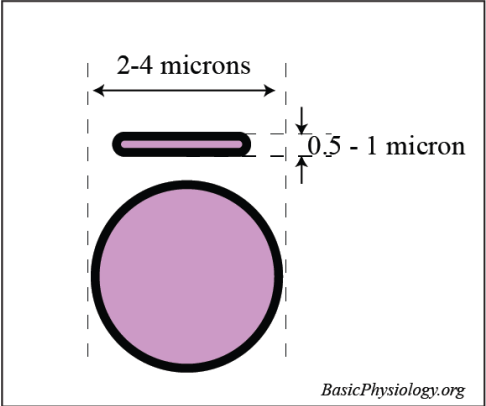
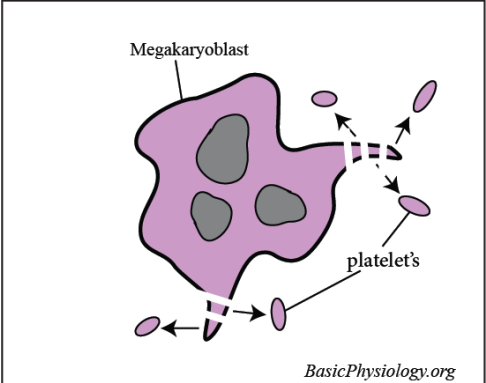


D.4. Thrombocytes & Hemostasis

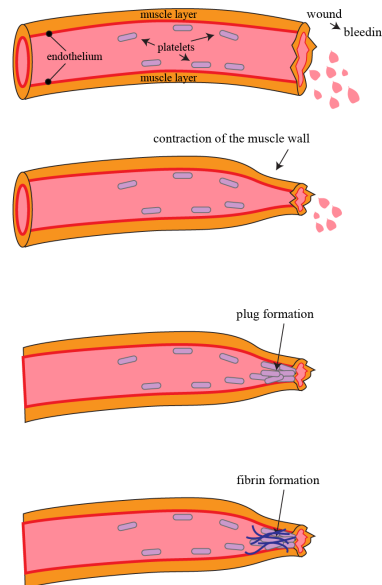
A. Thrombocytes:

1. Thrombocytes (also called platelets): - are actually small disks - do NOT have a nucleus -> therefore no reproduction - contain actin & myosin -> can therefore contract! - have an ER + Golgi apparatus -> can synthesize many enzymes - live for a short period (± 10 days)	 The diagram illustrates the size of a platelet compared to a red blood cell. The platelet is shown as a small, thin, purple disk with dimensions of 2-4 microns in length and 0.5 - 1 micron in thickness. Below it, a much larger purple circle represents a red blood cell. The source 'BasicPhysiology.org' is noted at the bottom right of the diagram.
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B. Origin of the Platelets:

1. The platelets are fragments (=pieces) from large multinucleate cells located in the bone marrow: the Megakaryoblast.	 The diagram shows a large, purple, multinucleated Megakaryoblast. It has several extensions or projections that are shown rupturing, releasing small, purple, disc-shaped platelets into the surrounding space. The source 'BasicPhysiology.org' is noted at the bottom right of the diagram.
2. The megakaryoblast develops extensions that rupture, releasing pieces of cytoplasm into the blood of a local capillary. In each fragment, the plasma membrane is quickly sealed (=closes) thereby creating a small cell (without a nucleus).	
3. There are about 250,000 - 500,000 platelets in 1 mm³ blood!	

