



## WHY SOME KIDS MAY NEED A NEW LIVER

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### YOUNG REVIEWERS:



**MAYESHA**

AGE: 14



**OLIVIA**

AGE: 15

The liver is a super organ that does hundreds of important jobs. It cleans your blood, makes critical proteins, and produces a liquid called bile, which helps digest the food you eat. In some children, the liver can get very sick because they are born with a blockage in the tubes that carry the bile to the intestine, which causes bile to build up in the liver and damage it. When the liver cannot do its job properly, the sick liver must be replaced through a major operation called a liver transplant. For children, a small piece of an adult liver is often enough. After surgery, patients need medication to help them adjust to their new liver. Liver transplantation in children is a wonderful example of how the liver can adapt, regenerate, and grow with its new owner, giving kids a new chance to live their best lives.

### THE LIVER: YOUR BODY'S POWERHOUSE

Did you know your liver is like a powerhouse inside your body, working every minute of every day to keep your body healthy? The liver

## BILE

A yellow-green liquid made by the liver that helps the body digest food, especially fats. Bile is stored in the gallbladder and released into the small intestine via bile ducts.

## BILE DUCTS

Tiny tubes in the liver that help carry the bile from the liver to the intestines, helping to digest food and stay healthy.

## HEPATIC

Related to, or having to do with, the liver.

## Figure 1

The liver is the largest organ in the body. It is divided into two main parts, the right lobe and the left lobe. The hepatic artery and portal vein nourish the liver, and the hepatic veins drain the blood into the vena cava, which then flows to the heart. The bile duct leads the bile out of the liver to the upper part of the intestines (duodenum). The gallbladder, which stores bile, is not seen in this image. This figure can be found at: <https://www.hug.ch/en/csfe/liver>.

performs hundreds of critical jobs, like cleaning your blood, fighting off germs, and transforming the food you eat into energy for you to move and run and live your life. For example, the liver produces several important proteins. Proteins are like building blocks for your body, like LEGO pieces. They come together to build and repair your muscles, skin, hair, and even help your body defend itself against viruses and bacteria. Proteins are super important for helping you grow up strong and healthy. And if your blood needs to clot when you have a cut, your liver makes proteins to do that, too.

When your body needs to get rid of medications or toxins, the liver can help: it mixes the medicine or toxin with the juice coming out of the liver, called **bile**. Bile flows through the **bile ducts** into the gut, which eventually deposits toxins in the toilet.

Did you know that your liver is the heaviest organ in your body? The liver is located in the right upper section of your belly. A sheet of muscle called the diaphragm lies between the liver and the lungs, and the ribs protect both the lungs and liver. If you weigh 40 kg, your liver is as heavy as a 1-liter milk bottle (1 kg). The liver is unique in another way: it is the only organ whose blood supply comes from both an artery (the **hepatic** artery) and a vein (the portal vein). Where those two vessels go into the liver, there is another tube coming out of the liver, called the bile duct, which carries the bile to the intestine (Figure 1).

