

# Hemostasis

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**Hemostasis** or **haemostasis** is a process which causes bleeding to stop, meaning to keep blood within a damaged blood vessel (the opposite of hemostasis is hemorrhage). It is the first stage of wound healing. This involves coagulation, blood changing from a liquid to a gel. Hemostasis has three major steps: 1) **vasoconstriction**, 2) temporary blockage of a break by a **platelet plug**, and 3) **blood coagulation**, or formation of a fibrin clot.

- **1. Vascular spasm (Vasoconstriction)** - Vasoconstriction is produced by vascular smooth muscle cells, and is the blood vessel's first response to injury. The smooth muscle cells are controlled by vascular endothelium, which releases intravascular signals to control the contracting properties. When a blood vessel is damaged, there is an immediate reflex, initiated by local sympathetic pain receptors, which helps promote vasoconstriction. The damaged vessels will constrict (vasoconstrict) which reduces the amount of blood flow through the area and limits the amount of blood loss.
- **2. Platelet plug formation-** Platelets adhere to damaged endothelium to form a platelet plug (*primary hemostasis*) and then degranulate. This process is regulated through thromboregulation. Plug formation is activated by a glycoprotein called Von Willebrand factor (vWF), which is **found** in plasma. When platelets come across the injured endothelium cells, they change shape, release granules and ultimately become 'sticky'.. Platelets release cytoplasmic

granules such as adenosine diphosphate (ADP) , serotonin and thromboxane A2 and prostaglandins .

- (ADP) attracts more platelets to the affected area, serotonin is a vasoconstrictor and thromboxane A2 assists in platelet aggregation, vasoconstriction and degranulation , prostaglandins which maintains vasoconstriction

. As more chemicals are released more platelets stick and release their chemicals; creating a platelet plug. This is referred to as **primary hemostasis**.

Platelets are involved in following sequence of events during the hemostatic process

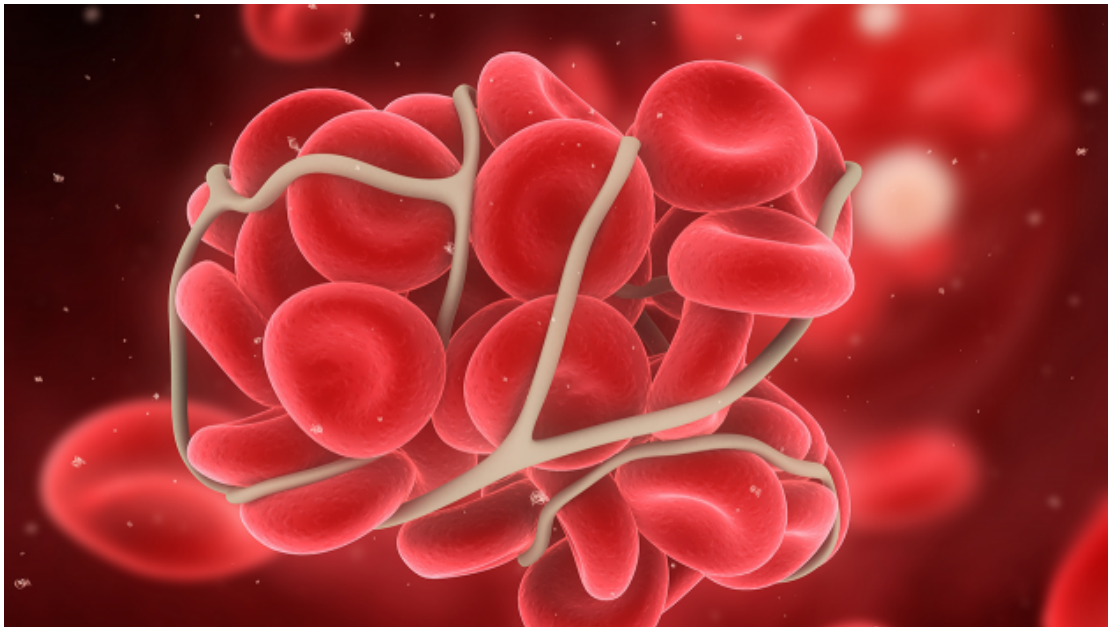
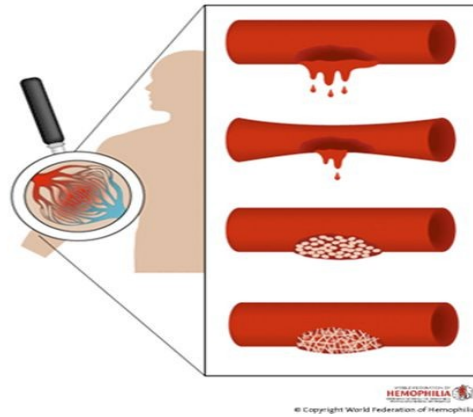
- Adherence
- Shape change
- Secretion and activation of circulating platelets (degranulation)
- Binding/aggregation of additional platelets.

