Apheresis

The process of apheresis involves removal of whole blood from a patient or donor. Within an instrument that is essentially designed as a centrifuge, the components of whole blood are separated. One of the separated portions is then withdrawn and the remaining components are retransfused into the patient or donor.

The components which are separated and withdrawn include:

- Plasma (plasmapheresis)
- Platelets (plateletpheresis)
- Leukocytes (leukapheresis)

In the diagram below, the process is illustrated. Whole blood is introduced into a chamber that is spinning, and the blood separates into components (P = plasma; PRP = platelet rich plasma; WBC = leukocytes; RBC = red blood cells) by gravity along the wall of the chamber. The component to be removed can be selected by moving the level of the aspiration device at the right. In this example, plasma is being removed.

Therapeutic Apheresis

The purpose of therapeutic apheresis is to remove a component of the blood which contributes to a disease state. Examples include:

- Plasmapheresis: within the plasma are contained antibodies and antigen-antibody complexes that may contribute to the deleterious effects of autoimmune diseases. Removal of the plasma (and replacement with saline solution) will help to reduce circulating antibodies and immune complexes. In rare circumstances, excess blood proteins are present that may cause circulatory problems. Examples of these diseases include:
- Waldenstrom’s macroglobulinemia
- Myasthenia gravis
- Guillain-Barré syndrome
- Hyperviscosity Syndromes
- Paraproteinemia
- Cryoglobulinemia
- Goodpasture’s syndrome

- Plateletpheresis: rarely, in myeloproliferative disorders, the platelet count can be very high (thrombocytosis). Removal of platelets can help to avoid complications of thrombosis and bleeding.
- Leukapheresis: in some cases of leukemia with very high white blood cell counts, removal of the excess leukocytes may help to prevent complications of thrombosis.
- Stem Cell Harvesting: the small number of circulating bone marrow stem cells can be harvested to use in transplantation procedures.

## Method

Depending on the substance that is being removed, different processes are employed in apheresis. If separation by weight is required, centrifugation is the most common method. Other methods involve absorption onto beads coated with an absorbent material and filtration.

The centrifugation method can be divided into two basic categories:

- Continuous flow centrifugation (CFC)

  Continuous flow centrifugation (CFC) historically required two venipunctures as the "continuous" means the blood is collected, spun, and returned simultaneously. Newer systems can use a single venipuncture. The main advantage of this system is the low extracorporeal volume (calculated by volume of the apheresis chamber, the donor’s hematocrit, and total blood volume of the donor) used in the procedure, which may be advantageous in the elderly and for children.

- Intermittent flow centrifugation

  Intermittent flow centrifugation works in cycles, taking blood, spinning/processing it and then giving back the necessary parts to the donor in a bolus. The main advantage is a single venipuncture site. To stop the blood from coagulating, anticoagulant is automatically mixed with the blood as it is pumped from the body into the apheresis machine.

### Centrifugation Variables

The centrifugation process itself has four variables that can be controlled to selectively remove desired components. The first is spin speed and bowl diameter, the second is "sit time" in centrifuge, the third is solutes added, and the fourth is not as easily controllable: plasma volume and cellular content of the donor. The end product in most cases is Types of apheresis.
There are numerous types of apheresis.

- **Plasmapheresis** - blood plasma. Plasmapheresis is useful in collecting FFP (fresh frozen plasma) of a particular ABO group. Commercial uses aside from FFP for this procedure include immune globulin products, plasma derivatives, and collection of rare WBC and RBC antibodies.

- **Erythrocytapheresis** - red blood cells. Erythrocytapheresis is the separation of erythrocytes from whole blood. It is most commonly accomplished using the method of centrifugal sedimentation. This process is used for red blood cell diseases such as sickle cell crises or severe malaria. The automated red blood cell collection procedure for donating erythrocytes is referred to as ‘Double Reds’ or ‘Double Red Cell Apheresis.’

- **Plateletpheresis** (thrombapheresis, thrombocytapheresis) - blood platelets. Plateletpheresis, like it sounds, is the collection of platelets by apheresis; while returning the RBC’s, WBC’s, and component plasma. The yield is normally the equivalent of between six and ten random platelet concentrates. Quality control demands the platelets from apheresis be equal to or greater than 3.0 x 10^11 in number and have a pH of equal to or greater than 6.2 in 90% of the products tested and must be used within five days.

- **Leukapheresis** - leukocytes (white blood cells). Leukopheresis is the removal of PMN's, basophils, eosinophils for transfusion into patients whose PMN's are ineffective or traditional therapy has failed. There is limited data to suggest the benefit of granulocyte infusion. The complications of this procedure are the difficulty in collection and short shelf life (24 hours at 20 to 24 C). Since the "buffy coat" layer sits directly atop the RBC layer, HES, a sedimenting agent, is employed to improve yield while minimizing RBC collection. Quality control demands the resultant concentrate be 1.0 x 10^10 granulocytes in 75% of the units tested and that the product be irradiated to avoid graft-versus-host disease (inactivate lymphocytes). Irradiation does not affect PMN function. Since there is usually a small amount of RBC's collected, ABO compatibility should be employed when feasible.

- **Stem cell harvesting** - circulating bone marrow cells are harvested to use in bone marrow transplantation.

  **Donation**
  Blood taken from a healthy donor can be separated into its component parts during blood donation, where the needed component is collected and the "unused" components are returned to the donor. Fluid replacement is usually not needed in these type of collections. There are large categories of component collections: