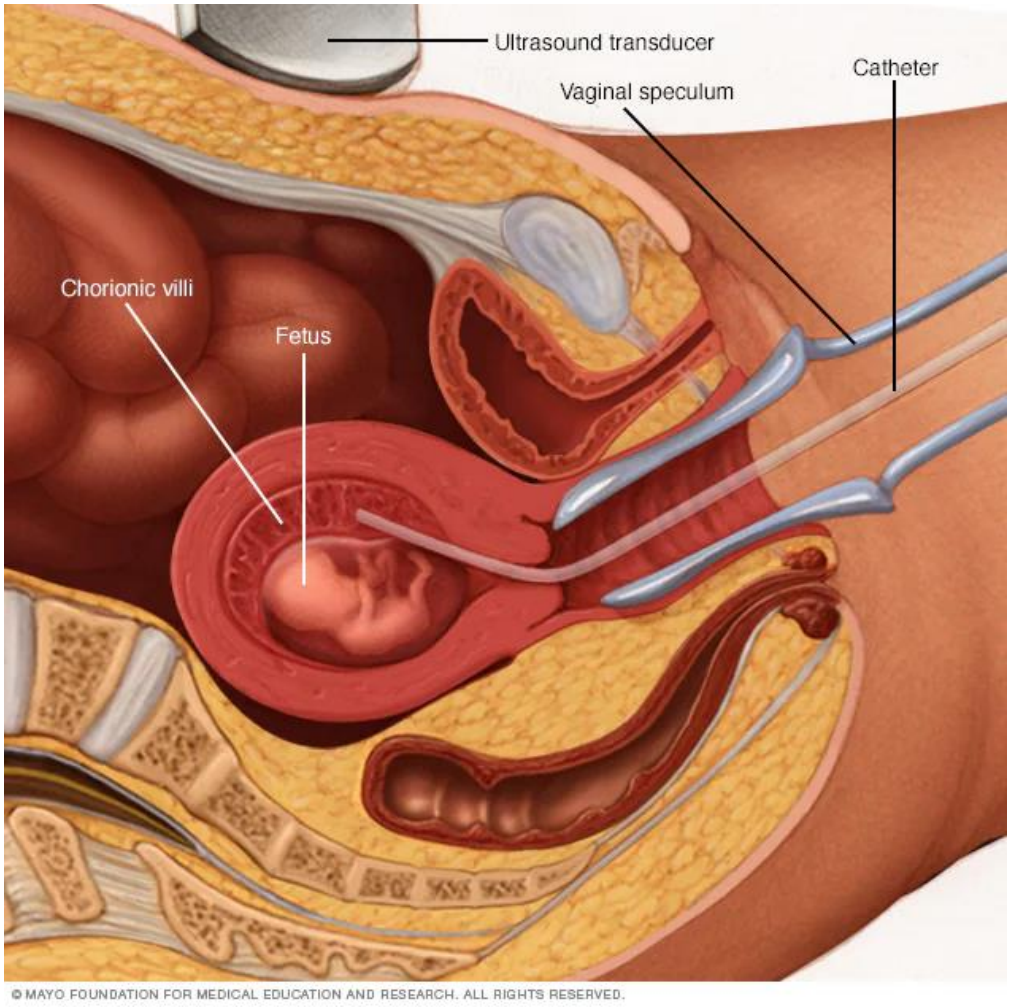

Figure 4: Chorionic Villus Sampling

Tuberculosis

Tuberculosis, or *TB* for short, is a disease that mainly affects the lungs though it affects other organs such as the kidneys or the spine. *Tuberculosis* is a contagious disease transmitted through droplets containing the *TB* bacteria; *TB* can only be transmitted if these droplets come from a cough, sneeze or spit from a person with active *TB* ("How TB Spreads", 2016). *TB* has two different phases: Latent Tuberculosis and Active Tuberculosis. Latent *TB* is when a patient is positive for *TB* but does not have any sign of symptoms and is not contagious, while active *TB* is when a patient is positive for *TB* and does show symptoms (contagious).

