**Plasmapheresis**

**https://en.wikipedia.org/wiki/Plasmapheresis**

**Plasmapheresis** (from the [Greek](https://en.wikipedia.org/wiki/Greek_language) πλάσμα, *plasma*, something molded, and ἀφαίρεσις *aphairesis*, taking away) is the removal, treatment, and return or exchange of [blood plasma](https://en.wikipedia.org/wiki/Blood_plasma) or components thereof from and to the [blood circulation](https://en.wikipedia.org/wiki/Circulatory_system). It is thus an [extracorporeal therapy](https://en.wikipedia.org/wiki/Extracorporeal_therapy) (a medical procedure performed outside the body).

Three general types of plasmapheresis can be distinguished:

* *Autologuous*, removing blood plasma, treating it in some way, and returning it to the same person, as a therapy.
* *Exchange*, removing blood plasma and exchanging it with [blood products](https://en.wikipedia.org/wiki/Blood_product) to be donated to the recipient. This type is called **plasma exchange** (**PE**, **PLEX**, or **PEX**) or **plasma exchange therapy** (**PET**). The removed plasma is discarded and the patient receives replacement donor plasma, [albumin](https://en.wikipedia.org/wiki/Albumin), or a combination of albumin and [saline](https://en.wikipedia.org/wiki/Saline_%28medicine%29) (usually 70% albumin and 30% saline).
* *Donation*, removing blood plasma, separating its components, and returning some of them to the same person while holding out others to become [blood products](https://en.wikipedia.org/wiki/Blood_product) donated by the donor. In such a [plasma donation](https://en.wikipedia.org/wiki/Blood_donation#Apheresis) procedure, blood is removed from the body, [blood cells](https://en.wikipedia.org/wiki/Blood_cells) and plasma are separated, and the blood cells are returned while the plasma is collected and frozen to preserve it for eventual use as [fresh frozen plasma](https://en.wikipedia.org/wiki/Fresh_frozen_plasma) or as an ingredient in the manufacture of a variety of medications.[[1]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-Frozen-1)

Plasmapheresis of the autologous and exchange types is used to treat a variety of disorders, including those of the [immune system](https://en.wikipedia.org/wiki/Immune_system), such as [Goodpasture's syndrome](https://en.wikipedia.org/wiki/Goodpasture%27s_syndrome%22%20%5Co%20%22Goodpasture%27s%20syndrome),[[2]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-MedlinePlus-2) [Guillain–Barré syndrome](https://en.wikipedia.org/wiki/Guillain%E2%80%93Barr%C3%A9_syndrome%22%20%5Co%20%22Guillain%E2%80%93Barr%C3%A9%20syndrome), [lupus](https://en.wikipedia.org/wiki/Lupus), [myasthenia gravis](https://en.wikipedia.org/wiki/Myasthenia_gravis),[[3]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-3)[[4]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-4) and [thrombotic thrombocytopenic purpura](https://en.wikipedia.org/wiki/Thrombotic_thrombocytopenic_purpura).

Medical uses

During plasmapheresis, [blood](https://en.wikipedia.org/wiki/Blood) (which consists of blood cells and a clear liquid called plasma) is initially taken out of the body through a needle or previously implanted [catheter](https://en.wikipedia.org/wiki/Catheter). Plasma is then removed from the blood by a cell separator. Three procedures are commonly used to [separate](https://en.wikipedia.org/wiki/Blood_fractionation) the plasma from the blood cells, with each method having its own advantages and disadvantages:

* Discontinuous flow [centrifugation](https://en.wikipedia.org/wiki/Centrifugation): One venous catheter line is required. Typically, a 300 ml batch of blood is removed at a time and centrifuged to separate plasma from blood cells.
* Continuous flow centrifugation: Two venous lines are used. This method requires slightly less blood volume out of the body at any one time, as it is able to continuously spin out plasma.
* Plasma [filtration](https://en.wikipedia.org/wiki/Filtration): Two venous lines are used. The plasma is filtered using standard [hemodialysis](https://en.wikipedia.org/wiki/Hemodialysis) equipment. This continuous process requires that less than 100 ml of blood be outside the body at one time.

