

## The Hepatic Portal System

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**The usual course of the blood starts from the heart into the arteries, through the capillaries, then into the veins and back to the heart. In a few cases, however, it does not flow immediately into the veins but flows through a second capillary bed. This is called the portal vessel system. In addition to the liver, it can be found in the anterior pituitary and pancreas.**



### A Second Capillary Bed as a Safety System

When blood passes through the gastrointestinal tract, it absorbs numerous substances from food. This may include vital nutrients (except fats that enter the blood via the lymphatic system), but also dangerous and harmful foreign particles and pathogens.

One of the important functions of the liver is the detoxification of the body. The blood carries these many substances from the gastrointestinal tract directly into the liver where they undergo biotransformation.

This way, harmful substances can be rapidly neutralized. In pharmacology, the presence of a first-pass effect must be taken into account when administering oral medications, and drug dosage must be adjusted to compensate for this effect. If a drug dosage is too low, the majority of the drug is metabolized in the liver and is no longer effective.

The liver must filter blood from the spleen as well since it is well known that red blood cells are degraded here. Their constituents accumulate in the blood and must be

completely disassembled and recycled in the liver.

## The Portal Vein System of the Liver

In addition to blood flow from the stomach and small and large intestines, blood from the gall bladder, pancreas, and spleen also flows to the liver via the portal vein (technically called the hepatic portal vein). The portal vein drains blood delivered to the above organs via the 3 large, unpaired branches of the aorta: The celiac trunk, the superior mesenteric artery, and the inferior mesenteric artery.

The hepatic portal vein is formed by the splenic and superior mesenteric veins. The inferior mesenteric vein drains into the splenic vein. The majority of blood from the abdomen runs through these 3 large veins. The following branches drain directly into the portal vein:

- Cystic vein
- Right and left gastric veins
- Pancreaticoduodenal superior posterior vein
- Pre-pyloric vein
- Paraumbilical vein

Since the blood is only partially saturated with oxygen, the liver needs additional oxygenated blood to supply its needs, and the hepatic artery from the celiac trunk assumes this task. The portal vein carries blood that contains chemicals to be transformed to ensure the safety of the body. The portal vein and the hepatic artery, together with the common bile duct, the main duct carrying bile, form the porta hepatis.

After the blood has been processed, it flows into the inferior vena cava via the hepatic veins. Their vascular tree collects blood from the centrilobular veins of the hepatic sinusoids after the vessels of the porta hepatis have delivered the blood to their intrahepatic ramifications (see liver).

## Portal-systemic Anastomoses

When the liver is damaged, for example in cirrhosis from chronic alcohol abuse, the vascular bed in the hepatic parenchyma is reduced. Therefore at a constant flow rate, the same volume of blood must be pushed out of the portal vein via fewer vessels. The pressure in the portal vein increases and portal hypertension develops.

This hypertension may be so great that the blood reverses its direction of flow. It does not flow directly into the liver anymore, but rather away from the liver. It seeks other ways back to the heart. These other pathways form the portosystemic anastomoses:

### 1. Esophageal Anastomoses:

Portal vein → gastric veins → esophageal veins → azygos/hemiazygos veins → superior vena cava

### 2. Paraumbilical Anastomoses:

a) Portal vein → umbilical veins → paraumbilical veins → superior epigastric vein → internal thoracic vein → subclavian vein → superior vena cava

b) Portal vein → umbilical veins → paraumbilical veins → inferior epigastric vein → external iliac vein → inferior vena cava

c) Portal vein → umbilical veins → paraumbilical veins → superficial abdominal veins: thoracoepigastric vein, lateral thoracic vein, and superficial epigastric vein