Cause

Tuberculosis is a bacterial infection that primarily affects the lungs, so when an infected person with active *TB* coughs or sneezes, the droplets containing the *TB* virus attack the lungs of the person who inhales the contaminated droplets. The bacteria that cause *TB* is called *Mycobacterium tuberculosis*. Though a newly infected person has dormant *TB*, a weakened immune system can cause the active phase of *Tuberculosis*; this could be due to diseases that have weakened the immune system, such as diabetes, HIV/AIDS or lack of hygiene.

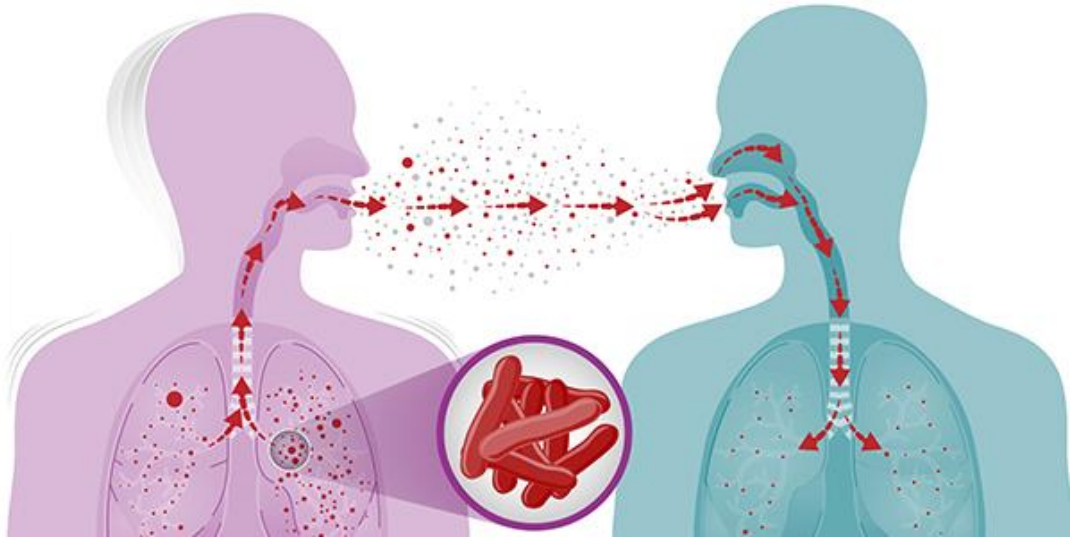

Figure 5: Transmission of Tuberculosis

Symptoms

Symptoms of *TB* are much like other lung diseases, but the arrival of the symptoms is sometimes not noticed until a few months or years have passed after first testing positive; this is possibly due to the inactive *TB* suddenly becoming active due to a weakened immune system. These symptoms include chronic cough and may be accompanied by blood, loss of appetite, chills, fatigue, chest pain while breathing, excessive sweating, weight loss and fever (Signs & Symptoms, 2022); ("Tuberculosis - Symptoms and causes", 2021).

