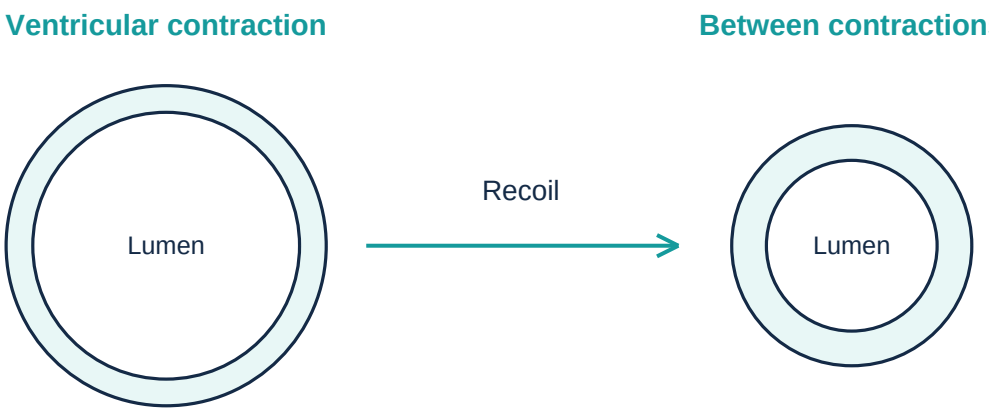
Arteries: stretch or adjust flow

Both artery types carry blood away from the heart and contain elastic tissue and smooth muscle. Their relative proportions suit different roles; neither tissue is exclusive to one type.

1. ELASTIC ARTERY: STRETCH, THEN RECOIL



Same vessel at two phases, schematically enlarged. Elastic recoil releases stored energy, sustaining arterial pressure and forward flow while the ventricle relaxes.

2. ELASTIC ARTERIES BUFFER THE PRESSURE PULSE

The aorta and other large arteries near the heart contain abundant elastic layers. Stretch accommodates the incoming surge; recoil helps keep blood moving between beats. It smooths the pulse rather than making pressure perfectly constant.

3. MUSCULAR ARTERIES DISTRIBUTE BLOOD

A relatively large smooth-muscle component changes lumen diameter. Contraction causes vasoconstriction; relaxation causes vasodilation. With the same pressure difference, narrowing raises resistance and reduces flow. Arterioles are especially important in controlling tissue blood supply.

Collagen reinforces the wall and limits excessive stretching. A thick wall withstands pressure; it does not create the pressure. Smooth muscle changes diameter actively, whereas elastic recoil is a passive response to earlier stretching.

Elastic and muscular artery organisation: University of Leeds, Arteries.
Resistance and control of flow: OpenStax Anatomy & Physiology 2e, section 20.2.

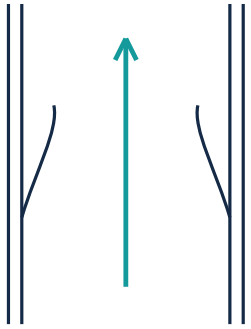
Scope: Cambridge Biology 9700 syllabus, section 8.1, outcome 4, p. 27.

Veins: return at lower pressure

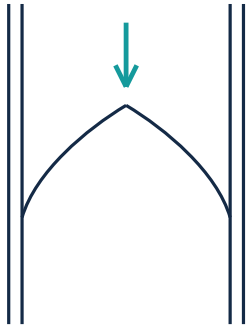
After blood crosses the tissue circulation, much of its pressure has been lost. Veins are adapted for low-pressure return to the heart, rather than for absorbing a strong arterial pulse.

1. VALVES PREVENT REVERSE FLOW

Towards the heart is upwards in both drawings



Forward flow: valve opens



Reverse pressure: valve closes

Original longitudinal schematics of one valve. Leaflets open passively with forward flow and meet when blood tends to move backwards; they do not pump blood.