After plasma separation, the blood cells are returned to the person undergoing treatment, while the plasma, which contains the [antibodies](https://en.wikipedia.org/wiki/Antibodies), is first treated and then returned to the patient in traditional plasmapheresis. Rarely, other replacement fluids, such as [hydroxyethyl starch](https://en.wikipedia.org/wiki/Hydroxyethyl_starch), may be used in individuals who object to blood transfusion but these are rarely used due to severe side-effects. Medication to keep the blood from clotting (an [anticoagulant](https://en.wikipedia.org/wiki/Anticoagulant)) is given to the patient during the procedure.

Plasmapheresis is used as a therapy in particular [diseases](https://en.wikipedia.org/wiki/Disease). It is an uncommon treatment in the United States, but it is more common in Europe and particularly Japan.[[5]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-5)

An important use of plasmapheresis is in the therapy of [autoimmune disorders](https://en.wikipedia.org/wiki/Autoimmune_disorder), where the rapid removal of disease-causing [autoantibodies](https://en.wikipedia.org/wiki/Autoantibodies) from the circulation is required in addition to other medical therapy. It is important to note that plasma exchange therapy in and of itself is useful to temper the disease process, while simultaneous medical and [immunosuppressive therapy](https://en.wikipedia.org/wiki/Immunosuppressive_therapy) is required for long-term management. Plasma exchange offers the quickest short-term answer to removing harmful autoantibodies; however, the production of autoantibodies by the immune system must also be suppressed, usually by the use of medications such as [cyclophosphamide](https://en.wikipedia.org/wiki/Cyclophosphamide), [cyclosporine](https://en.wikipedia.org/wiki/Cyclosporine), [mycophenolate mofetil](https://en.wikipedia.org/wiki/Cellcept%22%20%5Co%20%22Cellcept), [prednisone](https://en.wikipedia.org/wiki/Prednisone), [rituximab](https://en.wikipedia.org/wiki/Rituximab), or a mixture of these.

Other uses are the removal of blood [proteins](https://en.wikipedia.org/wiki/Proteins) where these are overly abundant and cause [hyperviscosity syndrome](https://en.wikipedia.org/wiki/Hyperviscosity_syndrome%22%20%5Co%20%22).

**Examples of diseases that can be treated with plasmapheresis**

*Further information:*[*Apheresis § Diseases and disorders*](https://en.wikipedia.org/wiki/Apheresis#Diseases_and_disorders)