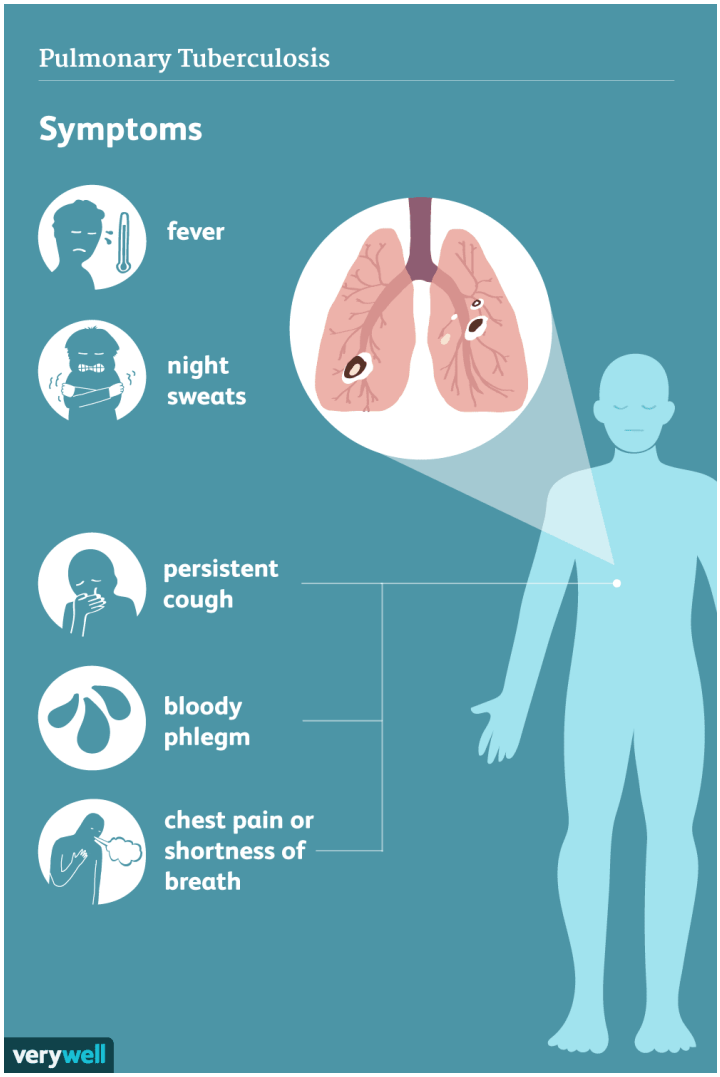

Figure 6: Symptoms of Tuberculosis

Diagnosis

Tuberculosis has two commonly used diagnostic tests taken to check for the presence of the *TB* virus within the body. Skin tests are taken when a chemical named 'tuberculin' is administered below the skin. While checking the administered area, a medical professional will determine whether the patient has *TB* from the characteristics of the lump caused by the chemical reaction of the substance administered (Tuberculosis - Diagnosis and treatment - Mayo Clinic, 2022). The second method is through a newly developed *TB* blood test that provides information on whether a patient is infected with TB and the phase of the *TB*.

Treatments

Treatments for *TB* vary depending on the phase of the *TB*, as active *TB* has different medications and treatments to latent *TB* and the age, secondary illnesses that weaken the immune system and if the patient is pregnant. For latent *TB*, a medication period of nine months of three different drugs is done. Isoniazid, Rifapentine and Rifampine are three drugs taken in a different order throughout the nine months (Treatment Regimens for Latent TB Infection (LTBI), 2022). The medication can vary between six to 12 months for patients with active TB. The patient undertakes the 'RIPE' antibiotic method; these medications include a combination of Rifampin, Isoniazid, Pyrazinamide and Ethambutol (Diagnosing and Treating Tuberculosis, 2020); (Treatment for TB Disease, 2022). *TB* can become drug-resistant; this is only due to patients stopping medication during the medication regimen. New treatments are developing as nanoparticles enter the medical field. Anti-TB nanoparticles decrease the chances of the bacteria becoming drug-resistant. The nanoparticles decrease the dosage regimen and reduce the patient's likelihood of discontinuing their medication. The drug can be delivered in a concentrated area and cure the patient in less time than the original medication regimen (Nasiruddin et al., 2017).

Prevention

Vaccines such as Bacille Calmette-Guérin or BCG vaccines are given to infants to **reduce** their chances of contracting the disease in the future. Frequently consult with doctors to check for signs of *TB.* Given that a patient has been identified to have dormant *TB*, they must take medication prescribed by the doctor to prevent dormant *TB* from progressing to active *TB*. Regular hygienic practices such as washing hands before eating, after going to the toilet, after sneezing or coughing, using hand sanitiser if accessible, limiting being close to a person with active *TB* for extended periods ("Vaccines", 2022), checking for the disease through a blood or skin test, regularly cleaning surfaces that get dirty. Patients with HIV/AIDS must have regular check-ups with a doctor since it is much easier for them to contract the illness; HIV/AIDS weakens the immune system by destroying the white blood cells.

