

# Spleen

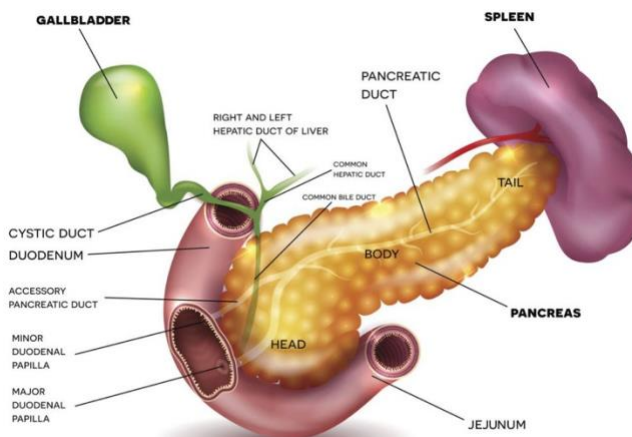
## 1. Functions

### Filtering and Storage of Blood

The spleen is an oval shaped organ within the left upper quadrant of the abdomen that is made of a fine net-like structure that is excellent at filtering the blood. This filtering system is not only used to process old, damaged cells, but also can filter out pathogens. As cells age, they undergo structural and chemical changes that can be recognized by macrophages in the spleen for removal. Macrophages are immune cells that can engulf the aged cells and break them down.

More specifically, the spleen can break down old red blood cells which have iron-containing hemoglobin within them. This iron can then be recycled back into the body for use or to store.

Though the spleen does not store many red blood cells, it does store other components of blood like platelets, eosinophils, and basophils. Platelets are responsible for helping to form clots when there is an injury in the body, but they do not need to be circulating and active when there is no injury present. Therefore, they are able to be stored in the spleen and wait until they are needed.



### Immune Mechanisms

The spleen also functions as the largest lymphatic organ. It contains many immune cells and receptors within it to trap and process pathogens that may have entered the body. There are macrophages in the spleen that can phagocytose (essentially means to eat) any foreign antigens that come through the spleen, either killing them or presenting them to other immune cells. B cells are also in the spleen, and when activated, can then produce antibodies against the pathogen that was found. Some cells that have been infected with a pathogen may express cell markers or antibodies on their surface that the spleen is also able to trap and process.

While other lymph nodes and immune cells throughout the body are still able to process foreign materials entering the body, the spleen is notable for processing carbohydrate-related antigens, as well as producing IgM antibodies. Carbohydrate-antigens are significant because these are usually found on bacteria that have coated themselves with a capsule to make them harder to detect. These encapsulated bacteria are able to hide from the immune system, but the spleen is able to recognize this entity and to filter it out from the blood. Some examples of bacteria with this capsule include *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Staphylococcus aureus*, and *Neisseria meningitidis* to name a few. IgM antibodies are also largely produced by the B-cells in the spleen because this is the first type of antibody that B-cells make after they encounter a pathogen. IgM antibodies are therefore important in the early stages of controlling infection. It is only after B-cells receive signals from other immune cells that they will change the type of antibody they create.

## 2. Problems Caused by Removal

- Removing the spleen puts patients at risk for infection, especially from encapsulated organisms.
- Since the spleen often holds many platelets, post splenectomy, there can be a significant rise in the platelet count because now the platelets are all in circulation. This could be problematic should the platelets begin to activate or interact with the endothelial cell lining.

## 3. Strategies for Mitigating Problems

- Receiving immunizations to protect against encapsulated bacteria is of great benefit. This ensures your body already has antibodies made against the bacteria so that you can appropriately mount an immune response should you encounter the bacteria. Ideally, it would be best to receive the vaccinations before the Whipple Procedure so that your spleen and immune system have proper time to process the vaccine and create the antibodies needed. Fortunately, there are vaccines for *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Neisseria meningitidis*.

In addition to vaccines, post-splenectomized patients may also be treated with prophylaxis antibiotics. The exact type, dose, and length of time taking the antibiotics may all depend on the patient's immune status and other comorbid conditions that may put them at risk. If at any point there are signs of infections, even if it is just a fever, the symptoms should be treated seriously. Communication with your physician is imperative and you may need to go to the emergency room. Other than vaccinations and antibiotics, it is essential to maintain good health hygiene. Always be sure to wash your hands, consider wearing a mask during flu season, and avoid known sick contacts.

It is highly recommended that any post-Whipple patients who have lost their spleen add an infectious disease doctor to their list of annual visits. These patients should also have a script for broad-spectrum antibiotics, like Amoxicillin on hand...especially if traveling...to be taken at the first sign of infection or fever. Without a spleen, infections can get out-of-control very rapidly.

Without a spleen, your liver tries to take on some of its blood-cleaning duties. However, this is hard on the liver, and can lead to fatty liver disease. It is important to be very cautious with any substances that are hard on the liver, like alcohol, caffeine, or medications like antifungals.

- To prevent platelet activation, antiplatelet therapy may be considered. However, platelets are also necessary to help during injuries and to help heal after surgery. Platelet activation and clot formation is a multifactorial process, and your physician will likely weigh the benefits and risks of antiplatelet therapy using a patient centered approach considering other comorbid conditions, platelet count, and other lab values. Lifestyle approaches, such as diet and exercise, are also very important. These will help to keep your cardiovascular system healthy, making it less likely for the platelets to become activated.