* [Acute disseminated encephalomyelitis](https://en.wikipedia.org/wiki/Acute_disseminated_encephalomyelitis) (ADEM)
* [Antiphospholipid antibody syndrome](https://en.wikipedia.org/wiki/Antiphospholipid_antibody_syndrome) (APS or APLS)
* [Behcet syndrome](https://en.wikipedia.org/wiki/Behcet_syndrome)
* [Chronic inflammatory demyelinating polyneuropathy](https://en.wikipedia.org/wiki/Chronic_inflammatory_demyelinating_polyneuropathy)
* [Goodpasture's syndrome](https://en.wikipedia.org/wiki/Goodpasture%27s_syndrome)
* [Granulomatosis with polyangiitis](https://en.wikipedia.org/wiki/Granulomatosis_with_polyangiitis)
* [Graves' disease](https://en.wikipedia.org/wiki/Graves%27_disease) in infants and neonates
* [Guillain–Barré syndrome](https://en.wikipedia.org/wiki/Guillain%E2%80%93Barr%C3%A9_syndrome)
* [HELLP syndrome](https://en.wikipedia.org/wiki/HELLP_syndrome)
* [HIV](https://en.wikipedia.org/wiki/HIV)-related [neuropathy](https://en.wikipedia.org/wiki/Neuropathy)[[6]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-6)
* [Hyperviscosity syndromes](https://en.wikipedia.org/wiki/Hyperviscosity_syndrome):
	+ [Cryoglobulinemia](https://en.wikipedia.org/wiki/Cryoglobulinemia)
	+ [Paraproteinemia](https://en.wikipedia.org/wiki/Paraproteinemia)
	+ [Waldenström macroglobulinemia](https://en.wikipedia.org/wiki/Waldenstr%C3%B6m_macroglobulinemia)
* [Idiopathic pulmonary fibrosis](https://en.wikipedia.org/wiki/Idiopathic_pulmonary_fibrosis)
* [Lambert-Eaton syndrome](https://en.wikipedia.org/wiki/Lambert-Eaton_syndrome)
* [Microscopic polyangiitis](https://en.wikipedia.org/wiki/Microscopic_polyangiitis)
* [Miller Fisher syndrome](https://en.wikipedia.org/wiki/Guillain%E2%80%93Barr%C3%A9_syndrome#Classification)[[7]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-7)
* [Multiple sclerosis](https://en.wikipedia.org/wiki/Multiple_sclerosis)
* [Myasthenia gravis](https://en.wikipedia.org/wiki/Myasthenia_gravis)
* [Neuromyelitis optica](https://en.wikipedia.org/wiki/Neuromyelitis_optica)
* [Opsoclonus myoclonus syndrome](https://en.wikipedia.org/wiki/Opsoclonus_myoclonus_syndrome)
* [PANDAS syndrome](https://en.wikipedia.org/wiki/PANDAS)
* [Pemphigus vulgaris](https://en.wikipedia.org/wiki/Pemphigus_vulgaris)
* [Recurrent focal and segmental glomerulosclerosis in the transplanted kidney](https://en.wikipedia.org/wiki/Focal_segmental_glomerulosclerosis)
* [Refsum disease](https://en.wikipedia.org/wiki/Refsum_disease)
* [Rhabdomyolysis](https://en.wikipedia.org/wiki/Rhabdomyolysis)
* [Systemic sclerosis](https://en.wikipedia.org/wiki/Systemic_sclerosis) (scleroderma)[[8]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-8)
* [Thrombotic thrombocytopenic purpura](https://en.wikipedia.org/wiki/Thrombotic_thrombocytopenic_purpura) (TTP) / [hemolytic uremic syndrome](https://en.wikipedia.org/wiki/Hemolytic_uremic_syndrome)
* [Toxic epidermal necrolysis](https://en.wikipedia.org/wiki/Toxic_epidermal_necrolysis) (TEN)
* [Transverse myelitis](https://en.wikipedia.org/wiki/Transverse_myelitis)

**Complications of plasmapheresis therapy**

Though plasmapheresis is helpful in certain medical conditions, like any other therapy, there are potential risks and complications. Insertion of a rather large [intravenous](https://en.wikipedia.org/wiki/Intravenous) catheter can lead to bleeding, lung puncture (depending on the site of catheter insertion), and, if the catheter is left in too long, it can get infected.

Aside from placing the catheter, the procedure itself has complications. When patient blood is outside of the body passing through the plasmapheresis machine, the blood has a tendency to clot. To reduce this tendency, in one common protocol,[[*which?*](https://en.wikipedia.org/wiki/Wikipedia%3AAvoid_weasel_words)] [sodium citrate](https://en.wikipedia.org/wiki/Sodium_citrate) is infused while the blood is running through the circuit. Citrate binds to [calcium](https://en.wikipedia.org/wiki/Calcium) in the blood, calcium being essential for blood to clot. Citrate is very effective in preventing blood from clotting; however, its use can lead to life-threateningly low calcium levels. This can be detected using the [Chvostek's sign](https://en.wikipedia.org/wiki/Chvostek%27s_sign%22%20%5Co%20%22Chvostek%27s%20sign) or [Trousseau's sign](https://en.wikipedia.org/wiki/Trousseau_sign_of_latent_tetany). To prevent this complication, calcium is infused intravenously while the patient is undergoing the plasmapheresis; in addition, calcium supplementation by mouth may also be given.

Other complications include:

* Bleeding or [hematoma](https://en.wikipedia.org/wiki/Hematoma) from needle placement
* [Hypotension](https://en.wikipedia.org/wiki/Hypotension)
* Potential exposure to blood products, with risk of [transfusion reactions](https://en.wikipedia.org/wiki/Transfusion_reaction) or transfusion transmitted diseases
* Suppression of the patient's [immune system](https://en.wikipedia.org/wiki/Immune_system)

Donation procedure



Plasma donation uses two lines - a single needle connects to one line that splits into an outgoing line and a return line. A spur can also be seen that is used for collecting test samples of the whole blood.



Detail shows the process as the return line is filling for the first time.