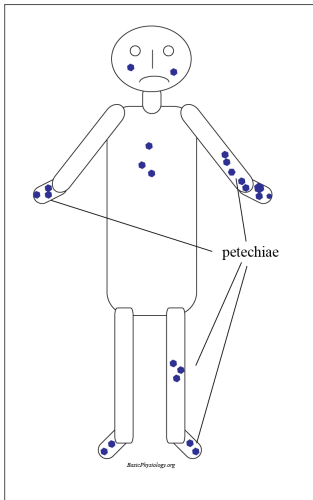
C. Hemostasis (stop the bleeding):

1. One of the major functions of the platelets is to stop bleeding! This process is called “hemostasis” (<i>hemo</i> = blood and “<i>stasis</i>” = stop/quiet/ or static).	2. Don’t confuse “hemostasis” with “homeostasis”. This is a very different process! (<i>link: A.1.2. Physiological Concepts</i>).
3. I have tried to show you in this diagram how this hemostasis works: please note that there is a layer of endothelial cells lining the blood vessels, located between the streaming blood and the muscles in the wall of the blood vessel.	
4. When a wound occurs, at first, the muscles will contract. This will cause a vascular spasm. This is initiated by many factors such as release of local chemicals (potassium ions) from damaged endothelial cells and platelets but also by local (pain) reflexes. This response is very fast and last for 20-30 minutes. This contraction can reduce and sometimes even stop the bleeding thereby giving time for the next step.	
5. Then the platelets in the neighborhood of injured endothelial cells start to swell and become sticky. This will make them accumulate in the neighborhood of the hole. There they start releasing chemicals such as serotonin (which prolongs the vascular spasm), ADP (which attracts additional platelets) and thromboxane A2 (which promotes both events).	6. All these factors will start to close the hole and reduce or stop even more the bleeding. However, this “plug” is very delicate and can easily be rubbed off if the next step does not occur.

7.

Coagulation: this is the name for the final blood clotting. This is a complicated process (which will be discussed in the next page) in which, as the last step, **fibrinogen** is converted into **fibrin**. The fibrinogen is already present and available in plasma and is **soluble**. Because of this coagulation step, the fibrinogen start to stick together into a mesh, a network, called **fibrin**. This fibrin is insoluble. The fibrin mesh traps the platelets and other blood cells in the plug, and makes this plug **very hard**. This is now called a (blood) **clot**.

D. Thrombocytopenia:

1. If a person suffers from a reduced number of thrombocytes (= thrombocytopenia), then she/he will have difficulty with hemostasis.	2. When a wound occurs, the first step (spasm) and the third step (clotting) are still functioning, but there will be less or no plug formation.
3. These patients typically show small purple bleedings in their skin, called petechiae.	 The diagram shows a stick figure of a human body. Small purple dots, representing petechiae, are scattered on the face, arms, and legs. A label 'petechiae' with a line points to one of these dots on the right arm. The source 'BasicPhysiology.org' is written at the bottom of the diagram.
4. This disease illustrates an important point: In daily life, because of wear and tear, we suffer constantly from (small) bleedings. The vast majority of these bleedings are not noticed because they are very small and are resolved before becoming visible.	
5. If a person however does not have enough platelets then plug formation is impaired. So, in that case, the spasms still occur (reducing the blood flow) and the third step (clotting) will also occur (because there is enough damage in that neighborhood) but there will be a small amount of blood lost in the tissue.	6. This becomes visible as small clots (purple or dark red). These petechiae most often occur where the tissue works most (wear and tear at joints, hand and feet) but can also occur in tissues inside the body, which are not visible.
7. The point this disease illustrates is that the hemostasis machine is working all the time to stop the bleeding in those (small) vessels that ruptures (also) all the time. Thank you so much for doing that!	