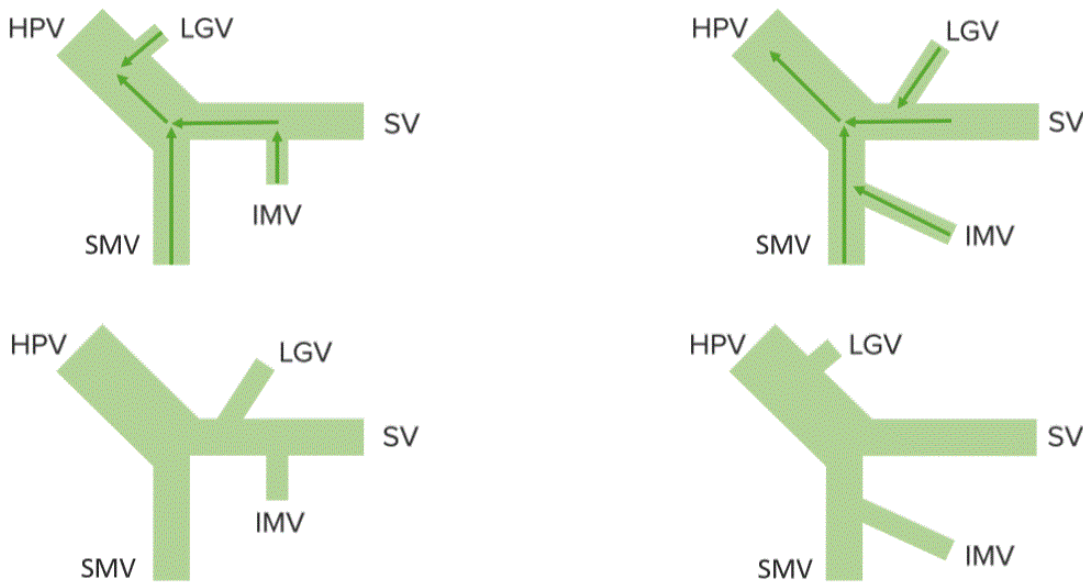
### 3. Colic Anastomoses:

Portal vein → superior and inferior mesenteric vein → colic veins → ascending lumbar veins → directly into the inferior vena cava or via azygos/hemiazygos veins → superior vena cava

### 4. Rectal Anastomoses:

Portal vein → inferior mesenteric vein → superior rectal (hemorrhoidal) veins → middle/inferior rectal (hemorrhoidal) veins → internal iliac vein → inferior vena cava

Usually, the aforementioned collateral circulation has to do with small vessels, which are not suitable for larger amounts of blood. Due to the increased pressure, they expand and can become visible.



"Hepatic portal vein. Formation variation" Image by Lecturio

The anastomosis through the veins of the esophagus forms esophageal varices. These thin veins may stretch to the point that they can burst, causing an upper intestinal hemorrhage. Chronic bleeding causes anemia, and acute situations can be life-threatening (see 1).

A phenomenon on the skin of the abdomen in which protruding veins develop around the umbilicus is called caput medusae. They arise through the bypass circuit over the re-opened umbilical veins (see 2).

The paraumbilical vein passes along the round ligament of the liver to join with superficial epigastric veins that drain into the external iliac. If these become dilated, the surface of the skin is elevated and these varicose veins radiate from the umbilicus as caput-medusae (see 3).

In the case of the colic vein, small branches from the colic veins unite with retroperitoneal veins that drain into the inferior vena cava (see 3).

The overfilling of the rectal veins causes hemorrhoids. These can also be extended to such an extent that they burst (see 4).

**Shunting procedures have emerged** to decompress the portal system in cases of severe hemorrhage but relatively preserved liver function. The most common are:

<b>Splenorenal shunt</b>	Decompression of the portal system via an anastomosis between the left renal vein and splenic vein
<b>Portocaval shunt</b>	Decompression of the portal system via an anastomosis between the portal vein and inferior vena cava
<b>TIPS procedure</b>	An interventional radiologic procedure designed to create an intrahepatic connection between an intrahepatic branch of the portal vein and hepatic vein

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