Detail shows the process when the return line is full.

Donating plasma is similar in many ways to [whole blood donation](https://en.wikipedia.org/wiki/Blood_donation), though the end product is used for different purposes. Most plasmapheresis is for [fractionation](https://en.wikipedia.org/wiki/Plasma_fractionation) into other products; other blood donations are transfused with relatively minor modifications. Plasma that is collected solely for further manufacturing is called Source Plasma.

Plasma donors undergo a screening process to ensure both the donor's safety and the safety of the collected product. Factors monitored include [blood pressure](https://en.wikipedia.org/wiki/Blood_pressure), [pulse](https://en.wikipedia.org/wiki/Pulse), temperature, total protein, [protein electrophoresis](https://en.wikipedia.org/wiki/Protein_electrophoresis), health history screening similar to that for [whole blood](https://en.wikipedia.org/wiki/Blood_Donation), as well as an annual physical exam with a licensed physician or an approved physician substitute under the supervision of the physician. Donors are screened at each donation for viral diseases that can be transmitted by blood, sometimes by multiple methods. For example, donations are tested for [HIV](https://en.wikipedia.org/wiki/HIV) by [ELISA](https://en.wikipedia.org/wiki/ELISA), which shows if they have been exposed to the disease, as well as by nucleic acid methods ([PCR](https://en.wikipedia.org/wiki/PCR) or similar) to rule out recent infections that the ELISA test might miss and are also screened for [hepatitis B](https://en.wikipedia.org/wiki/Hepatitis_B) and [hepatitis C](https://en.wikipedia.org/wiki/Hepatitis_C). Industry standards require at least two sets of negative test results before the collected plasma is used for injectable products. The plasma is also treated in processing multiple times to inactivate any virus that was undetected during the screening process.

In a few countries, plasma (like blood) is donated by unpaid volunteers. In others, including the United States, Austria, Germany and some Canadian facilities plasma donors are paid for their donations.[[9]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-9) Standards for donating plasma are set by national regulatory agencies such as the [U.S. Food and Drug Administration](https://en.wikipedia.org/wiki/Food_and_Drug_Administration_%28United_States%29) (FDA),[[10]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-10) the [European Union](https://en.wikipedia.org/wiki/European_Union), and by a professional organization, the Plasma Protein Therapeutics Association (or PPTA),[[11]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-11) which audits and accredits collection facilities. A National Donor Deferral Registry (NDDR) is also maintained by the PPTA for use in keeping donors with prior positive [viral](https://en.wikipedia.org/wiki/Virus) [antibody](https://en.wikipedia.org/wiki/Antibody) test results from donating at any facility.

Almost all plasmapheresis in the US is performed by automated methods.[[12]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-12) In some cases, automated plasmapheresis is used to collect plasma products like [fresh frozen plasma](https://en.wikipedia.org/wiki/Fresh_frozen_plasma) for direct transfusion purposes, often at the same time as [plateletpheresis](https://en.wikipedia.org/wiki/Plateletpheresis%22%20%5Co%20%22Plateletpheresis). These procedures are performed at facilities such as [community blood centers](https://en.wikipedia.org/wiki/List_of_blood_donation_agencies_in_the_United_States).[[13]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-13)

Since returning [red cells](https://en.wikipedia.org/wiki/Red_cells) causes the body to replace plasma more rapidly, a donor can provide up to a liter of plasma at a time and can donate with only a few days between donations, unlike the 56-day deferral for [blood donation](https://en.wikipedia.org/wiki/Whole_blood_donation). The amount allowed in a donation varies vastly from country to country, but generally does not exceed two donations, each as much as a liter (one-third of the total plasma volume), per seven-day period. If a significant amount of red blood cells cannot be returned, the donor may not donate for 56 days, just as if they had donated a unit of blood. Depending on the collection system and the operation, the removed plasma may be replaced by [saline](https://en.wikipedia.org/wiki/Saline_%28medicine%29). The body typically replaces the collected volume within 24 hours, and donors typically donate up to twice a week, though this varies by country.

