The Vascular System: What Is It?

1

Before going to the heart of the matter, the reader, if he or she does not already have a knowledge of biology, must familiarize him- or herself with a number of commonly used concepts and terminologies. The technical terminology and terms are easily understood and do not require specific knowledge. The reader may consult them at any time in the Glossary.

As already mentioned in the foreword, blood vessels are tubes of different calibers conducting the blood to the tissues and from the tissues to the heart (Fig. 1.1).

Blood vessels are not inert conduits; they are formed during embryonic development and have plasticity throughout adult life. Far from representing a uniform category, we must distinguish between the different types of blood vessels. The first is the arteries and veins, which have different structures and functions. The second subdivision of the vascular tree is a function of size and distinguishes between large vessels and smaller vessels called arterioles, venules, and capillaries (by decreasing size). Capillaries have an essential role in the exchange of nutrients and oxygen with the tissues. They are also heterogeneous and are distinguished as fenestrated and unfenestrated capillaries. Fenestrated capillaries have small openings that allow fluids and macromolecules to pass. They are mainly present in the kidneys and the lungs.

The structure of the blood vessels depends on their size; in other words, their form and function are different and constituted as microvessels or larger vessels. Capillaries consist mainly of endothelial cells, which may be covered with a layer of so-called mural cells or pericytes (Fig. 1.2). These cells are in contact with proteins forming a basal collagen membrane. The largest vessels are formed of several layers called intima, media, and adventitia.

The intima comprises the layer of endothelial cells and components of the extracellular matrices constituting the subendothelium. The media includes smooth muscle cells that have a contractile ability. The adventitia is made up of stromal cells and associated connective tissue. The stroma is the part of a tissue made up of matrix

A. Bikfalvi, *A Brief History of Blood and Lymphatic Vessels*,
https://doi.org/10.1007/978-3-319-74376-9_1

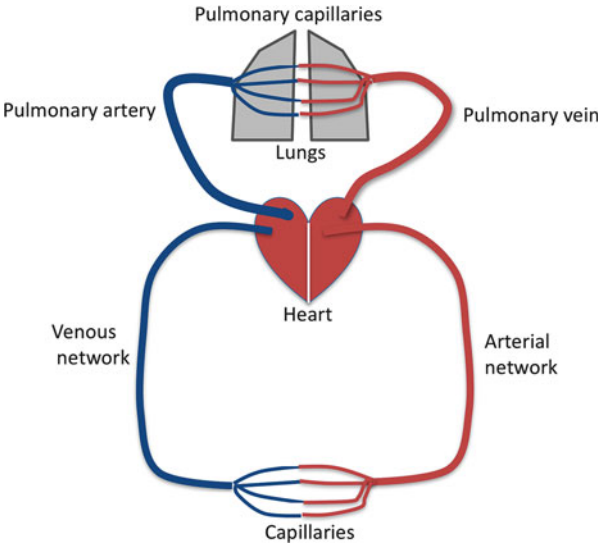

Fig. 1.1 The vertebrate blood circulatory system

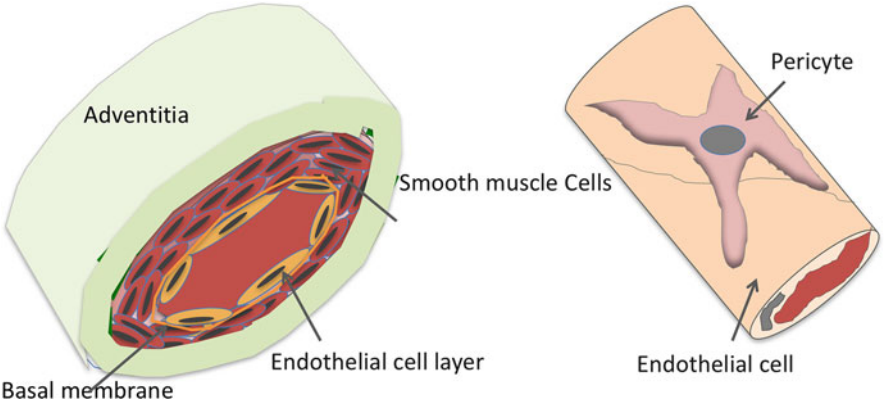

Fig. 1.2 Structure of large blood vessels and capillaries

proteins (collagen, fibronectin, etc.) and cells called fibroblasts. Fibroblasts are cells able to produce different matrix proteins.

Along with this closed circulatory system there coexists an "open" system (Fig. 1.3). The latter consists of lymphatic vessels that drain fluids from the tissues and play an important role in the immune defense of the body. Blood plasma is continuously filtered in the interstitial space, where the excess of liquid and macromolecules is drained through cell junctions made of endothelial cells. In addition, lymphatic vessels inside the intestinal villi absorb fat (lipids). Certain tissues such as skin and mucous membranes are exposed to foreign agents and antigens, and are particularly rich in lymphatic vessels.

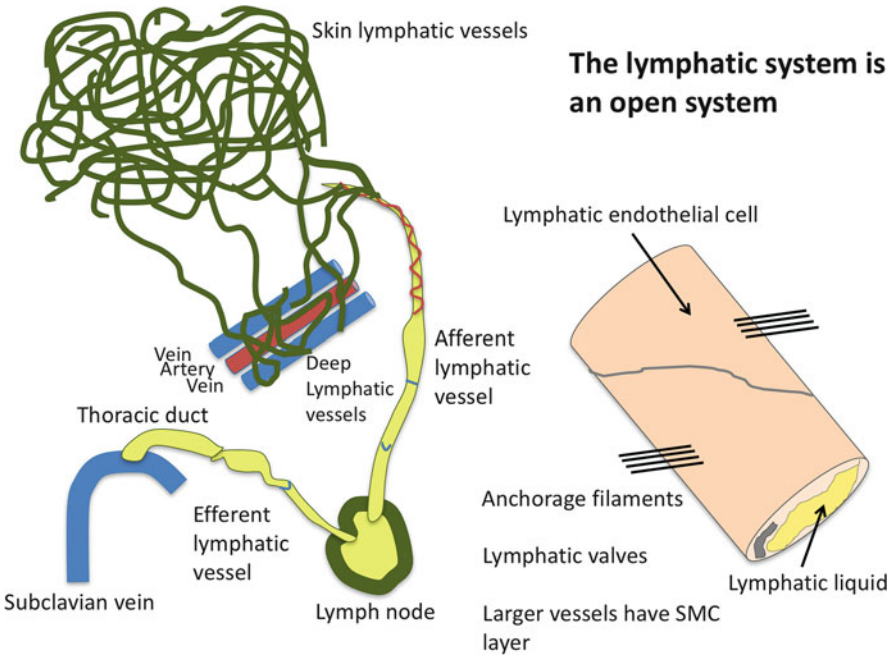

Fig. 1.3 Schematic representation of the lymphatic circulation and of the structure of a lymphatic vessel. Figure redrawn by the author, From Alitalo, Tammela and Petrova, Nature 2005, 438:946–953 [2]

Lymphatic capillaries are thin-walled vessels of about 30–80 μm diameter, composed of only one layer of lymphatic endothelial cells. Unlike the blood vessel capillaries, lymphatic capillaries generally do not have mural cells (pericytes). On the other hand, they have a discontinuous basal membrane which allows migration of immune cells such dendritic cells. Lymphatic endothelial cells also have discontinuous intercellular junctions, which allow the entry of lymphatic fluid and white blood cells into these vessels. Valves are another important structure found in lymphatics and allow the progression of the lymphatic fluid inside the lymphatic vessel, anchoring filaments made of collagen fibers and fixing the lymphatic cells to the matrix. In Fig. 1.3, the network of lymphatic vessels and their structure are shown.