E. Lysis (= disintegration of a clot):

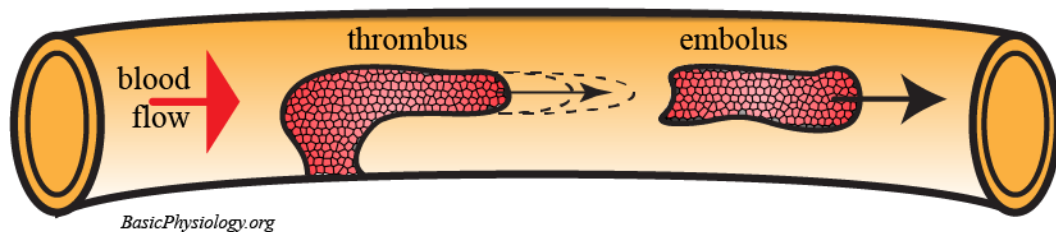
1. Because of the coagulation, hopefully the bleeding has stopped. But, this is not the end. In time, as you know, the wound has to be repaired and the clot will disappear.	2. Repairing the wound, forming new skin, blood vessels etc. is a whole process that takes some time.
3. Finally, the blood clot is also dissolved. This is the work of plasmin , which digests the fibrin threads in the clot.	4. In fact, plasmin is already in the clot when it is created, in the form of plasminogen .
5. Plasminogen is activated (to plasmin) by TPA (= tissue plasminogen activator) that is already present in the injured tissue and endothelium.	6. TPA and derivatives are now commercially available to treat clots such as in coronary arteries.

F. Excessive bleeding:

1. When a person shows excessive bleeding, this could be due to a deficiency in the clotting factors. Here are three examples	2. a) Vit. K deficiency (due to intestinal or liver diseases. Affects many clotting factor. b) Hemophilia: - shortage of factor VIII (85%) - shortage of factor IX (15%) c) Thrombocytopenia (platelet deficiency) makes the daily wear and tear visible in all our tissue (see panel D above)
3. Regarding the two hemophilia's, both are linked to the X-chromosome. Therefore the mother is carrier and the males are affected.	

G. Thrombo-embolic conditions:

1. This is a very serious complication of blood clot formation in a blood vessel, which can be deadly!	2. We start with a clot (= thrombus) formation in a blood vessel. Such a thrombus can be induced by a roughened endothelial surface of the blood vessel.
3. This 'rough' patch can be caused by arteriosclerosis (maybe due to a too high cholesterol level?), or because of a trauma or induced by an infection.	4. Or a thrombus can develop by very slow moving blood in a vessel. This can happen for example if you have to lie flat in a hospital bed for along time (> weeks), maybe because of a broken leg or something like that.



animation

5. In that situation, the blood will flow very slowly, especially in the large femoral veins in the legs.	6. And while you are lying in bed, the thrombus will slowly grow and grow and become quite long (centimeters long!).
7. So ..., at a certain point, a part of the thrombus can break off! Inside the blood vessel! This piece is then no longer attached to the wall of the blood vessel and will flow away with the blood stream.	8. This is called an embolus ! And ... where is the embolus going to flow? This depends on where the thrombus and the embolus were formed.
9. For example, in the case of our patient lying in bed for a long time, chances are that the thrombus was formed in the femoral veins. So, where does the embolus go? Back to the right heart, which it can easily pass through and then on to the lungs where it will be stuck in the capillaries!	10. If the thrombus is located in the coronary artery, then the embolus will flow into the capillaries of the heart -> heart infarct! These are all very dangerous situations!

H. Economy-class syndrome:

1. Recently, a new ‘disease’ was discovered: the economy-class syndrome .	2. A few years ago, a young lady, after a long flight, stepped out of the airplane and, while walking towards the luggage department to fetch her bags, she suddenly fainted and dropped dead!
3. Actually, with hindsight, it turns out that something like this has happened before. Not always so bad that the person died immediately, but many passengers complained of pain in the muscles, or in a limb, especially after a long flight.	4. Why? Well, because of the same thrombo-embolic process as with that person lying in bed for a long period. But in this case, people sat for a long time in a chair in an airplane. Also then, a thrombus can develop in the veins.
5. Upon arrival at the final destination, you stand up, start walking, which loosens the thrombus in your veins, this creates an embolus and that will cause pain in the capillaries where it gets stuck!	6. How can you avoid this economy-class syndrome? Move your legs, move around, at least once every hour or so, go to the toilet, even if you don’t need to, just to move your body, your muscles and especially your blood vessels.
7. By the way, the economy class syndrome is not limited to the tourist class. Passengers in first-class have the same risks of developing an embolus during a long flight if they don’t move around!	