The collected plasma is promptly frozen at lower than -20 °C (-4 °F) and is typically shipped to a processing facility for fractionation. This process separates the collected plasma into specific components, such as [albumin](https://en.wikipedia.org/wiki/Albumin) and [immunoglobulins](https://en.wikipedia.org/wiki/Immunoglobulins), most of which are made into medications for human use. Sometimes the plasma is thawed and transfused as Fresh Frozen Plasma (FFP), much like the plasma from a normal blood donation.

**Manual method**

For the manual method, approximately the same as a [whole blood donation](https://en.wikipedia.org/wiki/Blood_donation) is collected from the donor. The collected blood is then separated by centrifuge machines in separate rooms, the plasma is pressed out of the collection set into a satellite container, and the red blood cells are returned to the donor.

The danger with this method was that if the wrong red blood cells were returned to the donor, a serious and potentially fatal [transfusion reaction](https://en.wikipedia.org/wiki/Transfusion_reaction) could occur. Requiring donors to recite their names and ID numbers on returned bags of red cells minimized this risk. This procedure has largely become obsolete in favor of the automated method.

**Automated method**

The automated method uses a very similar process. The difference is that the collection, separation, and return are all performed inside a machine connected to the donor through a needle in the arm, typically the [antecubital vein](https://en.wikipedia.org/wiki/Cephalic_vein). There is no risk of receiving the wrong red cells.[[14]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-14) The devices used are very similar to the devices used for therapeutic plasmapheresis, and the potential for citrate toxicity is similar. The potential risks are explained to prospective donors at the first donation, and most donors tolerate the procedure well.[[15]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-15) In the UK in 2020, plasma donation is sought from volunteers who have recovered from [COVID-19](https://en.wikipedia.org/wiki/COVID-19). The process takes 560 ml (two units) of plasma in five or six consecutive cycles of about 100 ml per cycle over a period of approximately an hour.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed)]

**Antibodies**

Donors are sometimes immunized against agents such as [tetanus](https://en.wikipedia.org/wiki/Tetanus) or [hepatitis B](https://en.wikipedia.org/wiki/Hepatitis_B) so that their plasma contains the antibodies against the toxin or disease. In other donors, an intentionally incompatible unit of blood is transfused to produce antibodies to the antigens on the red cells. The collected plasma then contains these components, which are used in manufacturing of medications. Donors who are already ill may have their plasma collected for use as a positive control for laboratory testing.

History



Edwin J. Cohn & Josep Antoni Grífols Lucas at the 4th International Congress of Blood Transfusion, Lisbon, 1951.

Plasmapheresis was originally described by John Abel and [Leonard Rowntree](https://en.wikipedia.org/wiki/Leonard_Rowntree) of [Johns Hopkins Hospital](https://en.wikipedia.org/wiki/Johns_Hopkins_Hospital) in 1913.[[16]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-16) It was developed by Dr. Josep Antoni Grífols Lucas in 1950 and 1951. Grífols found that plasmapheresis allowed donors to donate more frequently without compromising their health, and this made it possible to respond more effectively to the demand for plasma. Grífols tried out the technique on himself, and, once he had confirmed that the technique was harmless, he practiced it on volunteer donors and gradually perfected it. He presented the results of his work in 1951 at the Fourth International Congress of Blood Transfusion in Lisbon, and in 1952 he published them in the [British Medical Journal](https://en.wikipedia.org/wiki/British_Medical_Journal).[[17]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-17) Michael Rubinstein was the first to use plasmapheresis to treat an immune-related disorder when he "saved the life of an adolescent boy with [thrombotic thrombocytopenic purpura (TTP)](https://en.wikipedia.org/wiki/Thrombotic_thrombocytopenic_purpura) at the …[Cedars of Lebanon Hospital](https://en.wikipedia.org/wiki/Cedars_of_Lebanon_Hospital) in Los Angeles in 1959".[[18]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-Wallace-18) The modern plasmapheresis process itself originated in the "[U.S.] [National Cancer Institute](https://en.wikipedia.org/wiki/National_Cancer_Institute) between 1963 and 1968, [where] investigators drew upon an old dairy creamer separation technology first used in 1878 and refined by [Edwin Cohn](https://en.wikipedia.org/wiki/Edwin_Joseph_Cohn)'s centrifuge marketed in 1953."[[18]](https://en.wikipedia.org/wiki/Plasmapheresis#cite_note-Wallace-18)