**3. Clot formation** - Once the platelet plug has been formed by the platelets, the clotting factors (a dozen proteins that travel along the blood plasma in an inactive state) are activated in a sequence of events known as 'coagulation cascade' which leads to the formation of Fibrin from inactive fibrinogen plasma protein. Thus, a Fibrin mesh is produced all around the platelet plug to hold it in place; this step is called "**Secondary Hemostasis**". During this process some red and white blood cells are trapped in the mesh which causes the primary hemostasis plug to become harder: the resultant plug is called as

'thrombus' or 'Clot'. Therefore 'blood clot' contains secondary hemostasis plug with blood cells trapped in it. Though this is often a good step for [wound healing](#), it has the ability to cause severe health problems if the thrombus becomes detached from the vessel wall and travels through the circulatory system; If it reaches the brain, heart or lungs it could lead to [stroke](#), [heart attack](#), or [pulmonary embolism](#) respectively. However, without this process the healing of a wound would not be possible. <sup>[3]</sup>

## How does bleeding start and stop?

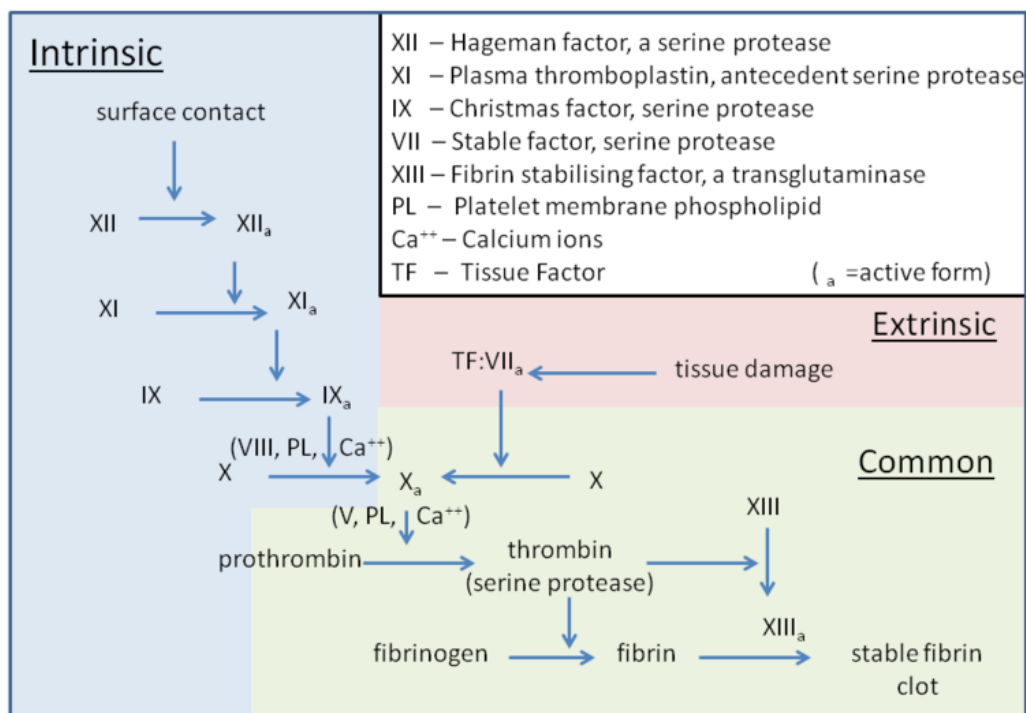
- Blood vessel injury
- The capillary contracts to help slow the bleeding.
- **Platelets** make a plug to patch the hole.
- **Clotting factors** in **plasma** work together to form a clot over the plug.



## Coagulation Cascade

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The three pathways that make up the classical blood coagulation pathway



**Extrinsic Pathway** (also known as the **tissue factor** pathway) begins when damage occurs to the surrounding tissues, such as in a traumatic injury.

**Entrinsic pathway** (also known as the contact activation pathway) is longer and more complex. In this case, the factors involved are intrinsic to (present within) the bloodstream. The pathway can be prompted by

damage to the tissues, resulting from internal factors such as arterial disease; however, it is most often initiated when factor XII (Hageman factor) comes into contact with foreign materials, such as when a blood sample is put into a glass test tube

Both of these (Extrinsic and Intrinsic) merge into a third pathway, referred to as the **common pathway**. All three pathways are dependent upon the 12 known clotting factors, including  $\text{Ca}^{2+}$  and vitamin K. Clotting factors are secreted primarily by the liver and the platelets. The liver requires the fat-soluble vitamin K to produce many of them.

## Glossary

**anticoagulant:** substance such as heparin that opposes coagulation

**antithrombin:** anticoagulant that inactivates factor X and opposes the conversion of prothrombin (factor II) into thrombin in the common pathway

**clotting factors:** group of 12 identified substances active in coagulation

**coagulation:** formation of a blood clot; part of the process of hemostasis

**common pathway:** final coagulation pathway activated either by the intrinsic or the extrinsic pathway, and ending in the formation of a blood clot

**embolus:** thrombus that has broken free from the blood vessel wall and entered the circulation

**extrinsic pathway:** initial coagulation pathway that begins with tissue damage and results in the activation of the common pathway

**fibrin:** insoluble, filamentous protein that forms the structure of a blood clot

**fibrinolysis:** gradual degradation of a blood clot

**hemophilia:** genetic disorder characterized by inadequate synthesis of clotting factors

**hemorrhage:** excessive bleeding

**hemostasis:** physiological process by which bleeding ceases

**heparin:** short-acting anticoagulant stored in mast cells and released when tissues are injured, opposes prothrombin

**intrinsic pathway:** initial coagulation pathway that begins with vascular damage or contact with foreign substances, and results in the activation of the common pathway

**plasmin:** blood protein active in fibrinolysis

**platelet plug:** accumulation and adhesion of platelets at the site of blood vessel injury

**serum:** blood plasma that does not contain clotting factors

**thrombin:** enzyme essential for the final steps in formation of a fibrin clot

**thrombosis:** excessive clot formation

**thrombus:** aggregation of fibrin, platelets, and erythrocytes in an intact artery or vein

**tissue factor:** protein thromboplastin, which initiates the extrinsic pathway when released in response to tissue damage

**vascular spasm:** initial step in hemostasis, in which the smooth muscle in the walls of the ruptured or damaged blood vessel contracts