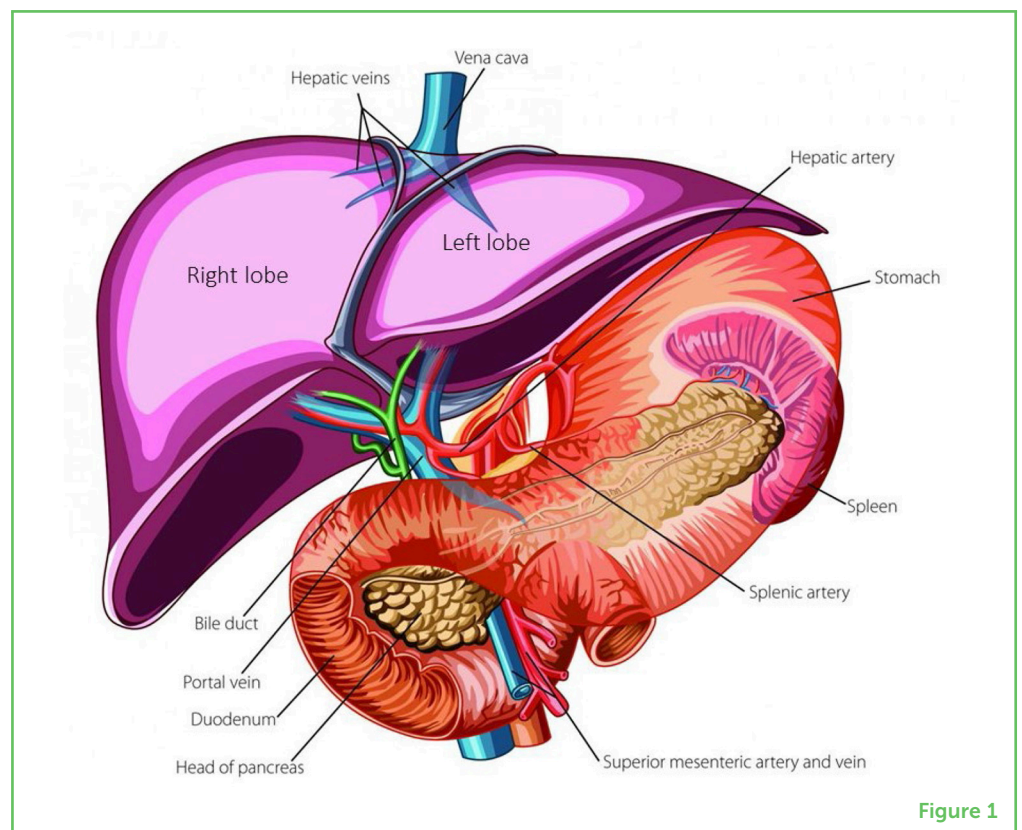


Figure 1

## WHEN A LIVER NEEDS A RESCUE

Sometimes, a liver gets sick and can no longer do its job well. When the liver is very damaged, doctors might decide it needs to be exchanged for a new one. This is called a liver transplant. Think of it like changing a broken piece in a car. Liver transplantation is a special operation where the sick liver is completely removed and replaced with a healthy one that comes from a **donor**. A donor is a person who died of a severe brain injury that caused their brain to stop functioning, which is called brain death. When brain death is identified, the other organs are usually still working and can be donated for transplantation. If the person stated before their death that they wanted to donate their organs, then patients with a sick liver, heart, kidney, or lung can benefit from a “new” healthy organ. Organ donation is a very special gift that can save someone’s life.

The liver is unique in the world of organ transplantation because one donor liver can save two lives. When a small child needs a liver, they often need only a small part from an adult liver: the left lobe. The left lobe is the small left part of the liver, approximately a quarter of the whole organ. The right lobe can then be given to an adult. The procedure of surgically separating the liver into two halves is called a liver split (Figure 2).

### DONOR

A person who gives an organ (such as the liver or part of it), to help someone else get better when they are sick and their organ does not function anymore.

### Figure 2

The donor liver can be split by a surgeon and then each of the two parts can be transplanted into two sick people needing new livers, thus saving two lives: a small child will get the left lobe and a teenager or adult will get the right lobe. This figure was designed with the online software *BioRender*.

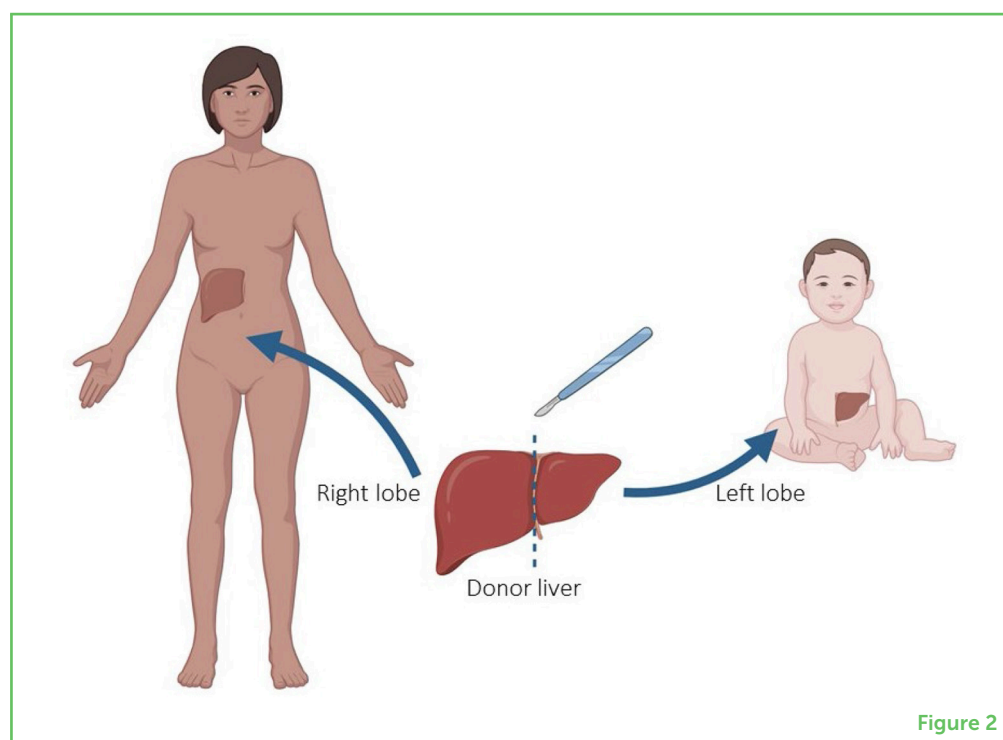


Figure 2

### BILIARY ATRESIA

The most frequent disease why a child might need a liver transplantation, where the bile ducts get blocked, causing liver damage and making it very sick.

## WHO MIGHT NEED A NEW LIVER?

The most frequent reason why a child would need a new liver is because they were born with a disease called **biliary atresia** [1]. In

## CIRRHOSIS

A very sick and scarred liver, making it hard for it to work properly, which can happen if it is hurt for a long time.

## INBORN ERRORS OF METABOLISM

Conditions some people are born with, where a protein does not work properly, causing problems like toxin buildup.

## JAUNDICE

A condition in which the skin and eyes turn yellow because the liver is not working properly, and the bile flow is not normal.

biliary atresia, the bile ducts are progressively damaged, leading to complete blockage of bile flow. When bile stays in the liver instead of flowing out, it gradually damages the liver, eventually resulting in **cirrhosis**, or severe liver disease. Another reason why children may need a new liver is because they are born with an **inborn error of metabolism** [2]. These are diseases in which a protein works incorrectly. In other words, a certain LEGO piece is the wrong shape to do its job, for example purifying toxins, which can make children very sick. Even if the liver looks normal in these children, a liver transplant may be the only way to cure the disease.

How do you know if someone's liver is in trouble? Look out for signs like **jaundice**, which shows up as yellow skin or eyes, together with feeling really tired and not hungry or having a bloated belly. These clues tell doctors that the liver might be sick. Doctors then draw blood samples and do other exams to understand, treat, and follow the liver disease.

## THE HEROIC JOURNEY OF A LIVER TRANSPLANT

Before performing a liver transplant, doctors do a lot of tests to make sure this major surgery is the right solution for the child. This important step helps ensure that the child is well taken care of, both before and after surgery [3]. Then, doctors put the child on a waiting list. This means the child waits their turn for a good liver match.

The surgery to take out the old liver and put in the new liver is long and complicated, but doctors and nurses make sure everything goes smoothly. The operation takes approximately 6–8 h. The sick liver is completely removed and replaced with the new one, and as you know now, often just with the small left lobe of an adult liver. During the operation, the child's liver veins and arteries and the bile duct are connected to those of the new liver using stitches, much like a tailor or a seamstress would use. This is quite tricky, since the vessels are very small, sometimes only 2 mm in diameter. Following the operation, the young patient stays in intensive care for several days. Intensive care is a special place in the hospital where doctors and nurses take care of people minute-by-minute, as is required after a transplant. Once the child is better, they move to the normal ward for up to a few weeks before returning home. When they finally return home, they feel like a regular kid again in a short period of time (Figure 3)! Throughout this journey, parents stay with their children to support them every step of the way.

## LIFE WITH A NEW LIVER

After receiving a new liver, life is a little different. During the 1<sup>st</sup> months after transplantation, the young patient will need to take

**Figure 3**

A liver transplant can completely transform a sick child with a diseased liver into a healthy-feeling child with a healthy liver, about 2 weeks after the liver transplant. Jaundice disappears within a few days following the transplant. This figure was designed with the online software *BioRender*.