2. A WIDE LUMEN OFFERS LESS RESISTANCE

Compared with an accompanying artery, a vein generally has a thinner wall with less muscle and elastic tissue, and a wider lumen. Lower resistance helps blood return despite the smaller pressure difference. Veins also accommodate a large volume of blood.

3. MUSCLE MOVEMENT HELPS VENOUS RETURN

Contracting skeletal muscles squeeze nearby veins. Valves direct the displaced blood towards the heart and prevent it falling back between contractions, especially in the limbs. Breathing-related pressure changes also assist venous return.

A thin venous wall is adequate for lower pressure, but it still contains supporting tissue. Many veins have valves, not all. Do not confuse surrounding skeletal muscles with smooth muscle in the vessel wall.

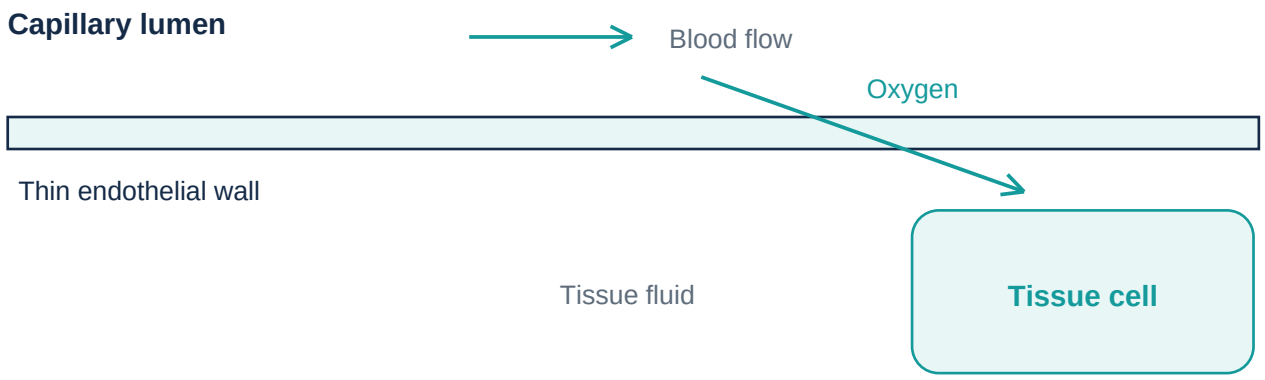
Vein walls and venous valves: OpenStax Anatomy & Physiology 2e, section 20.1.
Skeletal-muscle and respiratory pumps: OpenStax, section 20.2.

Scope: Cambridge Biology 9700 syllabus, section 8.1, outcome 4, p. 27.

Capillaries: built for exchange

Capillaries link arterioles to venules through branching networks. Their wall and arrangement minimise the distance between blood and tissue cells.

1. A SHORT ROUTE FROM BLOOD TO A CELL



One wall shown; schematic, not to scale. Oxygen diffuses through the wall and tissue fluid down its concentration gradient. Carbon dioxide can diffuse in the opposite direction.

2. THIN WALL: SHORT DIFFUSION DISTANCE

A single layer of flattened endothelial cells, supported by a basement membrane, separates blood from tissue fluid. There is no thick continuous muscle layer. Permeability allows exchange of appropriate substances; cells and most plasma proteins normally remain in the blood.

3. MANY SMALL VESSELS: LARGE EXCHANGE AREA

Dense capillary networks provide a large surface area and bring blood close to cells. A narrow lumen keeps red blood cells near the wall. Across the whole network, the large total cross-sectional area reduces average blood speed, allowing time for exchange.

Keep the two ideas separate: each capillary is narrow, but all capillaries together have a very large cross-sectional area. Slower flow is a network effect, not simply a consequence of one narrow lumen.

Capillary wall and permeability: University of Leeds, Capillaries.
Total cross-sectional area and blood speed: OpenStax, section 20.2.

Scope: Cambridge Biology 9700 syllabus, section 8.1, outcome 4, p. 27.