Figure 7: Ways to prevent Tuberculosis

<u>Comparison</u>

Cystic Fibrosis is an inherited illness where there is an excessive build-up of mucus in the airways of the lungs and ducts of the pancreas. *Cystic Fibrosis* can only be gotten by having two pairs of mutated genes from both parents. *TB* is a disease caused by bacteria and, therefore, not inherited. *TB* comes in two phases which are dormant and active; once the *TB* has begun the active phase, the disease is now contagious and highly infectious. Compared to *CF*, the disease itself (*Cystic Fibrosis*) cannot be caught. However, other diseases can arise from *CF* and such diseases can be contagious. There is no definite cure for *CF*, but for *TB*, there are antibiotics and a newly designed nanoparticle drug delivery. Gene therapy is exceptionally costly for *CF*, so new gene-editing tech such as CRISPR-CAS9 is currently in research if it may be applicable for *Cystic Fibrosis*. Couples can prevent their newborn from having *CF* by having both couples undertake a blood or saliva test to check for the presence of any mutated genes. Patients can prevent themselves from worsening their dormant *TB* to active *TB* by completing their medication and having repeating appointments with doctors. People with no *TB* can prevent themselves from contracting *TB* by practising proper hygiene and having regular check-ups with doctors. To conclude, we must acknowledge that both diseases can be equally lethal if not treated properly, and it is a must that people take precautions such as checking in with doctors and practising good hygiene to ensure their health and the health of their lungs.

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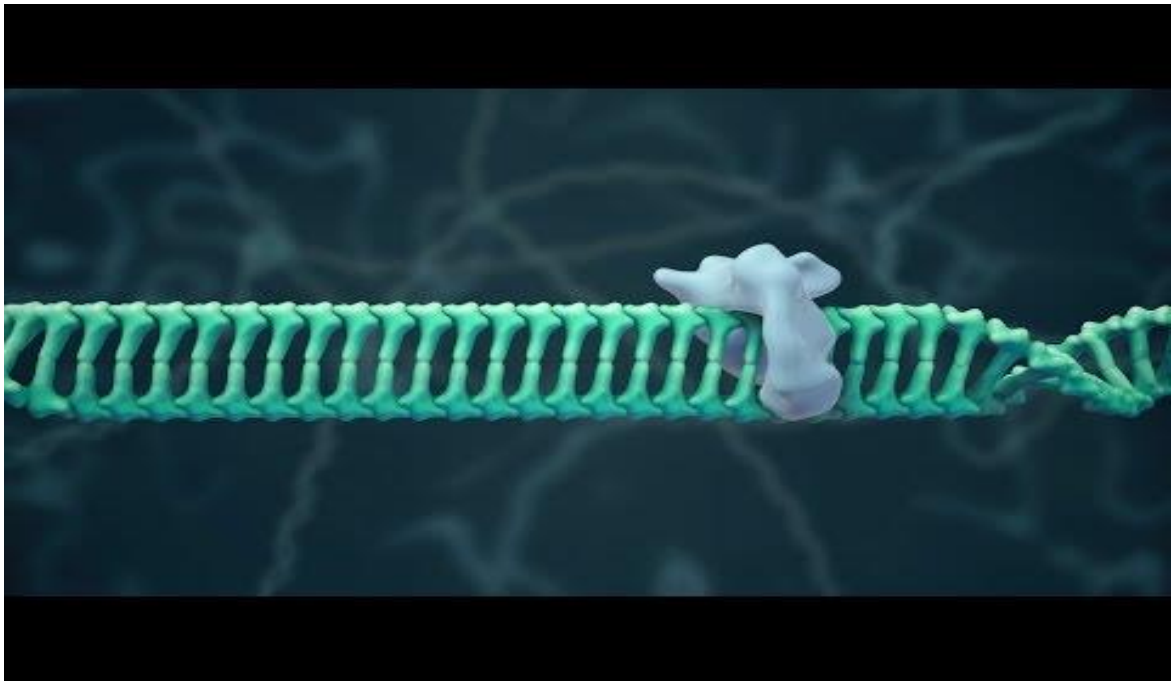

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