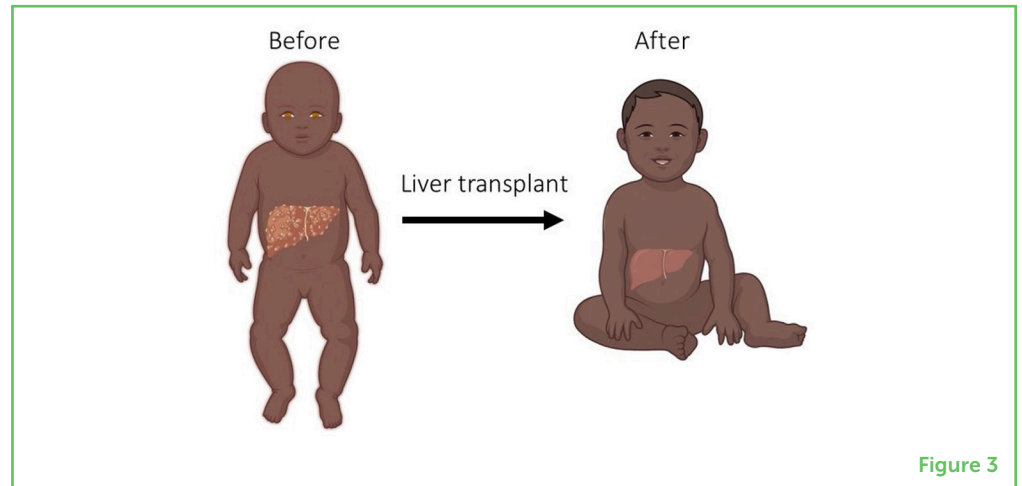


Figure 3

many medications, mostly to help their body and liver to get to know each other. Meanwhile, the liver recovers from its epic adventure by adjusting its size and shape to meet the needs of the child's body. As the child or young person grows, so does the transplanted liver, just like anyone's liver would!

Regular visits to the doctor are required to check on the patient's progress. After some months with their new liver, kids can go back to doing all the things they love and may only have to take 1–2 pills daily! They can go back to daycare or school, perform all their favorite sports or afterschool activities, and see their friends. Eventually, they grow up to be adults who can get married and have kids of their own, if they want to!

**HOW YOU CAN HELP**

By learning about organ donation, you can understand how special it is to give someone a second chance at life. You can become an organ donor just by saying so and writing it down. Donating an organ does not hurt, because at the time of donation, the person is brain dead and thus does not experience pain. You should also write down if you *do not* want to be an organ donor. Writing down your wishes means that, if your family is ever in the situation where they must decide if you are a donor, they will not have to guess what you might have wanted. Finally, you can talk to people to motivate them to think about organ donation and how it can help others.

**A WORLD OF HELP AND HOPE**

Liver transplants in kids show us how amazing medicine can be. They demonstrate how well the liver adapts, regenerates, and grows with its new host, giving the person a chance to live their best life. With the

help of donors, doctors, and families, the story of liver transplantation is a story of hope, courage, and the power of working together.

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## YOUNG REVIEWERS



### MAYESHA, AGE: 14

Hi! I am Mayesha, and I am currently in 9th grade at 14 years old. I have a strong passion for exploring science, particularly in the field of biomedical sciences. My favorite subjects are math and science, and I am proud to say that I excel in both! I have one sister who is also dedicated to her studies, and we often motivate each other to do our best. When I am not studying, I love spending time outdoors, whether it is playing sports or simply enjoying nature. I also enjoy playing Roblox, where I can connect with friends and unleash my creativity. I am excited about the future and look forward to discovering more about science and technology!



### OLIVIA, AGE: 15

My name is Olivia. I am 15 years old. I joined Frontiers for Young Minds because I like science, reading, and doing experiments. I like animals, especially dogs. I have an Irish Terrier. My hobbies are playing piano, singing, and karate. I like to travel.

## AUTHORS



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Barbara Wildhaber studied medicine in Zurich, Switzerland. She trained in pediatric surgery in Switzerland, South Africa, and the USA, and specialized in liver surgery and pediatric liver transplantation in Paris. Her research focuses on liver transplantation in children and biliary atresia, including developing a nationwide screening program for this disease. Barbara became head of the Division of Pediatric Surgery and full professor in Geneva in 2010. She shares the leadership of the Swiss Pediatric Liver Center at Geneva University Hospital (<https://csfe.hug.ch/>) with Valérie McLin. \*[barbara.wildhaber@hcuge.ch](mailto:barbara.wildhaber@hcuge.ch)



### VALÉRIE A. MCLIN

Valérie McLin completed her medical studies and residency in Geneva, Switzerland. She then pursued a fellowship in pediatric gastroenterology, hepatology, and nutrition in the US. Valerie's research includes long-term outcomes following pediatric liver transplantation, which has been a focus for most of her career. She participates in several international working groups focusing on the long-term health of transplanted livers. She is the head of the Unit of Pediatric Gastroenterology, Hepatology, and Nutrition at HUG, where she has been practicing since 2009 and shares the leadership of the Swiss Pediatric Liver Center with Barbara Wildhaber.